NFPA No.
13

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INSTALLATION OF SPRINKLER SYSTEMS 1969

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Official NFPA Definitions

Adopted Jan. 23, 1964. 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.

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Standard for the Installation of

Sprinkler Systems

NFPA No. 13 — 1969

This edition, adopted by the National Fire Protection Association on May 13, 1969, on recommendation of the Committee on Automatic Sprinklers, supersedes all previous editions.

Continued on page **13–2.**

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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.

This edition of the Standard includes amendments and editorial revisions to the 1968 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 1968 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 and 1969.

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Standard for the Installation of

Sprinkler Systems

NFPA No. 13 — 1969

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 and walkways 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. Complete sprinkler protection is desirable and recommended in all cases, but where buildings or portions of buildings of combustible construction, or containing combustible contents, are not equipped with sprinklers, standard cutoffs should be provided between the sprinklered and unsprinklered buildings or areas, with all openings protected in a standard manner and no sprinkler supply piping should be run in the unsprinklered areas. (See Standard for Fire Doors and Windows, NFPA No. 80.)

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 it is impractical to do otherwise, draft curtains extending down at least 3 inches below the deflectors of adjacent automatic sprinklers but not less than 12 inches deep, preferably constructed of substantial noncombustible material, may be provided. (See Fig. 1132.)

1133. Where required by the authority having jurisdiction in buildings of large single area, 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. 1133.) (See Guide for Smoke and Heat venting, NFPA No. 204.)

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

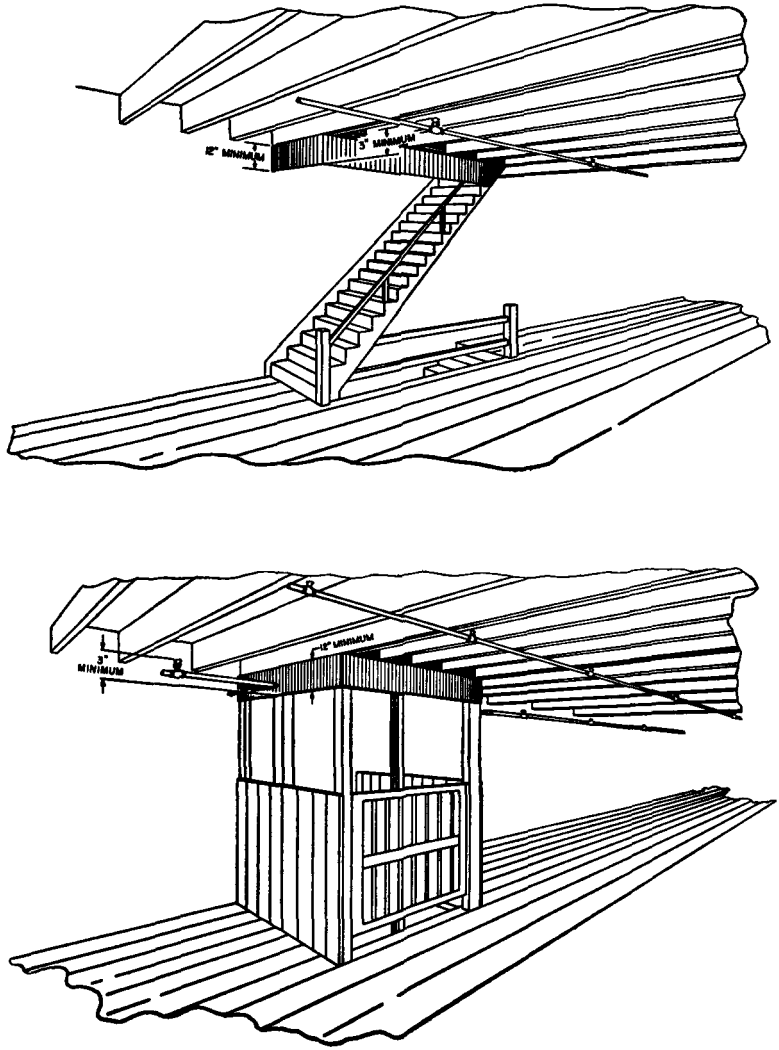


Fig. 1132. Draft Curtains around Open Stair and Elevator Shafts. Preferably of noncombustible material such as flat sheet or corrugated metal.

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.

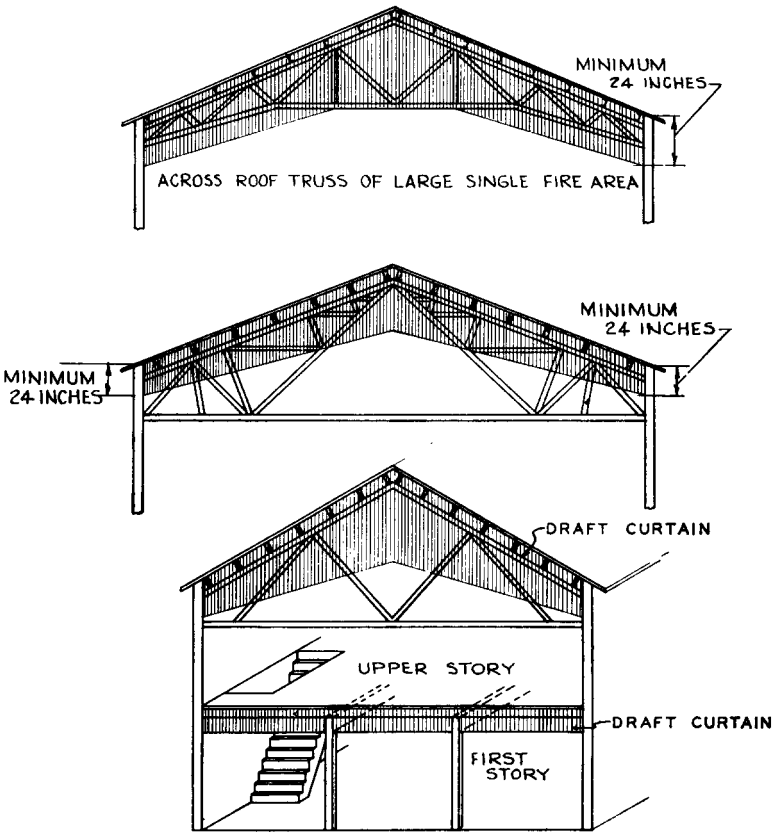


Fig. 1133. Draft Curtain for Subdivision of Large Areas. Preferably of noncombustible material such as flat sheet or corrugated metal.

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. Sprinkler systems employing limited water supplies, reduced pipe sizes and other departures from the requirements for standard systems contemplated by these rules shall not be classified as standard sprinkler systems. Systems of this type may include those pressurized with air or nitrogen. The authority having jurisdiction may recognize the degree of protection afforded by special types of sprinkler systems.

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
High Piled Combustible Storage in excess of 21 feet high
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 F 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

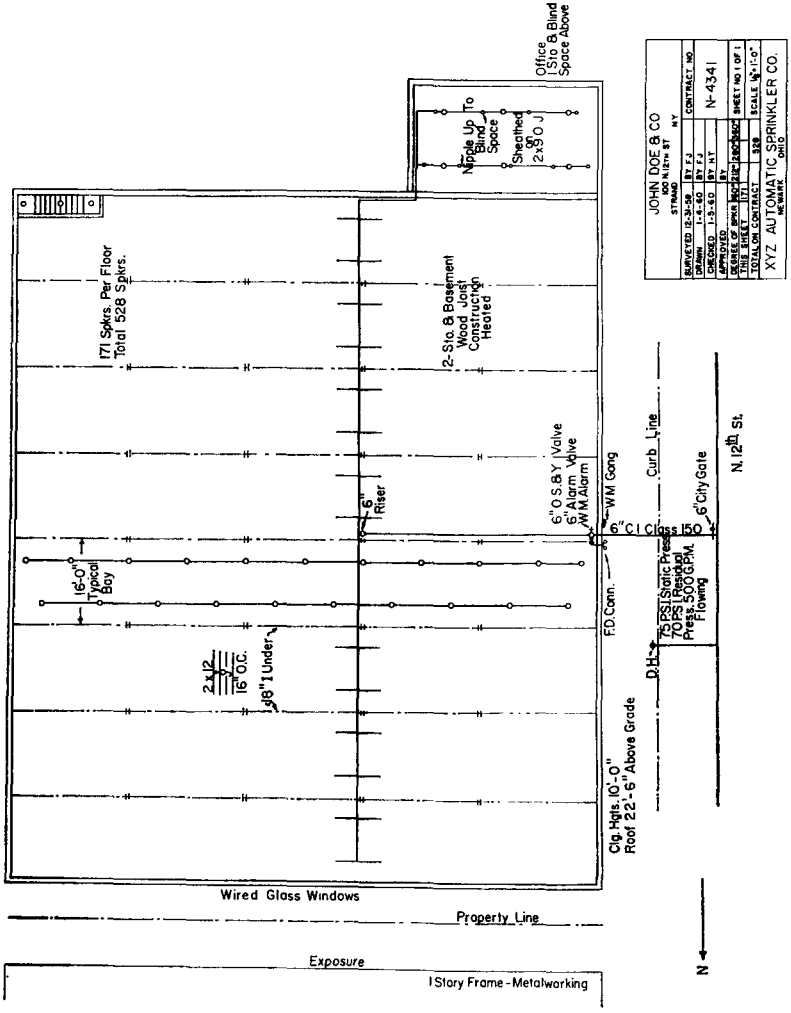


Fig. 1430. Typical Preliminary Plan.

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.

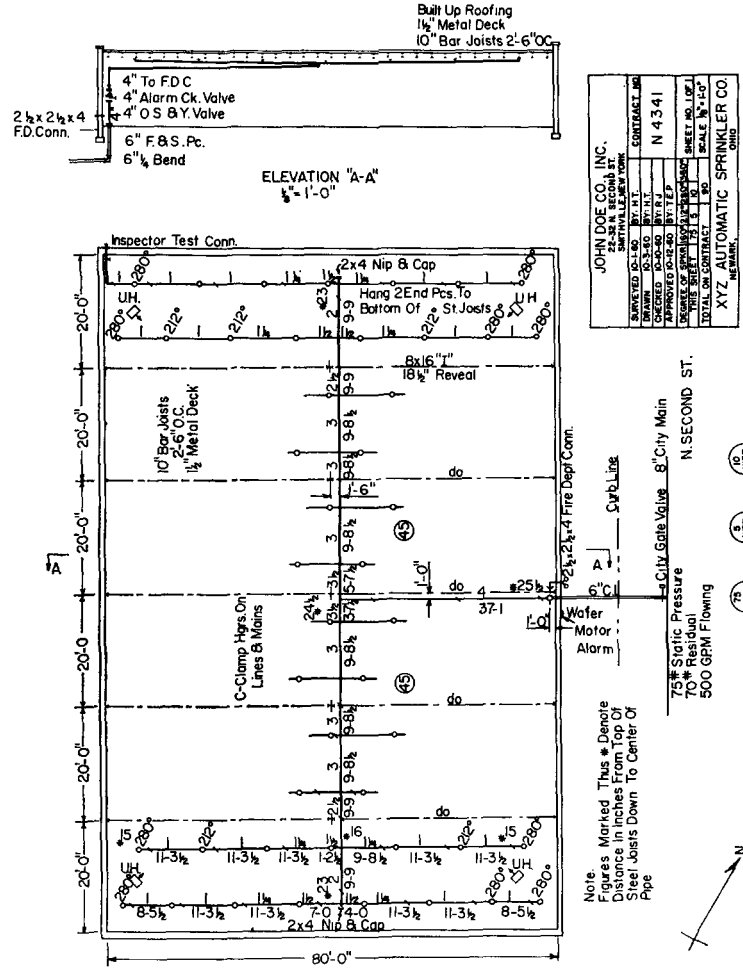


Fig. 1440-1. Typical Working Plans.

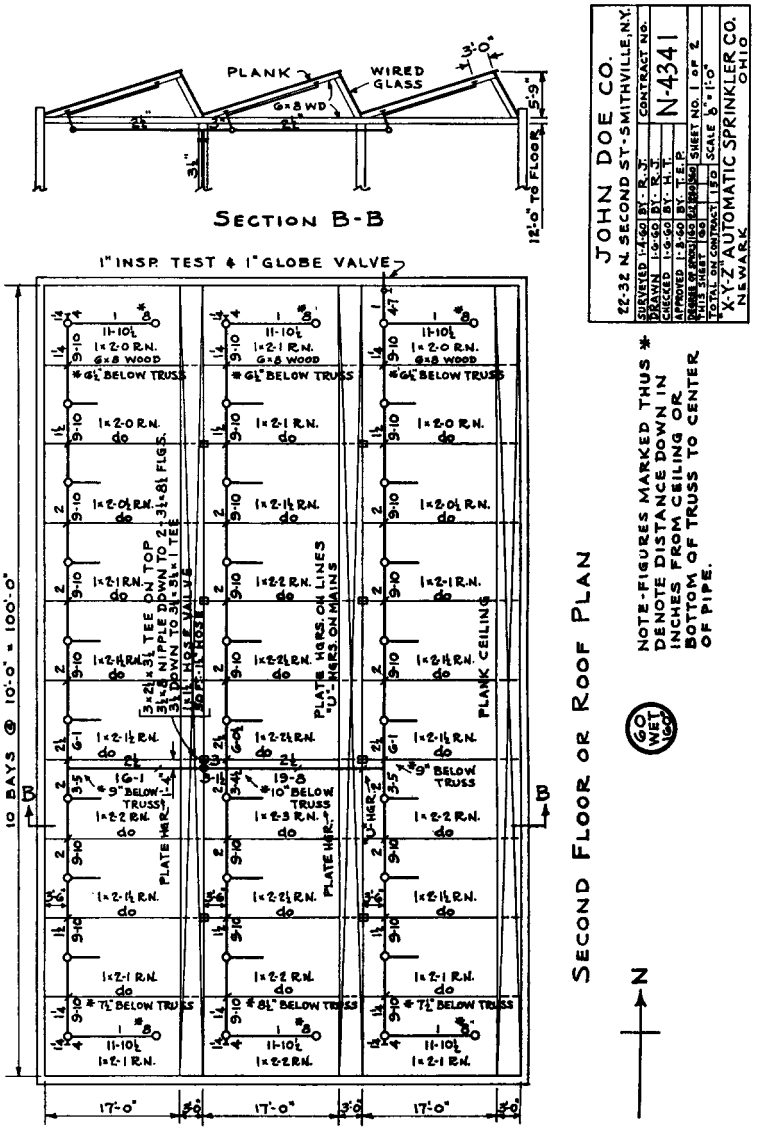


Fig. 1440-2. Typical Working Plans (cont.)

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 gates, 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.

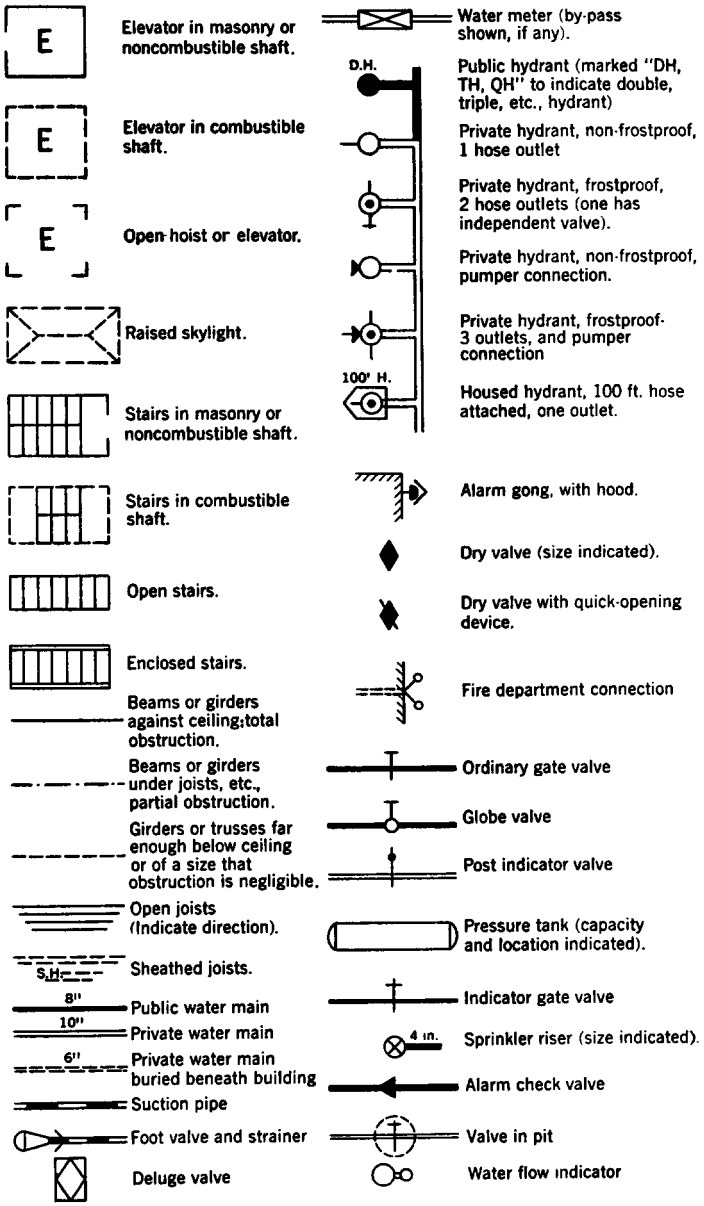
Provision for flushing. See Paragraph 3063.

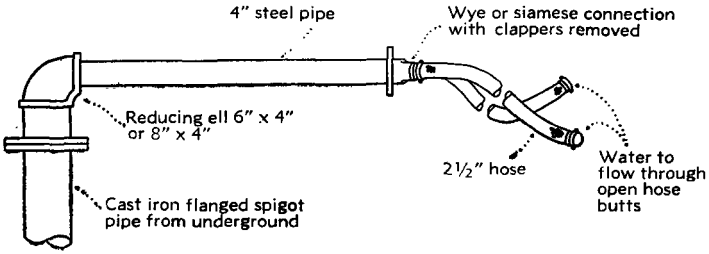
When the equipment to be installed is an addition to an old group of sprinklers without additional feed from the yard system, enough of the old system should be indicated on the plans to show the total number of sprinklers to be supplied and to make all conditions clear.

Name and address of contractor.

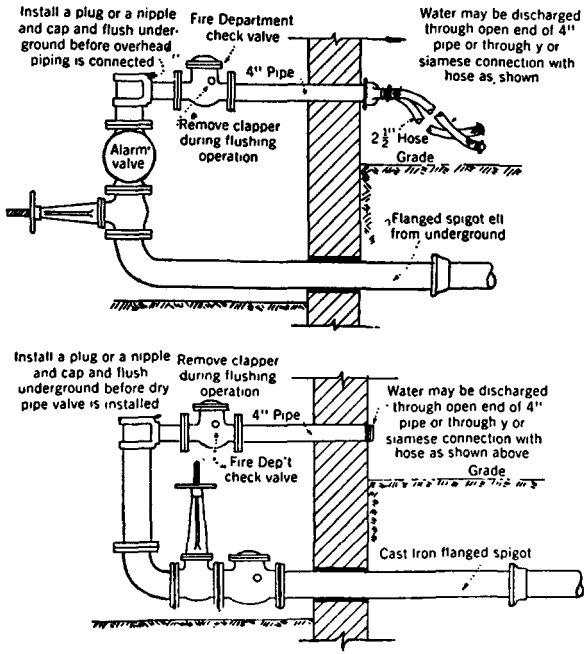
1450. Standard Plan Symbols.

1451. The Standard Plan Symbols are as follows:





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..... .....

REMARKS

Date left in service..... .....

.....

PARTS A AND B SIGNATURES

Name of sprinkler contractor..... .....

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

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

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.....

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 .....

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 Table.

2111. Guide Table 2111 is given as a general guide to determine the volume of water and pressure normally required.

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)*
LIGHT HAZARD	15 psi	500–750 gpm (See Note 3)
ORDINARY HAZARD (GROUP 1)	15 psi or higher	500–1000 gpm
ORDINARY HAZARD (GROUP 2)	15 psi or higher	500–1500 gpm
ORDINARY HAZARD (GROUP 3)	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.	
GENERAL STORAGE WAREHOUSES, SEE CHAPTER 7 AND APPENDIX A		
WOODWORKERS SEE APPENDIX B	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.

subject to approval of the authority having jurisdiction. THE TABLE IS TO BE USED ONLY WITH EXPERIENCED JUDGMENT, and the requirements for hose streams are to be added to the quantities given.

2120. Important Factors to Consider in Applying the Guide to Water Supply Requirements for Sprinkler Systems and Determination of Occupancy Classification.

2121. 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) com-

bustibility of contents, (3) areas shielded from proper distribution of water, (4) height of stock piles, (5) type of ceiling construction, (6) ceiling heights, (7) unprotected vertical openings, (8) undesirable draft conditions and (9) size of undivided areas.

2122. Where unfavorable features are prominently present, the water supply requirements should be increased.

2123. In the following tables the occupancy referred to is the occupancy of the individual building being protected.

2124. 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, 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

2125. 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

2126. 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

2127. 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

2128. 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
High piled combustible storage in excess of 21 feet high
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.

2129. 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.

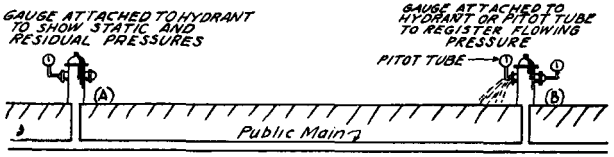


Fig. 2223. Method of Conducting Flow Tests.

(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.

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 of adequate capacity and elevation makes a good primary supply, and may be acceptable as a single supply. (See NFPA No. 22, Standard for Water Tanks for Private Fire Protection.)

2320. Capacity and Elevation.

2321. The size of the gravity tank should be at least large enough to supply the quantity of water required by guide Table 2111 for a period of 60 minutes for Light Hazard Occupancy, and 60 to 100 minutes for Ordinary Hazard Occupancy. The elevation of the tank and arrangement of underground supply piping should be sufficient so that the required delivery rate will be available at the base of the sprinkler riser at sufficient pressure to furnish the required residual pressure under the roof. Where fire department response is such as to ensure use of the fire department connection, or in the case of buildings of limited area, the size of the tank may be reduced by special permission of the authority having jurisdiction. Where a tank serves only as a secondary supply, capacity and elevation may be reduced by permission of the authority having jurisdiction.

2400. Pumps.

2410. Acceptability.

2411. A fire pump installation consisting of pump, driver and suction supply, when of adequate capacity and reliability, and properly located, makes a good secondary supply. An automatically controlled fire pump taking water from a water main of adequate volume, or taking draft under a head from a reliable storage of adequate capacity, may under certain conditions be accepted by the authority having jurisdiction as a single supply. (See NFPA No. 20, Centrifugal Fire Pumps.)

2420. Supervision.

2421. Where a centrifugal pump constitutes the sole sprinkler supply, it should be provided with supervisory service from an approved central station system or from an approved proprietary system or their substantial equivalent, which shall provide means for positive indication at the central office that the pump has operated normally. The above to be in addition to the supervision of power supply and other features that may be required by the authority having jurisdiction. These pumps should be operated at least monthly by the supervisory service representative, and at more frequent intervals where the authority having jurisdiction so requires.

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 of adequate size makes a good primary supply when used in conjunction with an adequate secondary supply. A pressure tank supply may be acceptable in some cases as a single supply. (See NFPA No. 22, Standard for Water Tanks for Private Fire Protection.)

2512. MAINTENANCE. Where a pressure tank constitutes the sole supply for sprinklers, the tank should be provided with an approved means for automatically maintaining the required air pressure on the tank. Also, there shall be provided an approved trouble alarm to indicate low air pressure and low water level, with the trouble alarm supplied from an electrical branch circuit independent of the air compressor.

2520. Capacity.

2521. The size of the pressure tank required shall be determined by the authority having jurisdiction, considering all features involved, including extra capacity needed to fill dry pipe systems. Minimum requirements 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.

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 connections 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.

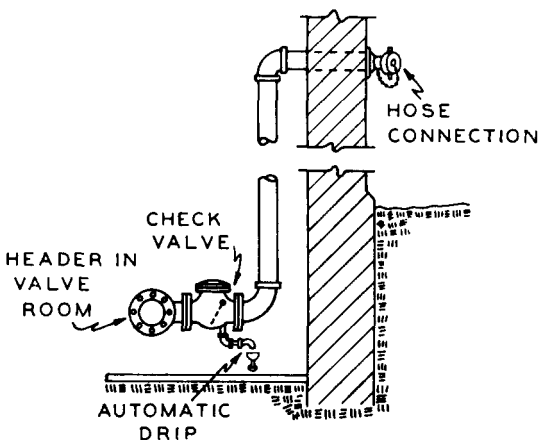


Fig. 2600. Fire Department Connection.

2630. Arrangement. See Paragraph 3424.

2631. On wet pipe systems with a single riser the connection shall be made on the system side of gate, check and alarm valves in the riser.

2632. On dry pipe systems with a single riser the connection shall be made between the gate 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." or "OPEN SPKR."

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.

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 steel piping and underground piping should be made with a properly strapped cast iron flanged piece.

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 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.)

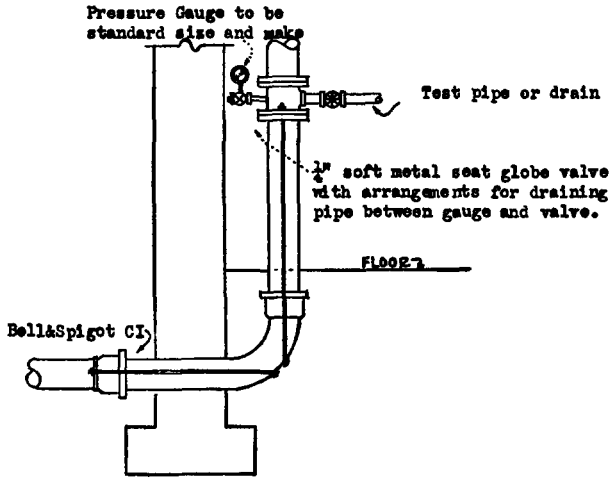


Fig. 2811-1. Test Pipe on Water Supply with Outside Control. Also applicable to an interior riser.

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

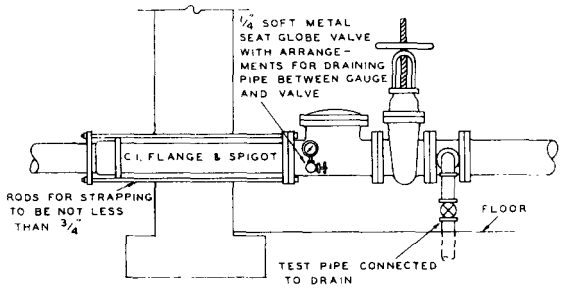


Fig. 2811-2. Water Supply Connection with Test Pipe.
Located on the system side of the gate valve, one test pipe may serve for more than one city connection. It will also indicate the condition of the gate valve. Located on the supply side of the check valve, it will serve to test out check valve by closing the waterworks gate or other outside valve.

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.

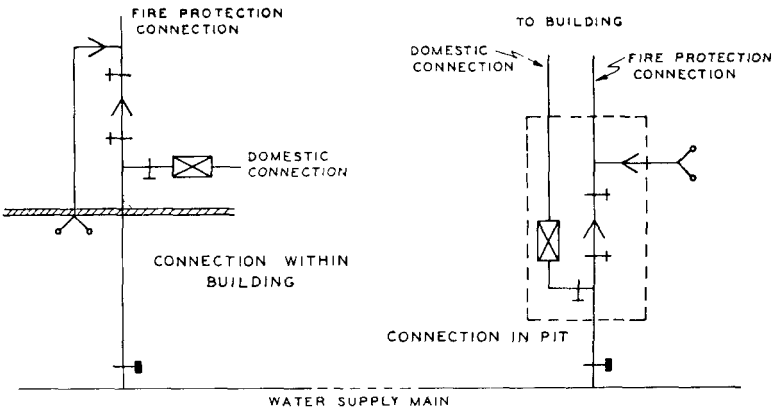


Fig. 2911. Connections for Domestic Water

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 O. S. & Y. gate 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.

TABLE NO. 3002

Material	*Standard*
Ferrous Piping (Welded and Seamless)	
Black Steel Pipe	ASTM A-120-65 USASI Standard B-36.10—1959*
Hot Dipped, Zinc Coated (Galvanized) Steel Pipe	ASTM A-120-65 USASI Standard B-36.10—1959*
Wrought Iron Pipe	ASTM A-72-64T USASI Standard B-36.10—1959*
Non-Ferrous Tube (Drawn, Seamless)	
Copper (Listed)	ASTM B-75-65 ASTM B-251-66
Brazing Alloy	AWS-ASTM Classification BCuP-3 ASTM Specification B260-62T.

*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 pipes supplying the sprinkler system.

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

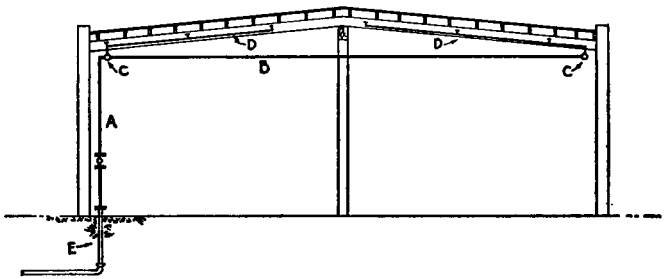


Fig. 3010. Building Elevation Showing Parts of Sprinkler Piping System. A — Riser; B — Feed Main; C — Cross Main; D — Branch Line; E — Underground Supply.

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 of Paragraphs 3020 through 3051 do not apply. 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 and Type II Storage*	52,000 sq. ft.
Ordinary Hazard, Type I Storage*	40,000 sq. ft.
Extra Hazard	25,000 sq. ft.

*As defined in Appendix A, Chapter 1.

Sprinkler spacing rules contained in Chapter 4 still apply.

3023. 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.

3024. 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.

3025. 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.

3026. 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 eight sprinklers on either side of a cross main. Pipe sizes should be as follows, except as modified by Paragraphs 3032 and 3033.

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	No limit	4 in. tube	No limit

(See Paragraph 3032)

The area protected by any one system on any one floor of one fire section shall not exceed 52,000 square feet.

3032. 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.

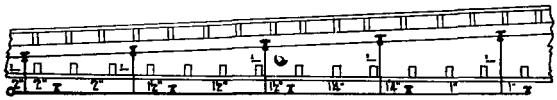


Fig. 3033-1. Arrangement of Branch Lines Supplying Sprinklers Above and Below a Ceiling.

3033. 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

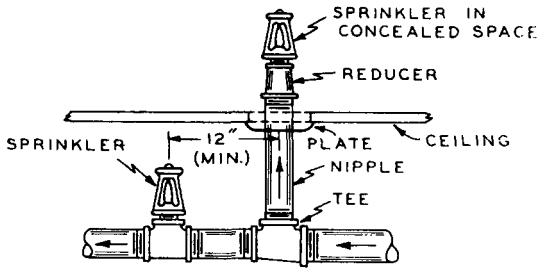


Fig. 3033-2. Sprinkler on Riser Nipple from Branch Line in Lower Fire Area.

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 eight sprinklers on either side of a cross main. Pipe sizes should be as follows, except as modified by Paragraphs 3042 and 3043.

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	400 sprinklers	8 in. tube	400 sprinklers

The area protected by any one system on any one floor of one fire section shall not exceed 52,000 square feet. This permits exceeding the number of sprinklers specified above for 8-inch pipe, except that for Type I Storage (as defined in Appendix A, Chapter 1) the area protected by one system shall not exceed 40,000 square feet.

3042. 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.

3043. 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		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 a 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
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	225 sprinklers	8 in. tube	225 sprinklers

The area protected by any one system on any one floor of one fire section shall not exceed 25,000 square feet. This permits exceeding the number of sprinklers specified above for 8-inch pipe.

3052. For open sprinkler and deluge systems pipe schedule see Paragraph 5371.

3053. For unusually severe conditions of occupancy or area,

the above pipe schedule may be inadequate and it is recommended that the systems be designed hydraulically in accordance with the provision of Chapter 7.

3060. Special Provisions Applicable to Piping.

3061. LOCATION OF RISERS. Figure 3061 shows typical riser locations. Center-central or side-central feed is recommended.

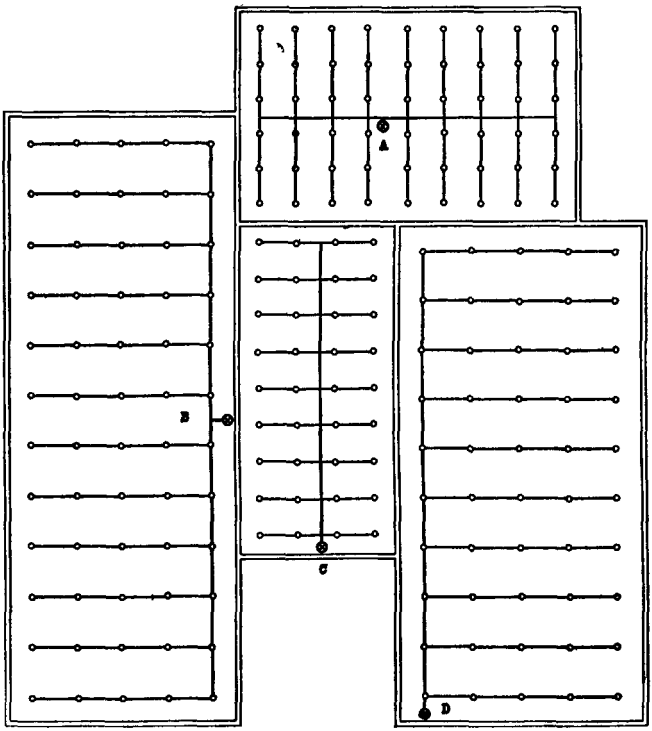


Fig. 3061. Typical riser locations.

A — Center Central Feed
B — Side Central Feed
C — Central End Feed
D — Side End Feed

Risers should not be located close to windows. They should be properly protected from mechanical injury or possible freezing.

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.

3063. 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. 3063). Flushing connections will ordinarily not be required for concealed piping systems, but will be required on deluge systems.

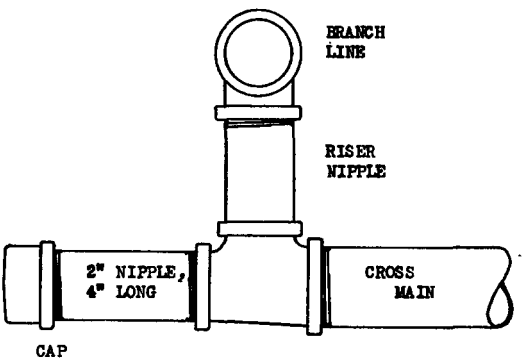
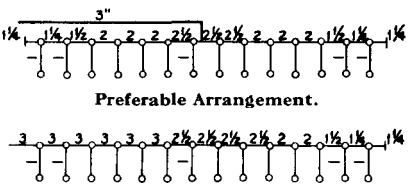


Fig. 3063. Flushing Connection.

3064. 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. 3064(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. 3064(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.

3065. 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.

3066. 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 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. (See Fig. 3066.)

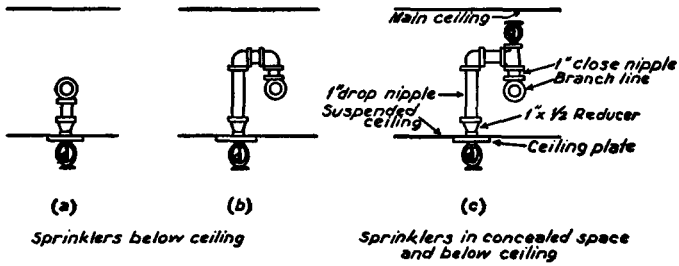


Fig. 3066. Pendent Sprinklers at Suspended Ceiling.

3067. 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.

3068. SLEEVES FOR PIPE RISERS. (See Fig. 3068.)

(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 material. 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.)

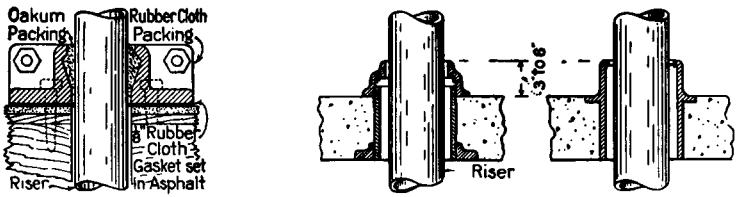
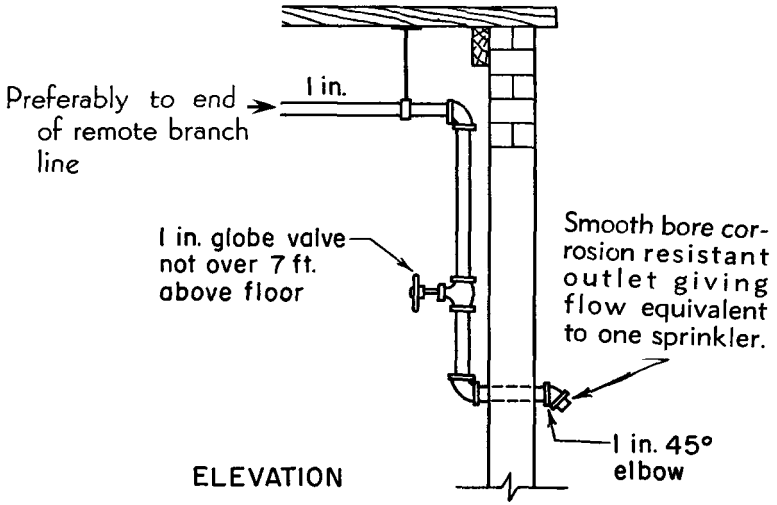


Fig. 3068. Watertight Riser Sleeves.
A — For wood or concrete floors; B and C — for concrete floors.

3069. 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.

3070. 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.)

3071. HAND HOSE CONNECTIONS. Hand hose, to be used for fire purposes only, may be attached to sprinkler pipes within a room subject to the following restrictions:



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

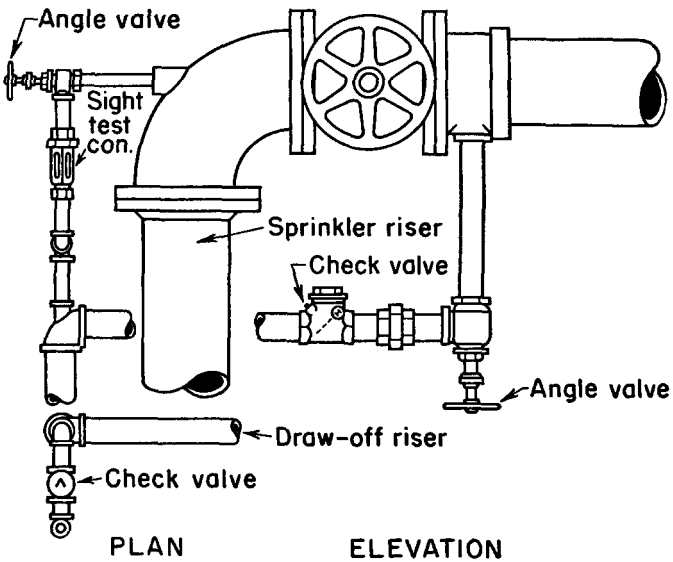


Fig. 3081. One-inch System Test Pipes on Wet-Pipe Systems.
Connect to top of main riser or to sprinkler pipe in the highest part of system. The drawing on the upper portion of the page shows the preferred arrangement. In special cases, the connection may be made in the manner shown in the lower drawing.

(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).

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. 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. 3082.)

3090. Joining of Pipe and Fittings.

3091. All threaded fittings and pipe shall have threads cut to ASME standard. 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.

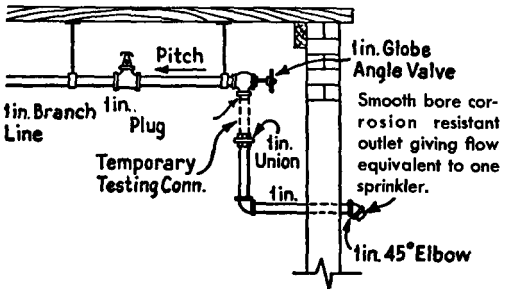


Fig. 3082. One-inch System Test Pipes on Dry-Pipe Systems.

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

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 enclosure 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.

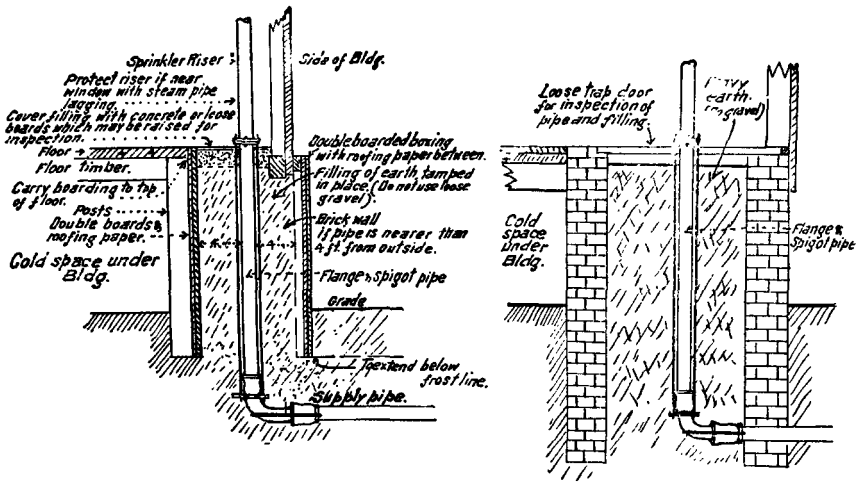


Fig. 3111. Protection of Sprinkler Risers Against Freezing.

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. In the list of special coatings are the following:

(a) A priming application of a mixture of beeswax and ozokerite dissolved in turpentine and carbon-tetrachloride, then a wrapper of lightweight canvas and finally a seal-in coating of the wax mixture.

(b) Where high temperatures and rapid oxidation are not a factor a priming coat of chlorinated rubber paint, then a complete wrapping with electrician's rubber splicing tape and a follow-up seal-in coating of rubber paint.

(c) Factory asphalt or bituminous coated and wrapped wrought pipe with coated fittings. The coating provided on this class of material gives excellent protection but great care must be used in thoroughly sealing-in all areas where the coating may be broken or damaged during installation.

3142. 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.

3143. 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.

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

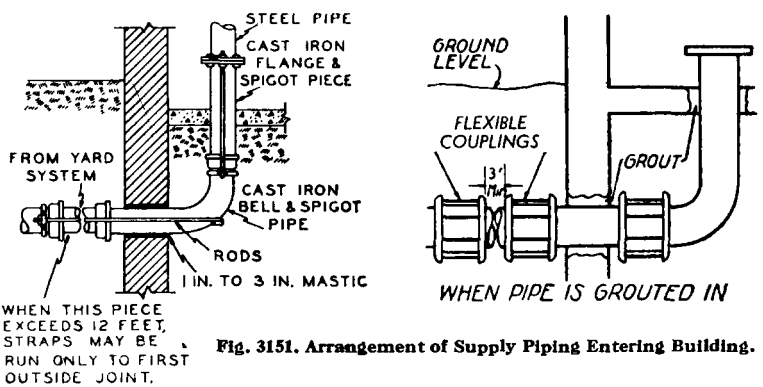


Fig. 3151. Arrangement of Supply Piping Entering Building.

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.

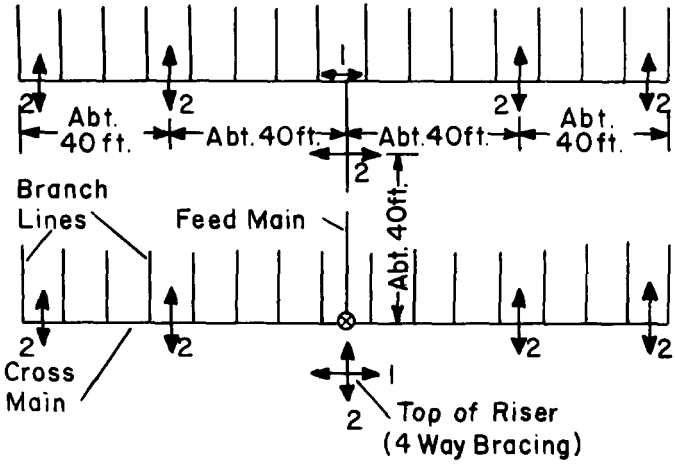
3156. Tank risers or discharge pipes should be treated the same as sprinkler risers for their portion within a building. The discharge pipe of tanks on buildings shall have a control valve above the roof line so any pipe-break within the building can be controlled.

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 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.



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.

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.

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°.

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 re-

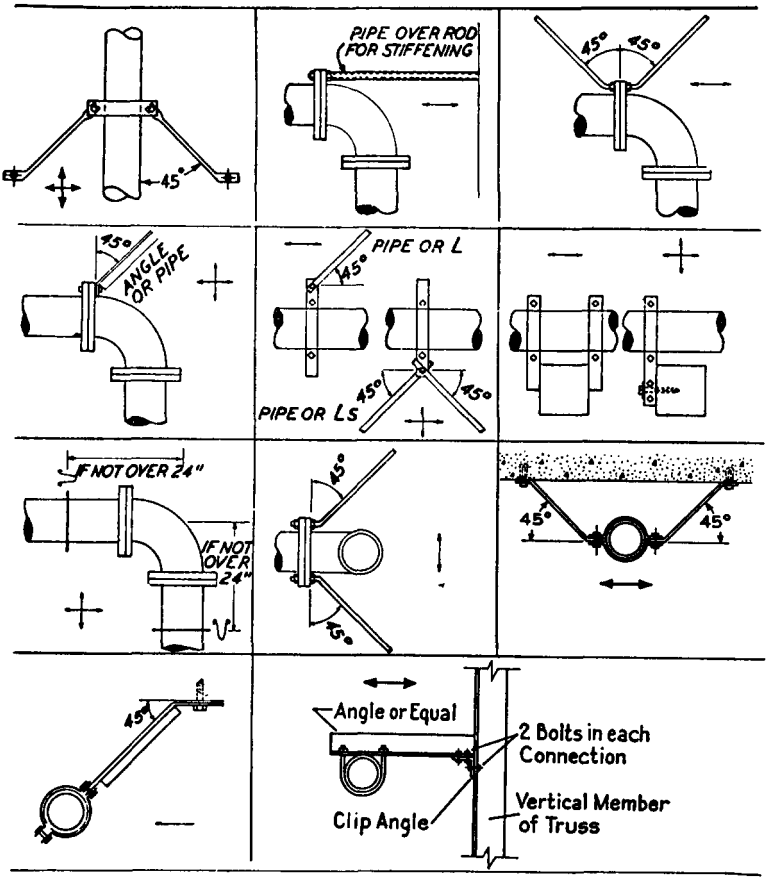


Fig. 3168. Acceptable Types of Sway Bracing.

quirements. 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 thoroughly drained. Where practicable, all piping should be arranged to drain to the main drain valve.

3212. Pipe shall be straightened before installation to prevent pockets which would interfere with proper drainage.

3213. On wet pipe systems sprinkler pipes shall be pitched not less than ¼ inch in 10 feet.

3214. 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.

3215. 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.

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.

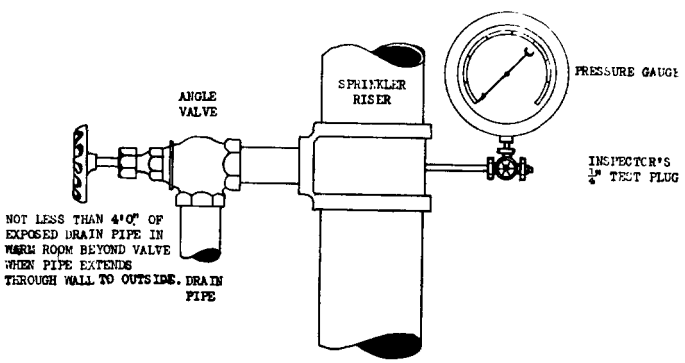


Fig. 3220. Drain Connection for Sprinkler Riser.

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

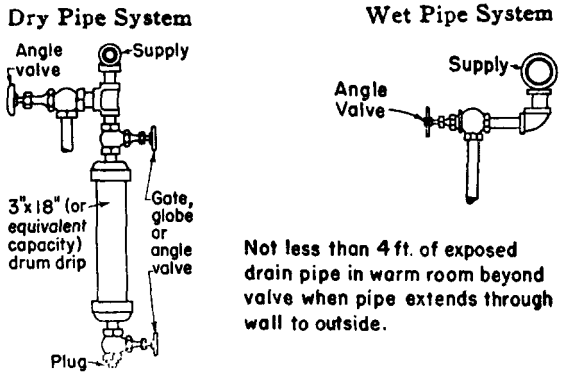


Fig. 3230. Auxiliary Drains.

3233. On wet pipe and deluge systems, all trapped sprinklers in excess of five shall be provided with drain valve and cast-iron plug or nipple and cap; where in excess of twenty, sprinklers shall be provided with drain valve and drain connection. For five or less sprinklers a brass drain plug or nipple and cap shall be provided.

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, where more than three sprinklers are trapped, a two-valve drum drip should be installed, if possible, in a warm location. (See Paragraph 3237.)

3236. On dry-pipe systems, where more than twenty sprinklers are trapped, a two-valve drum drip and a 1¼-inch draw-off valve shall be provided with drain properly piped to eliminate possibility of causing water damage. (See Paragraph 3237.)

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. 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.

3313. 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.

3314. 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.

3315. Where water pressures are 175 to 300 lbs. the USA 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.

3316. WELDED PIPING. All inside piping shall be installed 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 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.

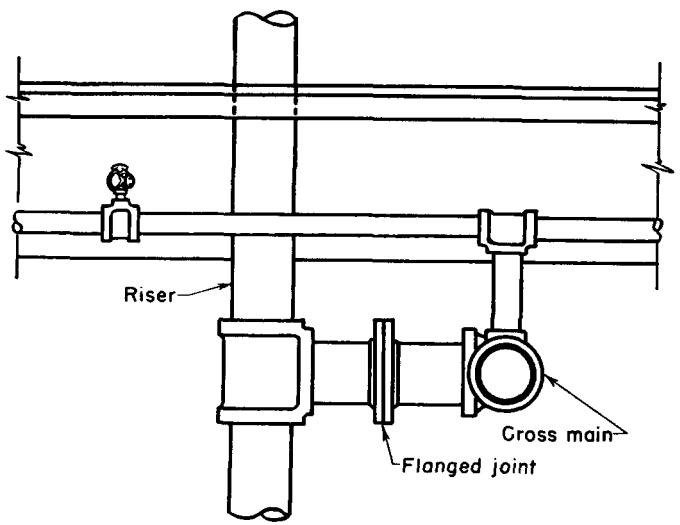


Fig. 3317. One Arrangement of Flanged Joint at Sprinkler Riser.

3317. Welding fittings should comply with USA Standard B16.9 — 1964, USA Standard B16.25 — 1964 and ASTM Designation A-234-65.

3318. Where risers are 3 inches in size or larger, a flange joint shall be used at the riser at each floor. (See Fig. 3317.)

3319. 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 D.)

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. In special cases, unions or couplings may be used to facilitate installation.

3330. Reducers, Bushings.

3331. A one-piece reducing fitting of good design should be used wherever a change is made in the size of pipe. Bushings introduce a point of weakness and should be used in reducing the size of openings of fittings only when standard fittings of the required size are not available. The use of bushings is further subject to the provisions of Paragraphs 3332, 3333, and 3334.

3332. Bushings are not permitted in elbow fittings.

3333. Bushings are not permitted when the reduction in size of the outlet is less than ½ inch.

3334. Bushings are not permitted in more than one outlet of any tee fitting or any two outlets of a cross fitting.

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 outside screw and yoke (O. S. & Y.) or approved indicator type. Underground gate 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 a gate 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 gate 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.

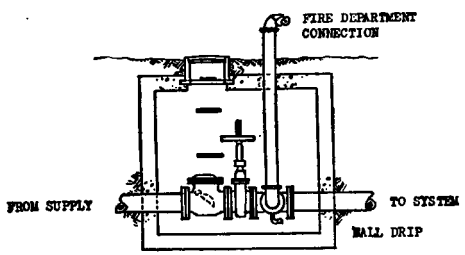


Fig. 3424. Pit for Gate Valve, Check Valve and Fire Department Connection.

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 gate 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 O. S. & Y. gate 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. A gate valve should be installed on each side of each check valve under conditions other than described in Paragraphs 3425, 3426 and 3427, except that in the discharge pipe from a pressure tank or a gravity tank of less than 15,000 gallons capacity no gate valve need be installed on the tank side of the check valve.

3429. Where a gravity tank is located on a tower in the yard, the gate valve on the tank side of the check valve should be of O. S. & Y. type; the other should be either an O. S. & Y. valve or an indicator post valve. Where a gravity tank is located on a building both gate valves should be of the O. S. & Y. type; and all fittings inside the building, except the drain tee and heater connections, shall be under the control of a gate valve.

3430. In a city connection serving as one source of supply the city valve in the connection may serve as one of the required gate valves. An O. S. & Y. valve or an indicator post valve should be installed on the system side of the check valve.

3431. 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 O. S. & Y. gate valve or under the control of an inside O. S. & Y. gate valve located near outside wall of the building.

3432. 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 gate should be of the indicator post type, located a safe distance outside of buildings.

3433. 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.

3434. All gate 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 required in special cases where area or height, or number of tenants is excessive, both in manufacturing and mercantile buildings, or where contents are more than ordinarily susceptible to damage. Floor valves should be located where they are readily accessible.

3460. Indicator Posts for Gate Valves.

3461. Outside control should be provided wherever possible.

3462. 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.

3463. 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.

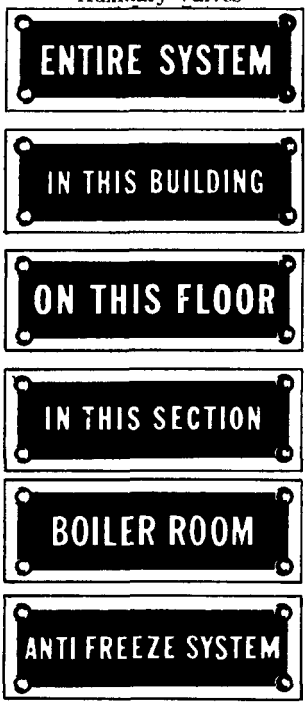
3464. When a building has no basement, and outside post indicator control cannot be furnished, short post indicator may be installed in a horizontal position in riser with handwheel projecting outside of wall.

3470. Pits for Underground Valves.

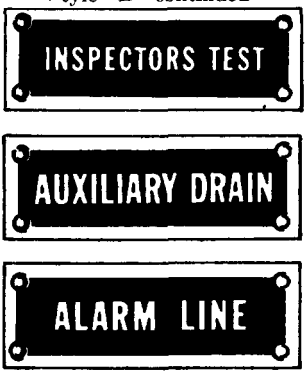
3471. Pits for underground valves, except those located at the base of a tank riser, are described in the Standard for Outside Protection (NFPA No. 24). For pits protecting valves located at the base of a tank riser, refer to the Standard for Water Tanks for Private Fire Protection (NFPA No. 22).

Style "A"
Sprinkler Control Valves

Style "B"
Auxiliary Valves



Style "B" continued



Style "C"
Outside Sprinklers

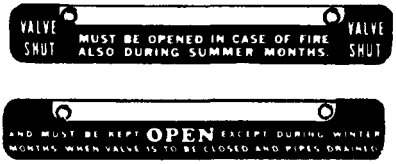


Fig. 3491. Identification Signs.

3480. Securing of Valves.

3481. All gate valves in supply pipes to automatic sprinklers, whether or not of indicator or post pattern, should be sealed open in a satisfactory manner.

3490. Identification of Valves.

3491. 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. 3491.

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 of a type approved for use with the pipe or tube involved. Sprinkler piping should be supported by round wrought-iron 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 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 $\frac{1}{8}$ 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 $\frac{3}{16}$ 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

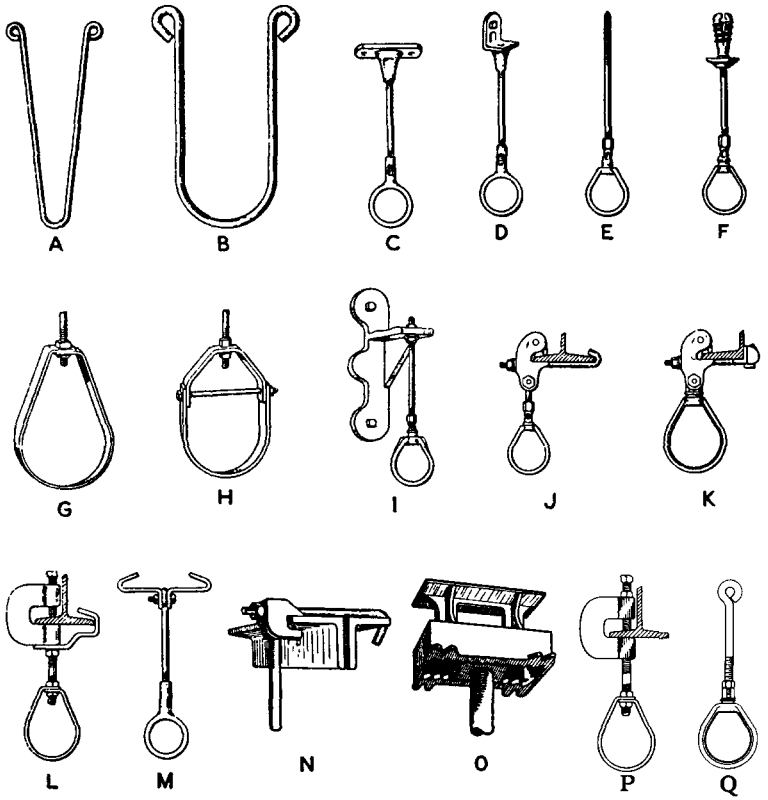


Fig. 3510. Common Types of Acceptable Hangers.

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.

through bolts. The distance from the bottom of the bolt hole to the bottom of the vertical member shall be not less than 3/8 inch.

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.

TABLE 3516

Trapeze Bars — One- to Eight-Foot Spans

SPAN OF TRAPEZE BARS	PIPE SIZE → 2" OR LESS	2 1/2"	3"	3 1/2"	4"	5"	6"	8"
1'-0"	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE
1'-6"	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	3" x 2" x 3/16" 1 1/2" PIPE
2'-0"	1 1/2" x 1 1/2" x 3/16" 1" PIPE	1 1/2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE
2'-6"	1 1/2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 1/4" 2" PIPE
3'-0"	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	3" x 2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3 1/2" x 2 1/2" x 1/4" 2 1/2" PIPE
4'-0"	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 1/4" 2" PIPE	3 1/2" x 2 1/2" x 5/16" 2 1/2" PIPE
5'-0"	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 1/4" 2" PIPE	3 1/2" x 2 1/2" x 1/4" 2 1/2" PIPE	4" x 4" x 1/4" 2 1/2" PIPE
6'-0"	2 1/2" x 1 1/2" x 3/16" 1 1/4" PIPE	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 1/4" 2" PIPE	3 1/2" x 2 1/2" x 1/4" 2 1/2" PIPE	4" x 3" x 1/4" 2 1/2" PIPE	4" x 4" x 5/16" 3" PIPE
7'-0"	2 1/2" x 1 1/2" x 3/16" 1 1/2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 3" x 3/16" 2" PIPE	3" x 2" x 1/4" 2 1/2" PIPE	3 1/2" x 2 1/2" x 1/4" 2 1/2" PIPE	4" x 3" x 1/4" 3" PIPE	4" x 3" x 3/8" 3" PIPE
8'-0"	3" x 2" x 3/16" 2" PIPE	3" x 2" x 3/16" 2" PIPE	3" x 3" x 3/16" 2 1/2" PIPE	3" x 2" x 1/4" 2 1/2" PIPE	3 1/2" x 2 1/2" x 1/4" 2 1/2" PIPE	3 1/2" x 2 1/2" x 5/16" 3" PIPE	4" x 3" x 5/16" 3" PIPE	5" x 3 1/2" x 1/4" 3 1/2" PIPE

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 non-combustible 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 and 1,000 lbs. for 3- or $3\frac{1}{2}$-inch pipe, and will not work loose by jiggling the stud or by vibration. The size of sprinkler pipe supported by powder driven studs in concrete shall not exceed $3\frac{1}{2}$ inches.

3534. Studs or other hanger parts should not be attached by welding to steel less than $\frac{3}{16}$ 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.	⅜ in.	6 in.	¾ in.
2½ in., 3 in., 3½ in.	½ in.	8 in.	⅞ in.
4 in., 5 in.	⅝ 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.	⅜ in.	6 in.	⅝ in.
3½ in., 4 in.	7/16 in.	8 in.	¾ 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 ⅜ in. x 2 in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 2 in.
8 in.	Lag Screw ⅝ in. x 2 in.

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

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

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*
3/8"	3/8"	2½"
½"	½"	3"
5/8"	½"	3"
¾"	½"	3"
7/8"	5/8"	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 3/8 in.	3 in.	2 in.
½ in.	4 in.	2 in.
5/8 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 1/8 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).

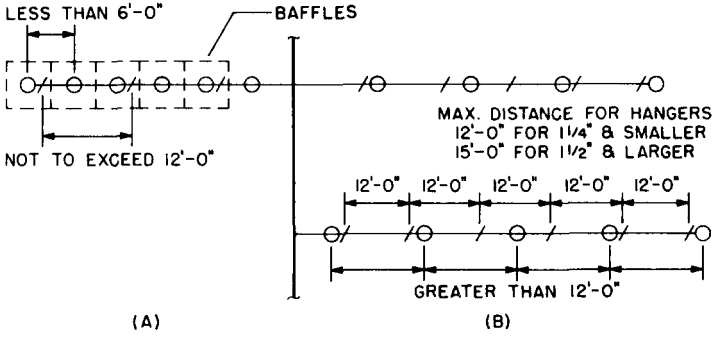


Fig. 3551. Distance Between Hangers.

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.

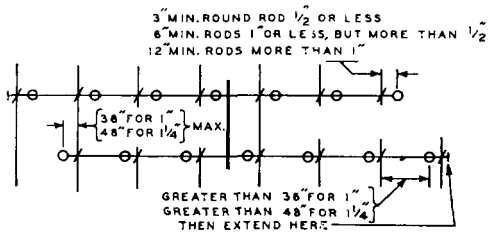


Fig. 3562. Distance Sprinkler to Hanger.

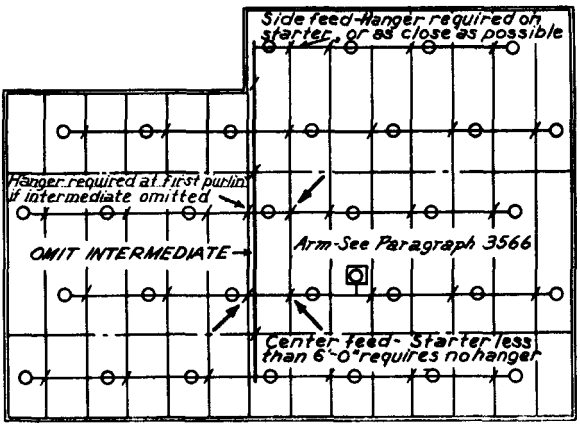


Fig. 3566. Hanger Omissions.

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.

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.

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.

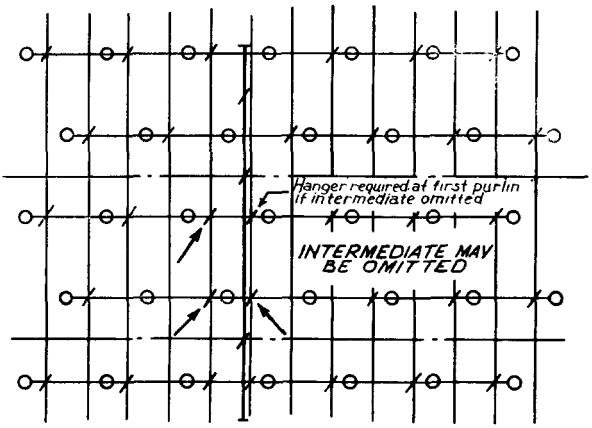


Fig. 3572. Hangers on Cross Main.

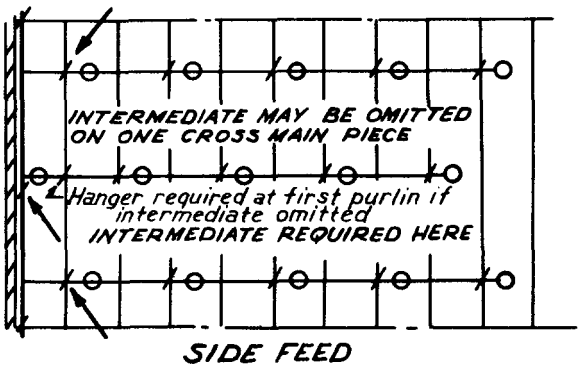


Fig. 3573. Hanger Omissions on Side Feed System.

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.

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.

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.

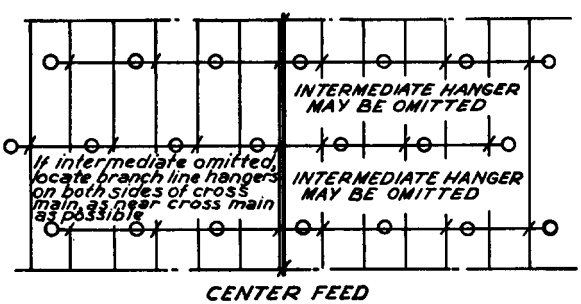


Fig. 3574. Hangers on Cross Main — Center Feed System.

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.

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. Automatic sprinklers with nominal ½-inch discharge orifice and of the ordinary degree temperature ratings will usually be required.

3613. 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.

3614. 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 3615 to 3636 inclusive shall be of types specifically approved for such use.

3615. Open sprinklers may be used to protect special hazards, for protection against exposures, or in other special locations.

3616. 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.

3617. 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 dis-

charge characteristics may be required where either a fine spray or directional discharge of water is needed.

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. The use of sidewall sprinklers should be confined to light hazard occupancies, such as hotels, clubs, schools, hospitals and churches.

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
3/8	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	7.8–8.4	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 and 17/32 inch orifice, ¾ in. IPT, orifice sprinkler the nominal orifice size is cast or stamped on the wrench boss of the sprinkler frame.

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 Intermediate or High Temperature Rating, as a means of limiting the total number of sprinklers which might open in a fire, is recommended subject to the approval of the authority having jurisdiction (the use of High Temperature Rating Sprinklers should be limited to buildings with structural steel fully protected). 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

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.

without the disadvantage of a potential increase in fire damage, this alternative should be given first consideration.

NOTE: Fire tests have shown that the number of sprinklers which might be expected to open, particularly under conditions where fast-developing fires may be expected, can be limited by the use of Intermediate or High Temperature Rating Sprinklers. 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 Intermediate or High Temperature Rating Sprinklers 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.

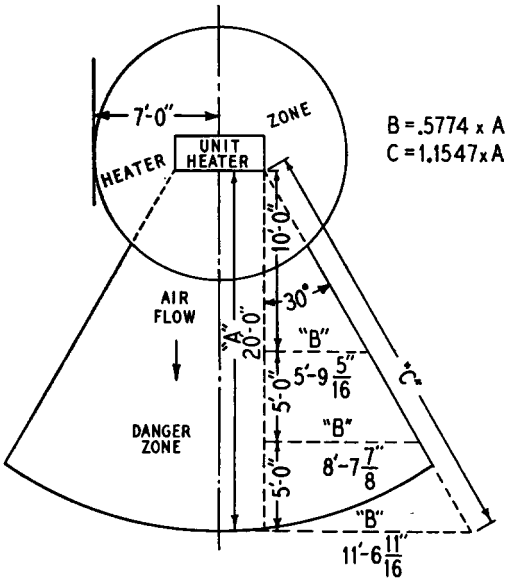


Fig. 3656(a). Heater and Danger Zones at Unit Heaters.

(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. Arrangements should be made to keep at least 18 inches clearance below sprinkler deflectors to reduce possible obstruction to the distribution of water. For high piled combustible stock increased clearance of 36 inches or more should be provided.

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 water flow 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 water flow 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. 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

Fig. 3771. Identification Sign.

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.

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.

4010. Authority Having Jurisdiction.

4011. The authority having jurisdiction shall be consulted in every case as to location and spacing of sprinklers for the protection of buildings and contents.

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.

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. BUILDINGS USED FOR HIGH PILED STORAGE. Buildings used for high piled storage are defined as buildings or areas designed or presently used for storage in which ceiling heights permit closely packed piles of material over 15 feet high or material on pallets or in racks piled over 12 feet high. See Appendix for availability of information for sprinkler protection of high piled storage.

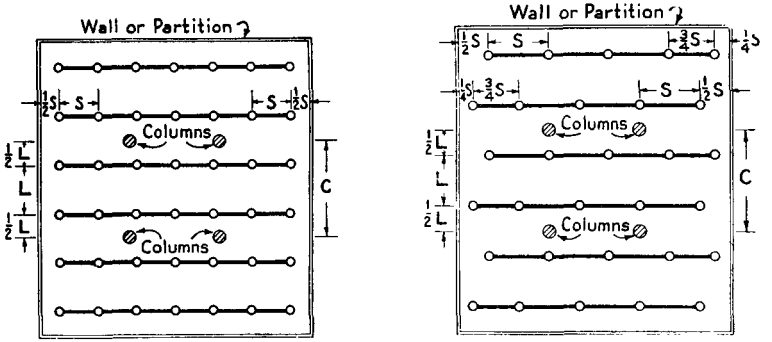
NOTE: To determine piling height, see Paragraph 3690 for clear space below sprinklers and see rules on position of sprinkler below ceiling.

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×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

No Stagger S 12 ft. or less			Stagger Required S more than 12 ft.		
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.

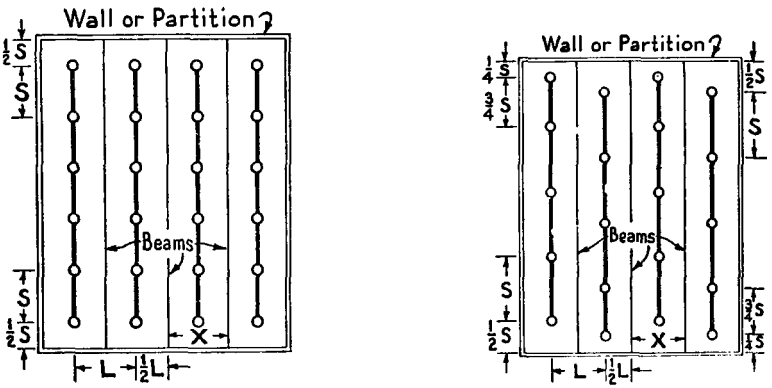
4112. For Ordinary Hazard Occupancies the maximum allowable distance between the branch lines and between sprinklers on the branch lines is 15 feet, except in buildings used for high piled storage (as defined in Paragraph 4045) the maximum allowable distance between the branch lines and between sprinklers on the branch lines is 12 feet. In bays 25 feet wide, however, a spacing of 12 feet, 6 inches between sprinkler lines may be 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.

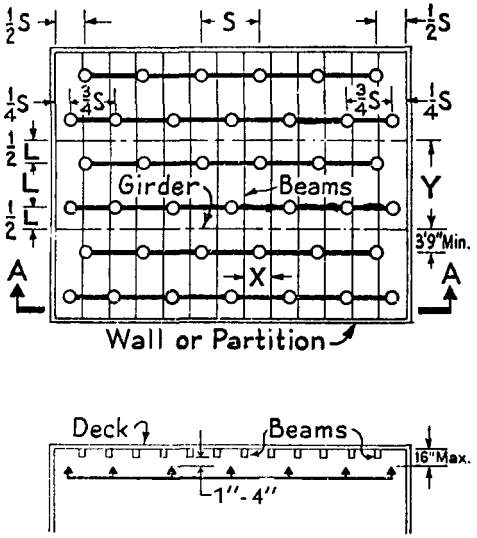
EXAMPLES

No Stagger S 12 ft. or less			Stagger Required S more than 12 ft.		
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.

Solid Concrete, Wood or Steel Beams Spaced Less than 5 Ft. Apart and Either Supported On or Framed Into Girders

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



Note: See Fig. 4156 if Sprinkler Deflector is Above Bottom of Beam.

Section A-A

KEY

L=Distance between branch lines, limit 15 feet.
S=Distance between sprinklers on branch lines, limit 15 feet.
X=Width of bay, 3 feet to less than 5 feet.
Y=Maximum distance between girders.

EXAMPLES

Y	Stagger Required L	S (Max.)
30 ft. 0 in.	15 ft. 0 in.	8 ft. 8 in.
22 ft. 0 in.	11 ft. 0 in.	11 ft. 9 in.
17 ft. 4 in.	8 ft. 8 in.	15 ft. 0 in.

Fig. 4100-C. Layout of Sprinklers Under Beam and Girder Construction With Solid Beams—Ordinary Hazard Occupancy.

not exceed one-half the allowable distance between the branch lines.

4120. Stagger.

4121. LIGHT HAZARD OCCUPANCY. Sprinklers need not be staggered except that under open Wood Joist Construction sprinklers should be stagger spaced if the distance between the sprinklers on the branch lines exceeds 12 feet.

4122. ORDINARY HAZARD OCCUPANCY. In all cases, sprinklers should be stagger spaced (1) if the distance between the sprinklers on the branch lines exceeds 12 feet, (2) under solid beams spaced 3 to 7½ feet on center. In offices, reception rooms, display rooms and the like of limited area and where appearance is a prime factor, sprinklers may be installed without stagger.

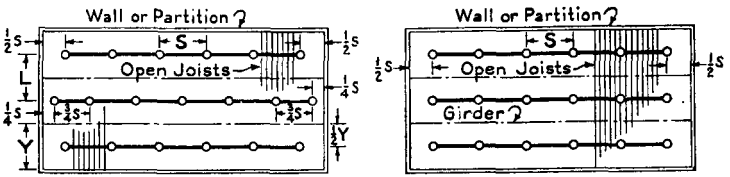
4123. EXTRA HAZARD OCCUPANCY. Sprinklers should be stagger spaced in all cases.

4130. Protection Area Limitations.

4131. LIGHT HAZARD OCCUPANCY. 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

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

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.
Y = Maximum distance between girders.

EXAMPLES

Stagger Required S more than 12 ft.			No Stagger S 12 ft. or less		
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. 4100-D. Layout of Sprinklers Under Open Wood Joist Construction — Light and Ordinary Hazard Occupancies.

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. Under open Wood Joist Construction (as defined in Paragraph 4044) the protection area per sprinkler shall not exceed 130 square feet. For all other types of construction the protection area per sprinkler shall not exceed 168 square feet.

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.

4133. EXTRA HAZARD OCCUPANCY. The protection area per sprinkler shall not exceed 90 square feet for any type of building construction.

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

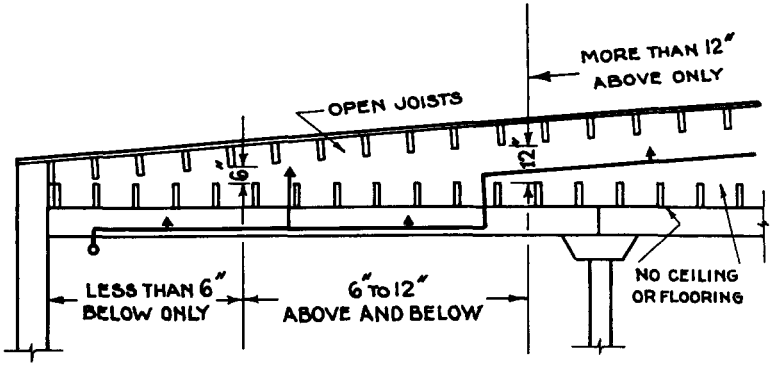


Fig. 4144. Arrangement of Sprinklers under Two Sets of Open Joists — no sheathing on lower joists.

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.

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.)

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. (See Fig. 4153.)

4154. OPEN WEB TYPE STEEL BEAMS. 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,

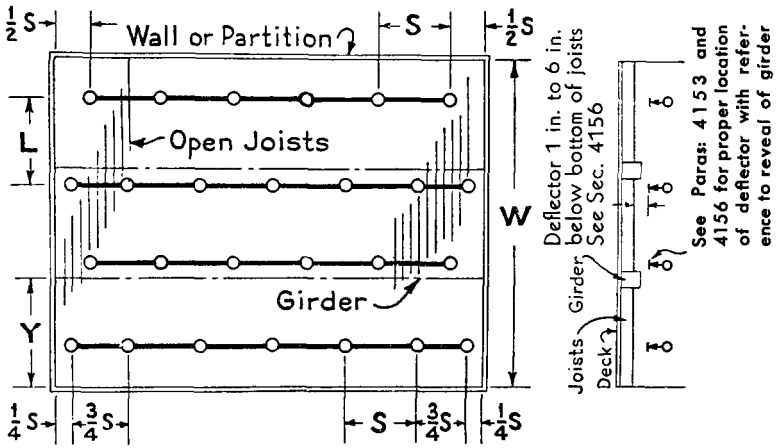
(c) the branch line is located within one inch horizontally of the opening center line, and

(d) sprinklers on alternate lines are staggered.

4155. BAR JOISTS. Sprinklers should be at least three inches

Joists Framed Into Girders; Branch Lines Not Uniformly Spaced Between Girders

Use when branch lines can be located so that reveal of girder offers no obstruction to discharge pattern. Maximum Spacing: 130 Sq. Ft. 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.
W=Width of building.
Y=Maximum distance between girders.

EXAMPLES

$$\text{Number of lines} = \frac{W}{L}$$

No Stagger S 12 ft. or less		Stagger Required S more than 12 ft.	
L	S (Max.)	L	S (Max.)
12 ft. 1 in.	10 ft. 9 in.	10 ft. 9 in.	12 ft. 1 in.
10 ft. 10 in.	12 ft. 0 in.		

Fig. 4153. Layout of Sprinklers Under Open Wood Joist Construction — Light and Ordinary Hazard Occupancies.

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

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

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.

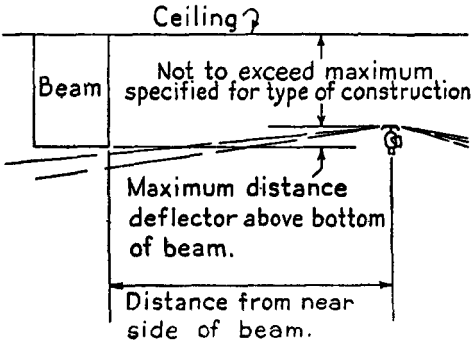


Fig. 4156. Position of Deflector, Upright or Pendent, When Located Above Bottom of Beam.

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.

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.

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 con-

stitute 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 combustible construction, as in walls, floors and ceilings, except as modified by Paragraph (b) 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) Permission may be given to omit sprinklers from combustible blind spaces where the following conditions prevail:

(1) Where the ceiling is attached directly to the under side of the supporting beams of a combustible roof or floor deck or otherwise installed to make the installation of sprinklers impracticable.

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

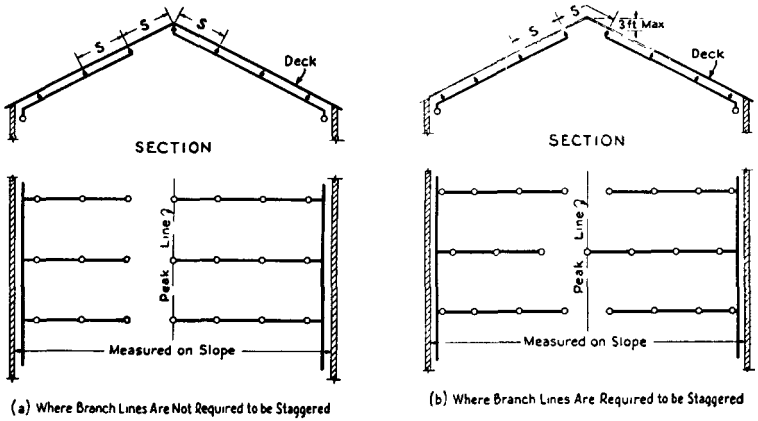
(3) Where there are small concealed spaces over closets, bathrooms and the like.

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).]

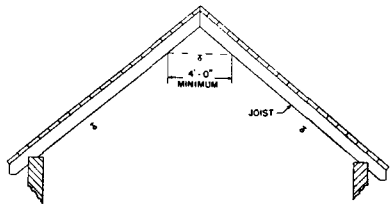


Fig. 4306(d). Desirable Horizontal Clearance for Sprinklers at Peak of Pitched Roof.

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 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

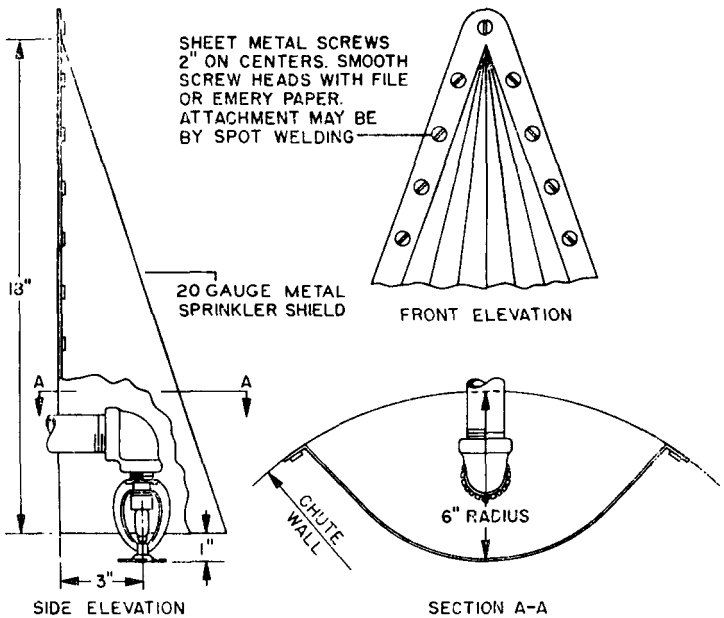


Fig. 4310. Protective deflector canopy for protecting sprinklers in building service chutes.

and, in addition, a sprinkler shall be installed within the chute at alternate floor levels in buildings over two stories in height. The room or area into which the chute discharges shall also be protected by automatic sprinklers. 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. Additional sprinklers may be required beneath catwalks in library stack rooms.

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.

(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 noncombustible 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 per cent 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 their listing.

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.

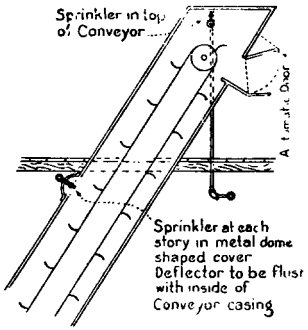


Fig. 4324(a). Sprinklers in Conveyor Enclosure.

(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, platforms 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 Ventilation of Restaurant 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.

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 sprin-

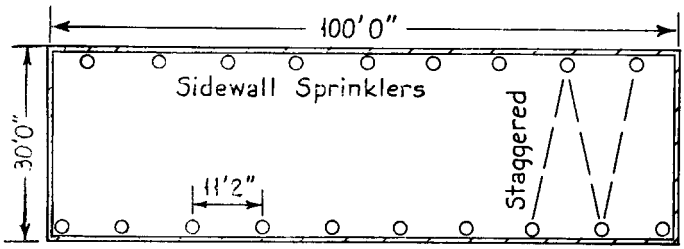


Fig. 4411. Spacing of Sidewall Sprinklers under Smooth Ceilings, with Light Hazard Occupancy.

klers 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.)

4412. DISTANCE BETWEEN THE SPRINKLERS ON THE BRANCH LINES. Sidewall sprinklers should be located not more than 14 feet apart. 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. Position of Sidewall Sprinklers. (See Fig. 4430.)

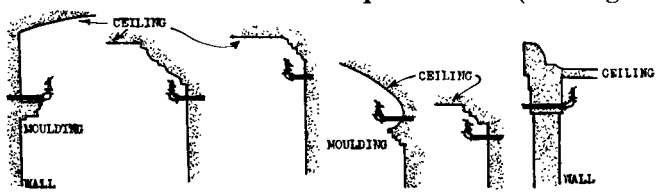


Fig. 4430. Suggested Arrangements for Sidewall Sprinklers — placed to receive early heat waves and provide effective distribution.

4431. Ordinarily, deflectors should be at a distance from walls and ceilings not exceeding 6 inches and never less than 4 inches.

4432. 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.

4433. 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.

4434. 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 Section 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. Sprinklers installed in the pendent position shall be of the approved dry pendent type.

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 Figs. 1132 and 1133.)

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 unless otherwise specified by the authority having jurisdiction.

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. A drain valve, connected in 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 **13–135**

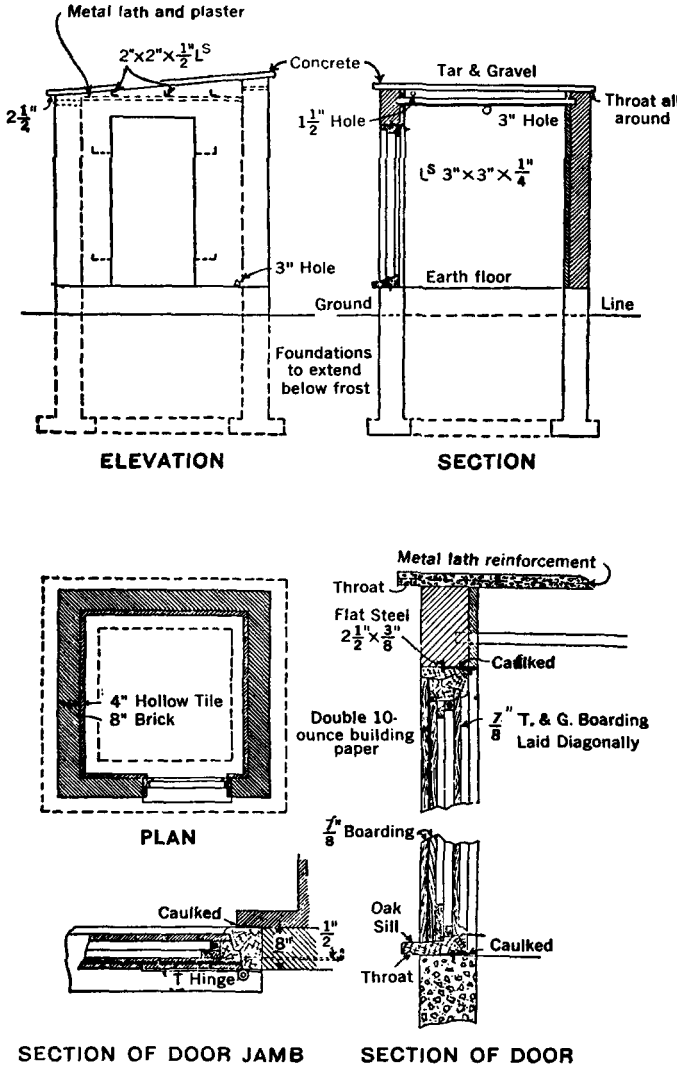
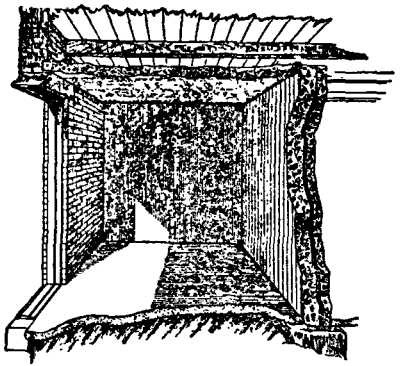


Fig. 5258-1. Dry-Pipe Valve Enclosures — Fire-Resistive Construction, Located Outside of Building with no Direct Communication to Building.



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.

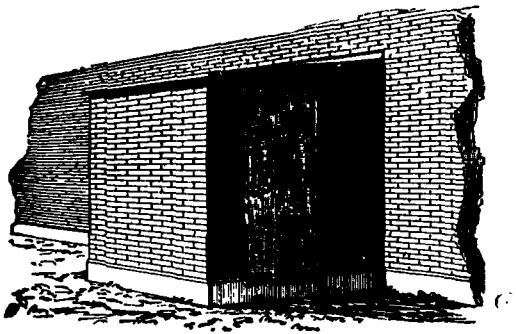
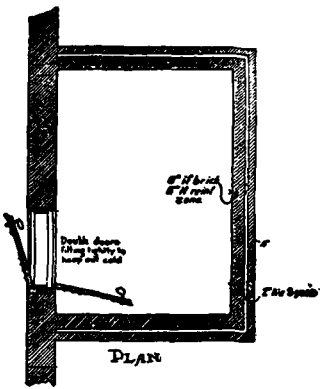
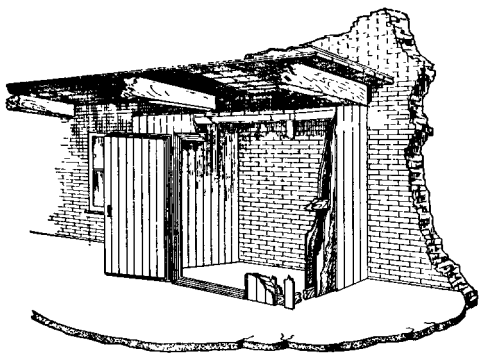


Fig. 5258-3. Dry-Pipe Valve Enclosures — Fire-Resistive Construction, Located Outside of Building with no Direct Communication to Building.



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.

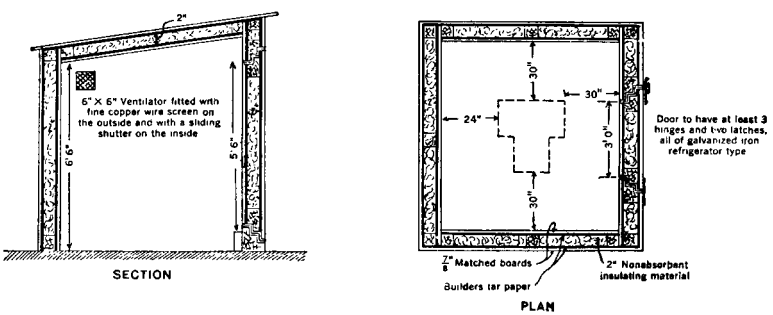
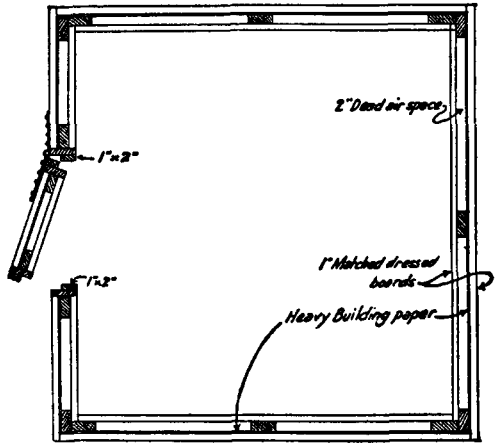
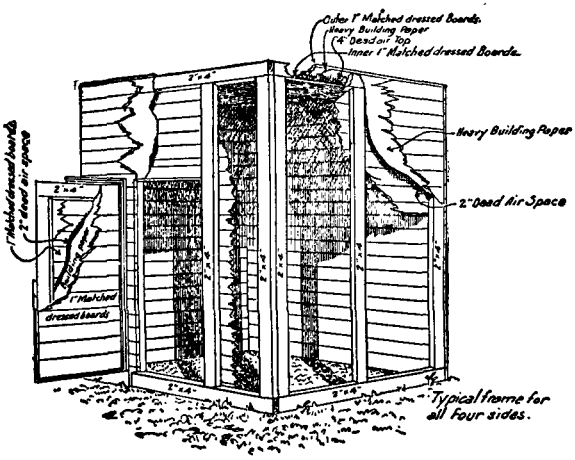


Fig. 5258-5. Dry-Pipe Valve Enclosure — Combustible Construction.

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 3063 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 3063, 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.

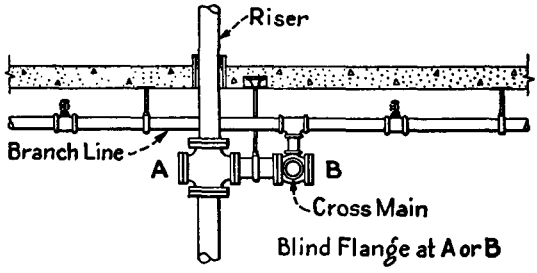
5265. Cross mains should be connected to risers or feed mains with flanges. In general, flanged fittings should be installed at points which would allow easy dismantling of the system. Split ring or other easily removable types of hangers will facilitate the dismantling.

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

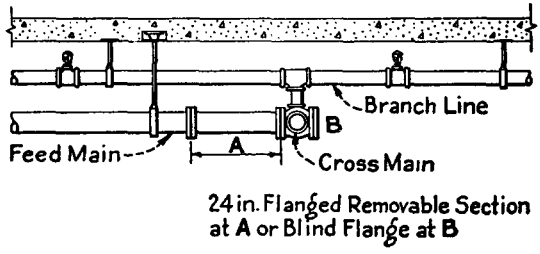
5267. Piping in cold storage rooms should be installed with ample pitch, as outlined in Section 3210.

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.

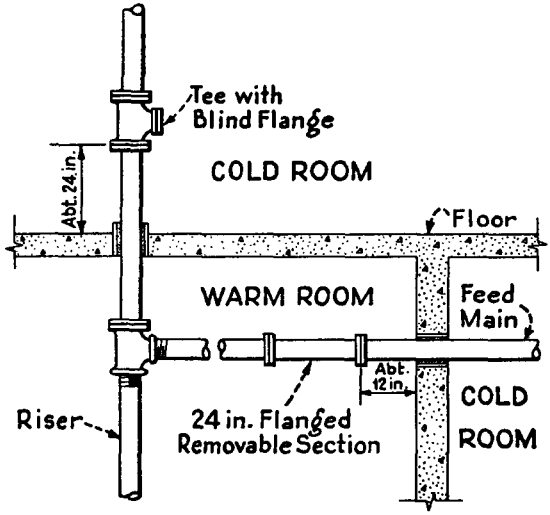


Fig. 5262-2. Fittings in Feed Main or Riser Passing Through Wall or Floor from Warm Room to Cold Room.

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.

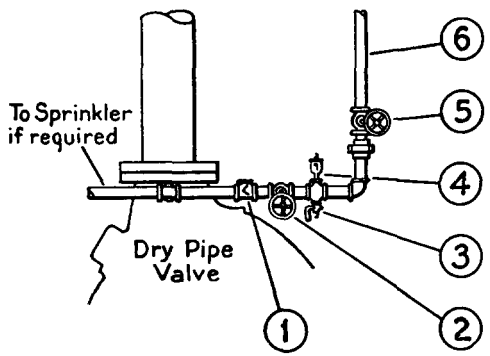


Fig. 5270. Air Supply from Shop System.

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.

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. Gate Valves.

5381. A gate valve shall be installed to control the water supply to each pre-action or deluge valve.

5382. In hazardous locations the gate valve and manual means for operation of pre-action or deluge valve shall be installed a safe distance away from the pre-action and deluge valve and where access to the control valves is not likely to be prevented under fire emergency conditions.

5383. In case of deluge systems the deluge valve shall be located as close as possible to the hazard protected, consistent with safety, preferably in an enclosure outside any fire or explosion hazard area.

5390. Devices for Test Purposes and Testing Apparatus.

5391. When heat-responsive devices installed in circuits are located where not readily accessible, an additional heat-responsive device shall be provided on each circuit for test purposes at an accessible location and shall be connected to the circuit at a point which will assure a proper test of the circuit.

5392. Suitable testing apparatus capable of producing the heat or impulse necessary to operate any normal heat-responsive device shall be furnished to the owner of the property with each installation. Where explosive vapors or materials are present, hot water, steam or other safe method of testing shall be used.

5393. PRESSURE GAUGES. Approved pressure gauges conforming to Paragraph 2822 shall be installed as follows:

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

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

5400. Combined Dry-Pipe and Pre-Action Systems.

5410. General.

5411. DEFINITION OF A COMBINED DRY-PIPE AND PRE-ACTION SPRINKLER SYSTEM. A system employing automatic sprinklers attached to a piping system containing air under pressure with a supplemental heat responsive system of generally more sensitive characteristics than the automatic sprinklers themselves, installed in the same areas as the sprinklers; operation of the heat responsive system, as from a fire, actuates tripping devices which open dry-pipe valves simultaneously and without loss of air pressure in the system. Operation of the heat responsive system also opens approved air exhaust valves at the end of the feed main which facilitates the filling of the system with water which usually precedes the opening of sprinklers. The heat responsive system also serves as an automatic fire alarm system.

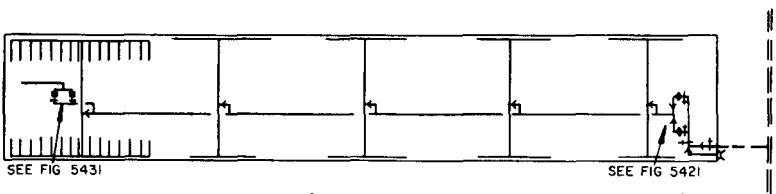


Fig. 5411. Typical Piping Layout for Combined Dry-Pipe and Pre-Action Sprinkler System.

5412. WHERE INSTALLED. Combined dry-pipe and pre-action systems may be installed where wet-pipe systems are impractical. They are intended for use but not limited to structures where a number of dry pipe valves would be required if a dry-pipe system were installed.

5413. Combined automatic dry-pipe and pre-action systems shall be so constructed that failure of the heat responsive system shall not prevent the system from properly functioning as a conventional automatic dry-pipe system.

5414. Combined automatic dry-pipe and pre-action systems shall be so constructed that failure of the dry-pipe system of automatic sprinklers shall not prevent the heat responsive system from properly functioning as an automatic fire alarm system.

5415. Provisions shall be made for the manual operation of the heat responsive system at locations requiring not more than 200 feet of travel.

5416. Automatic sprinklers installed in the pendent position shall be of the approved dry pendent type.

5420. Dry-Pipe Valves.

5421. Where the system consists of more than 600 sprinklers or has more than 275 sprinklers in any fire area, the entire system shall be controlled through two 6-inch dry-pipe valves connected in parallel and shall feed into a common feed main. These valves shall be checked against each other. (See Fig. 5421.)

5422. Each dry-pipe valve shall be provided with an approved tripping device actuated by the heat responsive system. Dry-pipe valves shall be cross connected through a 1-inch pipe connection to permit simultaneous tripping of both dry pipe valves. This 1-inch pipe connection shall be equipped with a gate valve so that either dry-pipe valve can be shut off and worked on while the other remains in service.

5423. The check valves between the dry-pipe valves and the common feed main shall be equipped with ½-inch bypasses so that a loss of air from leakage in the trimmings of a dry-pipe valve will not cause same to trip until the pressure in the feed main is reduced to the tripping point. A gate valve shall be installed in each of these bypasses so that either dry-pipe valve can be completely isolated from the main riser or feed main and from each other.

5424. Each combined dry-pipe and pre-action system shall

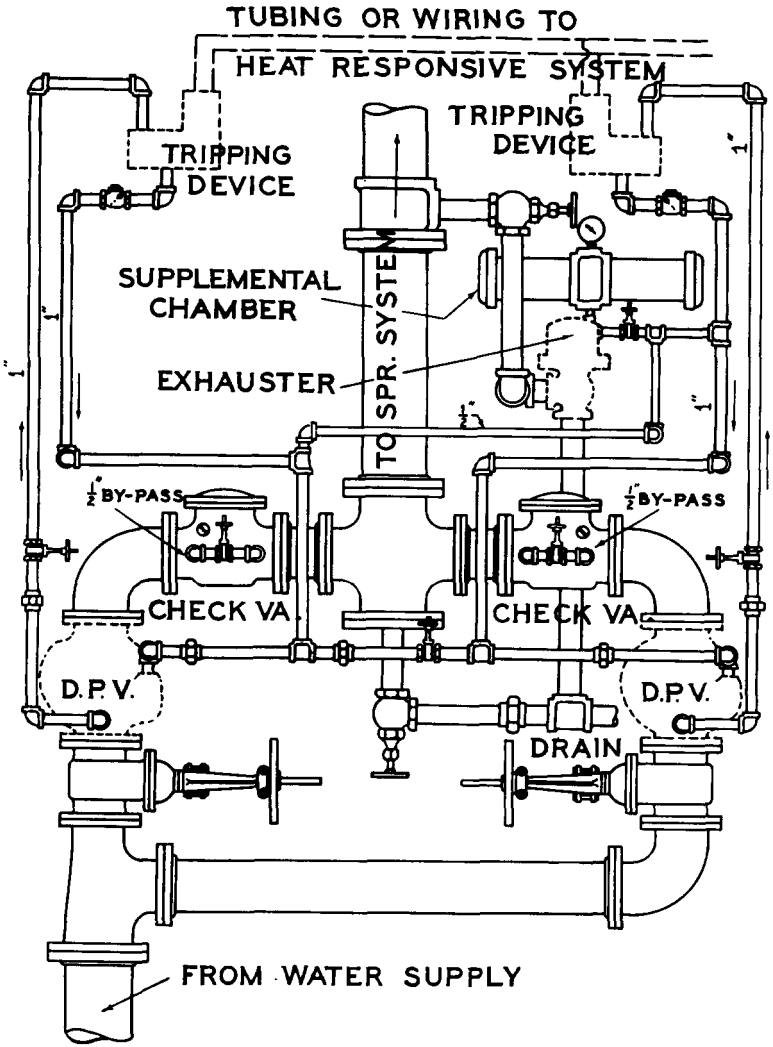


Fig. 5421. Header for Combined Dry-Pipe and Pre-Action Sprinkler System. Standard Trimmings Not Shown.

be provided with approved quick opening devices at the dry pipe valves.

5430. Air Exhaust Valves.

5431. One or more approved air exhaust valves of 2-inch or larger size controlled by operation of a heat responsive system shall be installed at the end of the common feed main. (See Fig. 5431.) These air exhaust valves shall have soft seated globe or angle valves in their intakes, also approved strainers shall be installed between these globe valves and the air exhaust valves.

5440. Sub-division of System Using Check Valves.

5441. Where more than 275 sprinklers are required in a single fire area, the system shall be divided into sections of 275 sprinklers or less by means of check valves. If system is installed in more than one fire area or story, not more than 600 sprinklers shall be supplied through any one check valve. Each section shall have a 1¼-inch drain on the system side of each check valve supplemented by a drum drip.

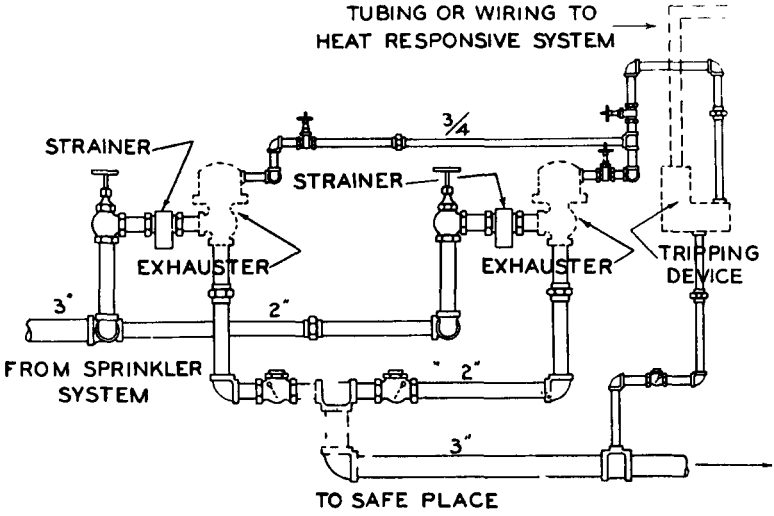


Fig. 5431. Arrangement of Air Exhaust Valves for Combined Dry-Pipe and Pre-Action Sprinkler System.

5442. Section drain lines and drum drips should be located in heated areas or inside of thermostatically controlled electrically heated cabinets of sufficient size to enclose drain valves and drum drips for each section. Drum drips should also be provided for all low points except that heated cabinets need not be required for 20 sprinklers or less. Air exhaust valves at end of feed main and associated check valves shall also be protected against freezing.

5450. Time Limitation.

5451. The sprinkler system shall be so constructed and the number of sprinkler heads controlled shall be so limited that water shall reach the furthest sprinkler within a period of time not exceeding one minute for each 400 feet of common feed main from the time heat responsive system operates. Maximum time permitted not to exceed three minutes.

5460. Inspector's Test Connection.

5461. The end section shall have an inspector's test connection as required for dry-pipe systems.

5500. Anti-Freeze Solutions.

5510. Where Used.

5511. Anti-freeze solutions may be used for maintaining automatic sprinkler protection in small unheated areas which would otherwise be shut off and drained during freezing weather. Anti-freeze solutions are recommended only for systems not exceeding 20 sprinklers. The cost of refilling the system or even of replenishing small leaks makes it more advisable to use small dry valves where more than 20 sprinklers are to be supplied.

5520. Recommended Anti-Freeze Solutions.

5521. Where sprinkler systems are supplied by public water connections the use of anti-freeze solutions other than water solutions of pure glycerine (C.P. or U.S.P. 96.5% Grade) or propylene glycol are undesirable from a public health standpoint. The use of anti-freeze solutions MUST be in conformity with any state or local health regulations which may apply. Suitable glycerine-water and propylene glycol-water mixtures are shown in Table 5521.

TABLE 5521.

ANTI-FREEZE SOLUTIONS.

TO BE USED IF PUBLIC WATER IS CONNECTED TO SPRINKLERS.

MATERIAL	SOLUTION (BY VOLUME)	SPEC. GRAV. AT 60 F.	FREEZING POINT F.
Glycerine C.P. or U.S.P. Grade*	50% Water	1.133	—15
	40% Water	1.151	—22
	30% Water	1.165	—40
	Hydrometer Scale 1.000 to 1.200		
Propylene Glycol	70% Water	1.027	+ 9
	60% Water	1.034	— 6
	50% Water	1.041	—26
	40% Water	1.045	—60
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)		

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

5522. Beyond certain limits, increased proportion of anti-freeze does not lower the freezing point of solution. (See Fig. 5522.)

5523. If public water is not connected to sprinklers, the commercially available materials indicated in Table 5523 are suitable for use in anti-freeze solutions.

5524. An anti-freeze solution should be prepared with a freezing point a few degrees below the expected minimum temperature for the locality. The specific gravity of the prepared solution should be checked by a hydrometer with suitable scale.

5525. Glycerine, diethylene glycol, ethylene glycol and propylene glycol should never be used without mixing with water in proper proportions because these materials tend to thicken near 32° F.

5530. Arrangement of Supply Piping and Valves.

5531. All anti-freeze solutions are heavier than water. At the point of contact (interface) the heavier liquid must be below the lighter liquid in order to prevent diffusion of water into the unheated areas. In most cases, this makes necessary the use of a 5-foot drop pipe or U-loop as illustrated in Fig. 5531. The preferred arrangement is to have the sprinklers below the interface between the water and the anti-freeze solution. If sprinklers are above the interface, a check valve with 1/32-inch hole in the clapper should be provided in the U-loop. A water control valve and

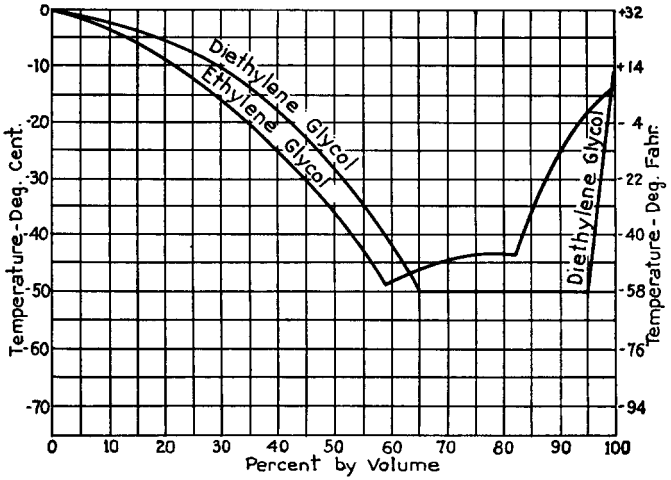


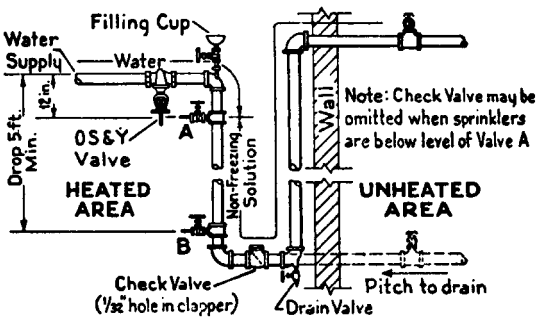
Fig. 5522. Freezing Points of Water Solutions of Ethylene Glycol and Diethylene Glycol.

TABLE 5523.
ANTI-FREEZE SOLUTIONS.

SUITABLE FOR USE IF PUBLIC WATER IS NOT CONNECTED TO SPRINKLERS.

MATERIAL	SOLUTION (BY VOLUME)	SPEC. GRAV. AT 60 F.	FREEZING POINT F.
Glycerine	If glycerine is used, see Table 5521.		
Diethylene Glycol	50% Water	1.078	—13
	45% Water	1.081	—27
	40% Water	1.086	—42
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)		
Ethylene Glycol	61% Water	1.056	—10
	56% Water	1.063	—20
	51% Water	1.069	—30
	47% Water	1.073	—40
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)		
Propylene Glycol	If propylene glycol is used, see Table 5521.		
Calcium Chloride 80% "Flake" *Fire Protection Grade** Add corrosion inhibitor of sodium bichromate ¼ oz. per gal. water	Lb. $CaCl_2$ per Gal. of Water		
	2.83	1.183	0
	3.38	1.212	—10
	3.89	1.237	—20
	4.37	1.258	—30
	4.73	1.274	—40
	4.93	1.283	—50

*Free from magnesium chloride and other impurities.



NOTE: The $\frac{1}{32}$ inch hole in the check valve clapper is needed to allow for expansion of the solution during a temperature rise and thus prevent damage to sprinkler heads.

Fig. 5531. Arrangement of Supply Piping and Valves.

two small solution test valves should be provided as illustrated in Fig. 5531. An acceptable arrangement of filling cup is also shown. To avoid leakage, the materials and workmanship must be excellent, the threads clean and sharp, and the joints tight. Use only metal-faced valves.

5540. Filling.

5541. With water supply valve closed and the system drained, fill the piping through the filling cup, using a suitable anti-freeze solution of the proper concentration. Vent the air at the end sprinklers. Back out all sprinklers slightly until the liquid appears so that the piping will be completely filled and all air expelled. If the filling cup is not above the highest sprinklers, the piping may be filled through valve B by means of a small pump or through a filling cup installed at the highest branch sprinkler line. If the last-named method is used, the drop pipe should be filled through the filling cup shown in diagram. Then tighten the sprinkler heads and open valve A until the 12-inch section of pipe above this valve is empty and the level of the anti-freeze solution in the drop pipe is at valve A. Close valve A. Close the filling connection valve and slowly open the supply valve wide.

5550. Testing.

5551. Before freezing weather each year, the solution in the entire system should be emptied into convenient containers

and brought to the proper specific gravity by adding concentrated liquid as needed. The resulting solution should be used to refill the system.

5552. Tests should be made by drawing a sample of the solution from valve B two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for repairs, changes, etc. A small hydrometer should be used so that a small sample will be sufficient. When water appears at valve B or when the test sample indicates that the solution has become weakened, empty the entire system and recharge as previously described.

5600. Limited Water Supply System.

5610. General.

5611. DEFINITION OF LIMITED WATER SUPPLY SYSTEM. A system employing automatic sprinklers and conforming to this Standard but supplied by a pressure tank of limited capacity.

5612. MAINTENANCE OF WATER SUPPLY (See Paragraph 2512.)

CHAPTER 6. OUTSIDE SPRINKLERS FOR PROTECTION AGAINST EXPOSURE FIRES.

6100. Water Supply and Control.

6110. Water Supply.

6111. Sprinklers installed for protection against exposure fires should preferably be supplied by connections from reliable water works systems, or by fire pumps, or fire department connections.

6112. Where water supplies feed other fire protection appliances, such as inside sprinklers, or hydrants, the system should be so arranged that there is no danger of impairing the efficiency of such other appliances, and water supply should be of sufficient capacity to adequately feed such appliances with the outside sprinklers in operation.

6113. Water supply for outside sprinklers should be of sufficient capacity to feed all sprinklers designed to be operated at one time and maintain not less than 10 pounds pressure at top of riser for a length of time depending on conditions, but not less than 60 minutes.

6114. Where fire department connections are used they shall be located so as to be safe from the exposing fire, as in the rear of building if exposure is on the front.

6120. Control.

6121. Where manually controlled open sprinklers do not have constant human supervision, exposure fires occurring nights, Sundays and holidays may enter or damage the exposed property before the manually operated open sprinklers can be brought into service. In such cases it may be advisable to consider the practicability of controlling the outside sprinklers either through a valve which is opened by the operation of a heat-responsive system or through the installation of a dry-pipe valve in conjunction with automatic sprinklers, the deflectors for which should preferably be designed for the specific application or else should be equipped with satisfactory baffles.

6122. Where automatic control of the supply of water to outside sprinklers is required by the authority having jurisdiction, the installation shall be in strict accordance with Para-

graphs 5341, 5381 and 5392 (see also Section 3720 and Paragraph 3733), except that spacing of thermostats of the approved rate-of-rise type shall not exceed 30 feet apart on buildings less than three stories in height and not exceed 40 feet apart on buildings three or more stories in height. On buildings in excess of eight stories in height there shall be at least one line of thermostats for each eight stories, with thermostats staggered. In any case, one line of thermostats shall be located close up under the cornice, eave, or outside the parapet. Where more than one valve is required, the division between the sprinklers on each valve shall be vertical and not horizontal and — except by special permission of the authority having jurisdiction — no one valve shall supply open sprinklers on more than one side of a building. (See Section 6210.)

6123. In automatically operated open outside sprinkler systems, the grouping of a number of such systems should be avoided where the present or probable future arrangement of buildings and streets will conduce to such action of heat waves in time of fire or conflagration as will result in severe drainage of public water supply; and in any event the adequacy of such supply and the possibility of water damage as compared with the severity of the exposure should be given careful consideration.

6124. Automatic protection against exposure fires may be secured in some cases by means of automatic sprinklers connected to dry-pipe systems of buildings. Automatic sprinklers so used shall be equipped with satisfactory baffles.

6125. Small orifice sprinklers (¼ inch, 5/16 inch and ⅜ inch) are used when the buildings are not too severely exposed and especially when the windows are narrow or recessed into the wall or the water supply is limited. Large orifice sprinklers (½ inch, ⅝ inch and ¾ inch) are used for protection against the more severe exposures, especially where a copious water supply is or can be made available.

6200. System Components.

6210. Valves.

6211. Where central feed risers are used, each riser should have a controlling valve. Where side feed risers are used, they should be connected together at bottom with one valve so located as to control the two risers.

6212. Not more than 40 sprinklers should be placed under the control of one gate valve and drain valve.

6213. Where outside sprinklers are installed to protect a building against more than one distinct and separate exposure, the system shall be subdivided and gate valves and drain valves shall be installed to separately control the sprinklers opposite each exposure.

6214. Valves shall be of approved type, and shall be distinctly marked by letters not less than one-half inch high to clearly explain their use.

6215. Valves should be so located as to be easily accessible, preferably in first story.

6216. Where it may be desirable or necessary to save water supplies for other service in case the outside sprinklers are ineffectual, control valves should be located outside the building itself and accessible as regards the exposure fire. Such valves may be located in properly cut off valve rooms or pits by special consent of the authority having jurisdiction. Underground control valves should be in approved pits with manhole or be fitted with standard post indicators.

6217. Where buildings are not heated and are equipped with a dry-pipe sprinkler system, control valves for outside sprinklers should be located in the dry-pipe valve enclosure.

6218. CHECK VALVES. Where sprinklers run on two adjoining sides of a building with separate control valve for each side, the end lines should be connected together with check valves so located that one sprinkler around the corner will oper-

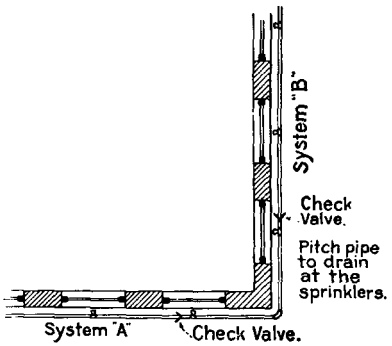


Fig. 6218. Arrangement of Check Valves.

ate when valve is opened. The intermediate pipe between the two check valves shall be so arranged as to drain properly.

6220. Pipe and Fittings.

6221. Galvanized pipe or other approved corrosion-resistant pipe shall be used for the equipment as far back as the control valve on the water supply. (See Paragraph 3004.) Fittings need not be galvanized. Pipe should be carefully inspected before being installed.

6222. All pipes and fittings should be carefully arranged and pitched so as to thoroughly drain the entire system as far back as the inside riser controlling valve. Drain pipes shall be not less than 1 inch in size.

6223. As an aid to flushing out scale and dirt which may accumulate inside the piping after installation, all branch lines should be extended horizontally 6 inches beyond the end heads and capped.

6230. Hangers.

6231. Pipe should be securely supported in a manner fully equal to that required for inside sprinklers.

6240. Strainers.

6241. An acceptable strainer should be provided in the riser or feed main which supplies sprinklers having orifices smaller than $\frac{3}{8}$ inch. Systems having only $\frac{3}{8}$-inch sprinklers may require a strainer, if the water is likely to contain obstructing material. An acceptable strainer should have $\frac{1}{4}$-inch screen openings and a ratio of free screen area to pipe cross sectional area not less than 4 to 1.

6250. Gauge Connections.

6251. Plugged outlets for gauge connections should be provided at the top of each riser and just below the control valve of each riser. Such outlets should be piped into the building for the purpose of conveniently attaching a test pressure gauge.

6260. Branch Lines.

6261. Branch line pipe sizes should be as follows, this applying with either central riser or gridiron system. With the gridiron system the end head is considered as being the one di-

rectly in the center (or on either side of center if the number on line be even).

Maximum Number of Sprinklers Allowed on Branch Lines.

Size of Pipe Inches	*⅜-inch Orifice*	*5/16-inch Orifice*	*¼-inch Orifice*
1	2	3	5
1¼	4	6	6
1½	6	—	—

6262. Where sprinklers are over twelve feet apart, pipe sizes in excess of those specified in Paragraph 6261 should be used.

6263. No branch line should have over six sprinklers where central riser system is used. Where gridiron system (*i.e.*, a riser at each side with sprinklers located on the connected pipes) is used, the lines between side risers should not have over twelve sprinklers.

6300. Small Orifice Sprinklers.

6310. Window Sprinklers.

6311. Only sprinklers of such types as are approved for window, cornice, side wall or ridge pole service should be installed for such use. (See Paragraph 6124 on use of automatic sprinklers, and Paragraph 6411 on use of large orifice sprinklers.)

6312. Where there is but one horizontal line of window sprinklers, the sprinklers should have ⅜-inch orifices. Where conditions require more than one line of sprinklers the sprinklers should have orifices as follows:

	2 Lines	*3 Lines*	*4 Lines*	*5 Lines*	*6 Lines*
Top line	⅜ in.	⅜ in.	⅜ in.	⅜ in.	⅜ in.
Next below	5/16 in.	5/16 in.	⅜ in.	⅜ in.	⅜ in.
Next below		¼ in.	5/16 in.	5/16 in.	5/16 in.
Next below			¼ in.	5/16 in.	5/16 in.
Next below				¼ in.	¼ in.
Next below					¼ in.

6313. For windows not exceeding 5 feet wide one sprinkler should be placed at center near top, so located that the water discharged therefrom will thoroughly wet the upper part of the window, and by running down over the sash and glass wet to the greatest extent the entire window. This may ordinarily be accomplished by placing one sprinkler in the center with deflector about on a line with the top of the upper sash, and 7, 8 and 9 inches in front of the glass, with windows 3, 4 and 5 feet wide, respectively.

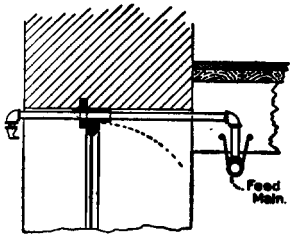


Fig. 6313. Connection for Window Sprinkler.

6314. Where windows are over 5 feet wide, or where mullions interfere, two or more heads should be used; this, together with size of orifice, should be determined by the authority having jurisdiction, it being understood that two ¼-inch sprinklers are approximately the equivalent of one ⅜ inch.

6315. For windows 5 to 6 feet wide one sprinkler may be used by special consent of the authority having jurisdiction.

6316. Where windows are 3 feet or less in width a size smaller orifice than required by Paragraph 6312 may be used, but in no case smaller than ¼ inch.

6317. Where there are over six horizontal rows of windows it may be preferable to omit sprinklers over the first story or possibly even the second story windows, but if over six lines are used the system should be divided horizontally with independent risers, and in some cases this may be desirable even where six lines or less are used. Thus where eight lines would be required, the four upper lines should be on one riser according to the table in Paragraph 6312 and the four lower lines similarly arranged on another riser. Where over six lines are used the authority having jurisdiction should be consulted regarding size of orifice.

6320. Cornice Sprinklers.

6321. When installing cornice sprinklers the rules for window sprinklers should be followed as far as they apply. The sizes of pipes should be the same as for window sprinklers of the same orifice.

6322. The discharge orifice should be at least ⅜ inch in diameter. Where exposure is serious and water supplies permit, ½-inch or ⅝-inch cornice sprinklers should be installed. (See Section 6400.)

6323. The sprinklers should not be over 8 feet apart and

with severe exposures a spacing somewhat less than 8-foot centers is needed. Projecting beams or other obstructions may make additional sprinklers necessary. Sprinklers should be so placed that the water will wet as much of the cornice as possible. With certain designs of cornice, extra sprinklers may be needed to protect the outside of the facia.

6324. Where the number of sprinklers and water supplies permit, it may be desirable to use sprinklers with orifices larger than ⅜ inch. (See Section 6400.)

6325. The value of open sprinklers for frame buildings is much enhanced by the use of wooden shutters at all window openings.

6330. Risers and Feed Mains.

6331. CENTRAL FEED RISERS.

1½ inch	Not over 6 sprinklers
2 inch	Not over 10 sprinklers
2½ inch	Not over 20 sprinklers
3 inch	Not over 36 sprinklers
3½ inch	Not over 55 sprinklers
4 inch	Not over 72 sprinklers

6332. For gridiron side feed risers, use the same sizes counting to the center of each line. If number on line is odd the center head may be neglected in figuring size of side risers, except that pipe feeding both risers must take into account all sprinklers which it feeds. Where feed main (including risers to the first branch line) is over twenty-five feet in length, feed main should be at least a size larger than the tables require. Where there is more than one riser, size of feed mains should be determined by the authority having jurisdiction, but should never be less than the full equivalent of the two largest risers.

6333. Where the water supply is adequate, outside sprinklers may be connected to cross mains of an inside automatic sprinkler system on the first floor, provided piping is sized as if all sprinklers were ½ inch and in the same area, including outside as well as inside sprinklers.

6400. Large Orifice Sprinklers (Window and cornice).

6410. Use.

6411. Large orifice sprinklers (½, ⅝, and ¾ inch) having deflectors designed to give a wide angle of distribution may be used for wide windows, windows in pairs, or for protecting windows in two stories from one line of sprinklers.

6420. Number and Location of Lines.

6421. At Windows. For buildings not over three stories in height, one line of sprinklers will often be sufficient, located at the top story windows. For buildings more than three stories in height, a line of sprinklers can be used in every other story beginning at the top. With an odd number of stories, the lowest line can protect the first three stories. When several lines are used, the orifice should be decreased, one size for each successive line below the top, but in no case should an orifice less than ½ inch be used. Where the construction is such, due to overhanging sills or deep set windows, that all parts of the windows and frames will not be thoroughly wet by a single line or lines at alternate stories with large orifice sprinklers, sprinklers of small orifice

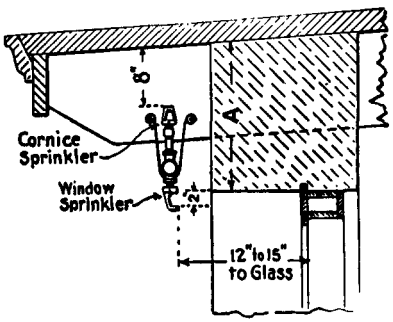


Fig. 6422-1. Location of Window and Cornice Sprinklers Where "A" Is Less Than 30 Inches.

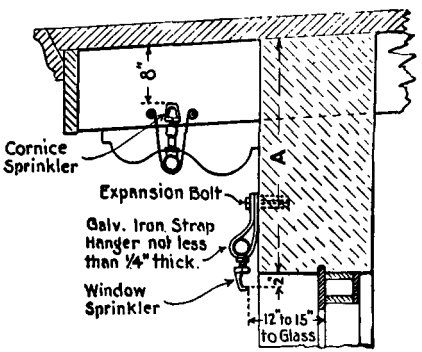


Fig. 6422-2. Location of Window and Cornice Sprinklers Where "A" Is More Than 30 Inches.

should be installed over windows of each story. A test may be advisable preceding each important installation to determine that all parts of the glass and frame in each story will be wet.

6422. At Cornices. Wood cornices where only a short distance above the windows can be protected by cornice sprinklers supplied by the same pipe used for the window sprinklers. (See Fig. 6422–1.)

Where cornices are a considerable distance above the upper windows, an independent line may be necessary as shown in Fig. 6422–2.

6423. At Wood Walls. For the protection of the side of a wooden building one row of window sprinklers at the extreme top should be used, so arranged that both the cornice and the side of the building will be wet. Protection can usually be provided without the introduction of additional sprinklers for the cornice.

6430. Position for Sprinklers.

6431. Cornice sprinklers should be located with deflectors 8 inches below the roof plank and window sprinklers with deflectors 2 inches below the top of the sash and 12 to 15 inches out from the glass. Typical arrangements are shown in Figures 6422–1 and 6422–2. Special conditions may make modifications necessary. Where the face of the glass is close to the exterior wall, cantilever brackets or similar type hangers may be used to maintain the window sprinklers 12 to 15 inches out from the glass.

6440. Size of Orifice and Number of Sprinklers.

6441. For windows up to 5 feet wide use one ½-inch sprinkler at the center of each window. For windows from 5 to 7 feet wide use one ⅝-inch sprinkler at center of each window. For windows from 7 to 9½ feet wide use one ¾-inch sprinkler at center of each window. For windows from 9½ to 12 feet wide use two ½-inch sprinklers at each window.

6442. For cornices with bays up to 8 feet use one ½-inch cornice sprinkler in center of each bay. For cornices with bays from 8 to 10 feet wide use one ⅝-inch cornice sprinkler in center of each bay. For cornices with longer pockets use ½-inch cornice sprinklers spaced not over 8 feet apart or ⅝-inch cornice sprinklers spaced not over 10 feet apart.

6443. Where the overhang of the cornice is not much over

1 foot, window sprinklers should be used and should be spaced as follows:

½-in. sprinklers.....not over 5 ft. apart
⅝-in. sprinklers.....not over 7 ft. apart
¾-in. sprinklers.....not over 9½ ft. apart

6444. The window sprinklers should be placed above the pipe near the outer edge of the cornice with the deflectors not over 3 inches down from the cornice and at such an angle as to throw the water upward and inward.

6445. With an overhang of more than about 1 foot, cornice sprinklers should be used to protect the cornice and window sprinklers to protect the wall. The spacing of the cornice sprinklers should follow the schedule in Paragraph 6442 and the spacing of the window sprinklers should follow the schedule in Paragraph 6443.

6446. Usually the cornice sprinklers can be supplied from the same pipe which supplies the window sprinklers. (See Fig. 6422–1.) Where the overhang of the cornice is too great to bring the pipe supplying the cornice sprinklers within 15 inches of the wooden wall, a separate line of pipe should be provided for the window sprinklers protecting the wall.

TABLE 6451.

FOR BRANCH LINES

Pipe Sizes	*Maximum Area of Outlets Supplied*	*Maximum Number of Sprinklers Supplied* ½″ *Orifice*	⅝″ *Orifice*	¾″ *Orifice*
1¼ in.	0.4 sq. in.	1	1	
1½ in.	0.8 sq. in.	3	2	1
2 in.	1.5 sq. in.	7	4	3
2½ in.	3.0 sq. in.	14†	9†	6
3 in.	4.0 sq. in.		12†	9†
3½ in.	6.0 sq. in.			13†

†These figures apply only where both window and cornice sprinklers are attached to the same pipe. See lines 4, 5, 6 and 7 of Fig. 6454.

FOR RISERS AND FEED MAINS SUPPLYING BRANCH LINES

Riser Sizes	*Maximum Area of Outlets Supplied*	*Maximum Number of Sprinklers Supplied* ½″ *Orifice*	⅝″ *Orifice*	¾″ *Orifice*
2½ in.	2.3 sq. in.	11	7	5
3 in.	3.9 sq. in.	19	12	9
3½ in.	5.9 sq. in.	29	19	13
4 in.	8.1 sq. in.	40	26	18
5 in.	14.0 sq. in.	70	45	32
6 in.	23.0 sq. in.	115	74	52

6450. Schedule of Pipe Sizes.

6451. The area of outlets or the number of sprinklers supplied by a given size of pipe should not exceed that shown in Table 6451.

6452. Usually not more than six, or at the most seven sprinklers, should be supplied by a branch line, except where cornice and window sprinklers are installed in the same fitting.

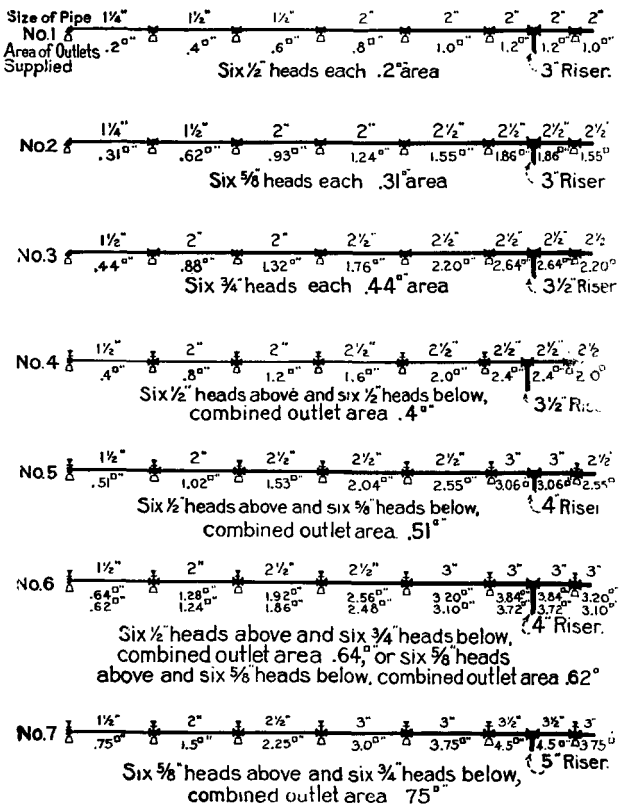


Fig. 6454. Schedule of Pipe Sizes.
Figures above the lines indicate the size of pipe. Figures below the lines indicate area of outlets supplied by each length of pipe.

6453. Where riser or feed main supplying nearly the maximum allowable number of sprinklers for a given size is more than 30 feet in length, the next larger size of pipe should be used.

6454. From Tables 6451 and 6454 and Fig. 6454, the size of pipe needed for any given number of sprinklers and the approximate amount of water needed to properly supply them can be readily determined. For example, a line of four ⅝-inch orifice sprinklers has a combined area of 4 x .31 or 1.24 square inches. A 2-inch pipe is therefore necessary for the first length on the line. The second length feeding three sprinklers (3 x .31=.93 square inch) also requires 2-inch pipe as 1½-inch pipe will supply only 0.8 square inch. The third length (2 x .31=.62 square inch) should be 1½-inch pipe and the end length on the line, viz., supplying one sprinkler (.31 square inch) should be 1¼-inch pipe.

TABLE 6454.

TABLE OF AREAS OF ORIFICES, SIZE OF PIPE THREADS ON NIPPLES AND APPROXIMATE DISCHARGE CAPACITIES OF LARGE ORIFICE SPRINKLERS

Size of Sprinklers or Orifices	*Size of Pipe Thread on Nipple*	*Area of Orifices or Outlets*	*Discharge of Ring Nozzles (Coef. of discharge .8) Pressure at Sprinklers*		
			5 lbs.	*10 lbs.*	*15 lbs.*
½ in.	½ in.	.20 sq. in.	13 G.P.M.	19 G.P.M.	23 G.P.M.
⅝ in.	¾ in.	.31 sq. in.	21 G.P.M.	29 G.P.M.	36 G.P.M.
¾ in.	¾ in.	.44 sq. in.	30 G.P.M.	43 G.M.P.	52 G.P.M.

6500. Tests and Flushing.

6510. Tests.

6511. All piping inside of buildings should be tested hydrostatically as specified in Section 1630.

6512. An operating test should be made of the system when completed, and all defects remedied.

6520. Flushing.

6521. Where the outside sprinkler riser is supplied through an independent connection to the yard mains, the connecting branch should be flushed out before connecting the open sprinkler riser as specified in Section 1620.

6522. All systems should be thoroughly flushed before sprinklers are in place in order to free the system from any stones or other obstructing material which might clog the orifices of the sprinklers.

CHAPTER 7. HYDRAULICALLY DESIGNED SPRINKLER SYSTEMS

7010. Definition:

7011. A hydraulically designed sprinkler system is one that is specifically designed to provide a prescribed water discharge when connected to an acceptable water supply.

7012. The design basis for a hydraulically designed system supersedes existing rules governing pipe schedules as presently covered in this Sprinkler Standard, however, all other requirements should be observed. (See Paragraph 3022.)

7020. Nameplate Data

7021. The installer shall properly identify a hydraulically designed automatic sprinkler system by a permanent placard, or sign under glass, indicating the location, number of sprinklers in the hydraulically designed section, and the basis of design (discharge density over design area of discharge, including gpm and residual pressure demand at base of riser). Such signs should generally be placed at the controlling alarm valve or dry pipe valve, for the system containing the hydraulically designed layout.

7100. Information Required

7110. Basic Design Information.

7111. Basic design criteria should be obtained from the authority having jurisdiction that recommends the hydraulically designed system, and water supply information should be reviewed with the authority having jurisdiction.

7120. Sprinkler System Requirements

7121. The following information should be included:

(a) Area of water application . . . . . sq. ft.

(b) Minimum rate of water application (density) . . . . . gpm/sq. feet.

(c) Area per sprinkler . . . . . sq. ft.

(d) Allowance for inside hose and outside hydrants . . . . . gpm.

7130. Water Supply Information

7131. The following information should be included:

(a) Description of existing or proposed water supply.

(b) Water flow data with existing or proposed water supply including:

(1) Location and elevation of hydrant or reference point.

(2) Static pressure ..... psi.

(3) Residual pressure ..... psi at ..... gpm for hydrant or reference point.

7140. Information Required on the Drawing.

7141. In addition to the requirements of Section 1440, the drawings should also contain the information mentioned in the remainder of this Section 7140.

7142. HYDRAULIC REFERENCE POINTS. Reference points may be shown by a number and/or letter designation and should indicate the comparable reference points shown on the hydraulic calculation sheets.

7143. SPRINKLERS. Description of sprinklers used.

7144. SYSTEM DESIGN CRITERIA. The minimum rate of water application (density), the design area of water application and the water required for hose streams both inside and outside should be included.

7145. ACTUAL CALCULATED REQUIREMENTS. The total quantity of water and the pressure required should be noted at a common reference point for each system.

7146. ELEVATION DATA. Relative elevations of sprinklers, junction points and supply or reference points should be noted.

7200. Data Sheets and Abbreviations.

7210. General.

7211. Hydraulic calculations should be prepared on form sheets that include a summary sheet, detailed work sheets and a graph sheet. (See copy of typical forms, Figures 7231 and 7241.)

7220. Summary Sheet.

7221. The summary sheet should contain the following information:

(a) Date

(b) Location

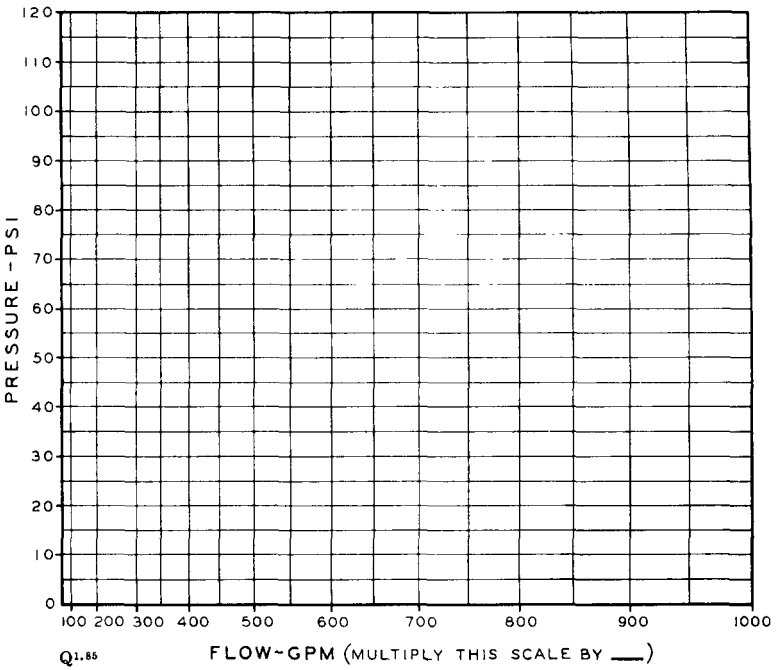


Fig. 7241. Sample Graph Sheet.

(c) Name of owner and occupant

(d) Building number

(e) Description of hazard

(f) Name and address of contractor

(g) Name and address of approving agency

(h) System design requirements

(1) Design area of water application . . . . . sq. ft.

(2) Minimum rate of water application (density) . . . . . gpm square feet.

(3) Area per sprinkler . . . . . square feet.

(i) Total water requirements as calculated including allowance for inside hose and outside hydrants.

(j) Water supply information

HYDRAULIC CALCULATIONS

FOR ____

____

SHEET ___ OF ___
BY ________
DATE ________
JOB NO. ______

SPRINK. IDENT. AND LOCATION	FLOW IN G.P.M.	PIPE SIZE	PIPE FITTINGS AND DEVICE	EQUIV. PIPE LENGTH	FRICTION LOSS PSI/FOOT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot.		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	
				Lgth		Pt	Pt	
	q			Fit		Pe	Pv	
	Q			Tot		Pf	Pn	

Fig. 7231. Sample Work Sheet.

7230. Detailed Work Sheets.

7231. Detailed work sheets (for sample work sheet, refer to Fig. 7231) or computer printout sheets should contain the following information:

(a) Sheet number.
(b) Sprinkler description and discharge constant (K).
(c) Hydraulic reference points.
(d) Flow in gpm.
(e) Pipe size.
(f) Pipe lengths, center to center of fittings.
(g) Equivalent pipe lengths for fitting and devices.
(h) Friction loss in psi per foot of pipe.
(i) Total friction loss between reference points.
(j) Elevation head in psi between reference points.
(k) Required pressure in psi at each reference point.
(l) Velocity pressure and normal pressure if included in calculations.
(m) Notes to indicate starting points, reference to other sheets or to clarify data shown.

7240. Graph Sheet.

7241. The graph sheet should be made to $N^{1.85}$. Water supply curves and system requirements plus hose demand should be plotted so as to present a graphic summary of the complete hydraulic calculation. (For sample graph sheet, refer to Fig. 7241.)

7250. Abbreviations and Symbols.

7251. The following standard abbreviations and symbols should be used on the calculation form:

Symbol or Abbreviation	*Item*
p	Pressure in psi
gpm	U. S. Gallons per minute.
q	Flow increment in gpm to be added at a specific location.
Q	Summation of flow in gpm at a specific location.
P_t	Total pressure in psi at a point in a pipe.

P_f	Pressure loss due to friction between points indicated in location column.
P_e	Pressure due to elevation difference between indicated points. This can be a plus value or a minus value. Where minus, the (—) shall be used; where plus, no sign need be indicated.
P_v	Velocity pressure in psi at a point in a pipe.
P_n	Normal pressure in psi at a point in a pipe.
E	90° Ell.
EE	45° Ell.
Lt.E	Long Turn Elbow
Cr	Cross
T	Tee — flow turned 90°
GV	Gate Valve
Del V	Deluge Valve
DPV	Dry-Pipe Valve
AL.V	Alarm Valve
CV	Swing Check Valve
St.	Strainer
psi	Pounds per square inch
v	Velocity of water in pipe in feet per second.

7300. Calculations.

7310. Friction loss formula.

7311. Pipe friction losses should be determined on the basis of Hazen and Williams formula.

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

where p is the frictional resistance in pounds pressure per square inch per feet of pipe, Q is the gallons per minute flowing and d is the actual internal diameter of pipe in inches with C as the friction loss coefficient.

7320. Equivalent Pipe Lengths of Valves and Fittings.

7321. Table 7321 should be used to determine the equivalent lengths of pipe for fittings and devices.

7330. Calculating Procedure.

7331. In order to maintain consistency in calculating a sprinkler system, manually or by computer, the following rules in this Section 7330 should be followed. Experience has shown that good results are obtained if the calculations are made in accordance with these rules.

(a) The design area shall be the hydraulically most remote area and shall include all sprinklers on both sides of the crossmain. Where it is not obvious by comparison that the rate of water application (density) in other areas is equal to or greater than the minimum specified then additional calculations should be submitted. (Sketch should be included to indicate the remote area.)

(b) All sprinklers in the design area except for the most remote sprinkler should discharge at a flow rate at least equal to the stipulated minimum water application rate (density).

(c) Calculate pipe friction loss in accordance with Hazen and Williams formula for a "C" value of 120 for black steel pipe, C-140 for copper tube and cement-lined cast-iron pipe, and C-100 for unlined cast-iron pipe. The authority having jurisdiction may recommend other "C" values.

(d) The density should be calculated on the basis of the floor area.

(e) Include pipe, fittings and devices such as valves, meters and strainers and calculate elevation changes which affect the sprinkler discharge.

(f) Calculate the loss for a tee or a cross where flow direction change occurs and based on the equivalent pipe length for the smaller size of the tee or cross in the path of the turn. Do not include any loss for that portion of the flow which passes straight through the run of a tee or a cross.

(g) Calculate the loss of reducing elbows based on the equivalent feet value of the smallest outlet. Use the equivalent feet value for the "standard elbow" on any abrupt ninety-degree turn, such as the screw-type pattern. Use the equivalent feet value for the "long turn elbow" on any sweeping ninety-degree turn, such as a flanged, welded or mechanical joint-type elbow.

TABLE 7321

EQUIVALENT PIPE LENGTH CHART

Fittings and Valves	*Fittings and Valves Expressed in Equivalent Feet of Pipe.*												
	1 in.	*1¼ in.*	*1½ in.*	*2 in.*	*2½ in.*	*3 in.*	*3½ in.*	*4 in.*	*5 in.*	*6 in.*	*8 in.*	*10 in.*	*12 in.*
45° Elbow	1	1	2	2	3	3	3	4	5	7	9	11	13
90° Standard Elbow	2	3	4	5	6	7	8	10	12	14	18	22	27
90° Long Turn Elbow	2	2	2	3	4	5	5	6	8	9	13	16	18
Tee or Cross (Flow Turned 90°)	5	6	8	10	12	15	17	20	25	30	35	50	60
Gate Valve	–	–	–	1	1	1	1	2	2	3	4	5	6
Swing Check*	5	7	9	11	14	16	19	22	27	32	45	55	65

Use with Hazen and Williams' C = 120 only. For other values of C, the figures in Table 7321 should be multiplied by the factors indicated below:

Value of C	100	120	130	140
Multiplying factor	0.713	1.00	1.16	1.32

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

Specific friction loss values or equivalent pipe lengths for alarm valves, dry-pipe valves, deluge valves, strainers and other devices shall be made available to the authority having jurisdiction.

*Due to the variations in design of swing check valves, the pipe equivalents indicated in the above chart to be considered average.

(h) Friction loss should be excluded for tapered reducers and for the fitting directly supplying the sprinkler.

(i) Orifice plates or sprinklers of different orifice sizes should not be used for balancing the system.

(j) Feed mains and cross mains may be looped to divide the total water flowing to the design area.

(k) The water allowances for inside hose and for outside hydrants may be combined and added to the system requirement at the system connection to the underground main. The total water requirement should then be calculated through the underground main to the point of supply.

APPENDIX A

Standard for

Indoor General Storage

NFPA No. 231 — 1965

Excerpts pertaining to sprinkler protection

1. Application and Scope.

(a) This standard applies to storage, 21 feet or less in height, of commodities which with their packaging and storage aids would classify as ordinary combustibles. This standard also applies to storage of commodities which with their packaging and storage aids would classify as noncombustibles regardless of storage height. This standard does not cover unpackaged bulk storage such as grain, coal or similar commodities.

Certain specific commodities introduce hazards different than contemplated by this standard. Examples are rubber tires, roll paper, and wax-coated cartons. The Authority having jurisdiction should be consulted for protection recommendations of these and materials with similar hazard.

3. Definitions.

ORDINARY COMBUSTIBLES. This term designates commodities, packaging or storage aids which have heats of combustion (British thermal units per pound) similar to wood, cloth or paper and which produce fires that may normally be extinguished by the quenching and cooling effect of water. This type of fire is defined as a Class A fire in the Standard for the Installation of Portable Fire Extinguishers, NFPA No. 10 — 1969.

HORIZONTAL CHANNEL. Any uninterrupted space in excess of five feet in length between horizontal layers of stored commodities. Such channels may be formed by pallets, shelving, racks or other storage arrangements.

CHAPTER 1. CLASSIFICATION OF STORAGE

11. Type I Storage.

111. Type I storage is that in which combustible commodities or noncombustible commodities involving combustible packaging or storage aids are stored over 15 feet but not more than 21 feet high in solid piles or over 12 feet but not more than 21 feet high in piles that contain horizontal channels.

Minor quantities of commodities of hazard greater than ordinary combustibles may be included without affecting this general classification.

12. Type II Storage.

121. Type II storage is that in which combustible commodities or noncombustible commodities involving combustible packaging or storage aids are stored not over 15 feet high in solid piles or not over 12 feet high in piles that contain horizontal channels.

Minor quantities of commodities of hazard greater than ordinary combustibles may be included without affecting this general classification.

13. Type III Storage.

131. Type III Storage is that in which the stored commodities, packaging and storage aids are noncombustible or contain only a small concentration of combustibles which are incapable of producing a fire that would cause appreciable damage to the commodities stored or to noncombustible wall, floor or roof construction. Ordinary combustible commodities in completely sealed noncombustible containers may qualify in this classification subject to the authority having jurisdiction. General commodity storage that is subject to frequent changing and storage of combustible packaging and storage aids is excluded from this category.

CHAPTER 2. BUILDING ARRANGEMENT

22. Areas.

221. Fire areas of warehouses should be limited to maintain the total value of the commodity within reasonable limits yet not be too restrictive for low value commodities. Conversely, high value and vital commodities should be restricted to smaller areas than for average value commodities such as found in the usual general warehouse. The combustibility of the commodity and its packaging or storage aids should be taken into account. Other considerations are the difficulty encountered in fire fighting and salvage operations in large undivided areas.

222. Type I and Type II Storage. When protected in accordance with this standard, 50,000 square feet is considered the maximum area for average value commodities enclosed by exterior walls or a combination of exterior walls and fire walls. This can be increased or decreased depending on conditions noted in Section 221. A multistory building having three-hour fire-resistive construction at each floor with all vertical openings adequately protected shall be considered as having each floor a separate fire area. A multistory building of less than three-hour fire resistance at each floor shall be considered to be one fire area with the floor area per level being cumulative.

CHAPTER 4. FIRE PROTECTION

42. Water Supplies.

421. Water supplies for automatic sprinklers shall be provided in accordance with Standard for Installation of Sprinkler Systems, NFPA No. 13 — 1966. The following should be used to supplement information in Standard for Installation of Sprinkler Systems, NFPA No. 13 — 1969, Table 2111, Guide to Water Supply Requirements for Sprinkler Systems. The minimum acceptable flow from sprinklers, with reasonably uniform distribution for any area protected, should be as follows:

Type I Storage: 1,250 gallons per minute distributed over an area not exceeding 5,000 square feet to 1,800 gallons per minute distributed over an area not exceeding 6,000 square feet for at least three hours duration.

Type II Storage: 750 gallons per minute distributed over an area not exceeding 3,750 square feet to 1,250 gallons per minute distributed over an area not exceeding 5,000 square feet for at least two hours duration.

NOTE 1: In using these performance criteria, due consideration should be given to the type of construction, the height of piling, elevation of roof, piling methods or configuration, pile size, aisle width, venting, type of system (wet or dry), and other critical factors.

NOTE 2: For Type III Storage, see Standard for Installation of Sprinkler Systems, NFPA No. 13 — 1969.

422. Water supplies for hose streams shall be provided to supplement that required for automatic sprinklers. Residual pressures at yard level for the total flow required (hose streams and sprinklers) should be sufficient to provide for proper hose streams without reducing residual pressures below those necessary for sprinklers. The water supplies shall be capable of supplying at least 750 gallons per minute for three hours for Type I Storage, 500 gallons per minute for two hours for Type II Storage in addition to the sprinkler demand. For locations containing several warehouses or for warehouses larger than recommended in Section 222, flows greater than listed above are desirable.

423. Where values are high, it is advisable to obtain an adequate water supply from two reliable sources.

APPENDIX B

Standard for Storage of

Cellular Rubber and Plastic Materials

NFPA No. 231B — 1968

Excerpts pertaining to sprinkler protection

1. Application and Scope

(a) This standard contains recommendations for the proper arrangement and safeguarding of foam rubber, sponge rubber, and plastic foams (hereinafter referred to as "cellular materials") when stored up to 20 feet high, against damage by fire when these materials are stored inside buildings as packaging, fabricated products, or bulk stock.

Table I

Rubber or Plastic Cellular Materials
(See definition in Paragraph 3)

1. Cellular Rubber
   a. natural
   b. synthetic
2. Cellular Plastic
   a. polyethylene
   b. polystyrene
   c. urethane (flexible and rigid)
   d. vinyl (polyvinyl chloride)
   e. other

(b) The provisions contained in this standard apply to new buildings. They should be used as a basis for evaluating or improving arrangements, safeguards and protection at existing storage facilities or when converting existing buildings or sections of buildings to this type of storage.

(c) This standard is not intended to apply to relatively small, isolated buildings where the cost of the recommended provisions is unreasonable for the total value involved.

3. Definitions

AVAILABLE HEIGHT FOR STORAGE. The maximum height at which commodities can be stored above the floor and still maintain adequate clearance from structural members and the required clearance below sprinklers.

CONTAINER (shipping, master, or outside container). A receptacle which is sufficiently strong, by reason of material, design, and construction, to be shipped safely without further packaging. Examples: Drums — fibre, plywood, metal; Sacks — paper, fabric; Boxes — wood, fibre, cellular plastic.

EXPOSURE. The exterior presence of combustibles which, if ignited, could cause damage to the storage building or its contents.

FIRE WALL. A wall designed to prevent the spread of fire, having a fire resistance rating of not less than four hours and having sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of wall.

HORIZONTAL CHANNEL. Any uninterrupted space in excess of five feet in length between horizontal layers of stored commodities. Such channels may be formed by pallets, shelving, racks or other storage arrangements.

NONCOMBUSTIBLE. This term designates commodities, packaging or storage aids which will not ignite, burn or liberate flammable gases when heated to a temperature of 1,380 degrees Fahrenheit for five minutes.

PACKAGING. This term designates any commodity wrapping, cushioning or container.

RUBBER OR PLASTIC CELLULAR MATERIAL (also referred to as "Foam" or "Sponge Material"). Rubber or plastic material the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout its mass.

STORAGE AIDS. This term designates commodity storage devices such as shelves, pallets, dunnage, decks, platforms, trays, bins, separators and skids.

WAREHOUSE. Any building or area within a building used principally for the storage of commodities.

41. Sprinkler Systems.

411. For proper protection of storage of cellular materials or noncombustible material in cellular rubber or plastic packaging, automatic sprinklers shall be provided in accordance with the Standard for Installation of Sprinkler Systems, NFPA No. 13 — 1969. The following should be used to supplement information contained in that standard.

412(a). For the protection of expanded polystyrene containers or packaging, the following sprinkler discharge densities should be used.

Piling Height	Sprinkler Discharge Density
Feet	*Gallons per Minute per Square Foot*
7	0.15
10	0.20
15	0.35
20	0.55

NOTE: The sprinkler discharge densities indicated above were developed from large scale fire tests by a recognized testing laboratory on expanded polystyrene containers and packaging both flame-inhibited and uninhibited types.

(**b**) For the protection of other cellular materials, test data are either insufficient or lacking to establish a recommended schedule of sprinkler discharge densities. The authority having jurisdiction should be consulted.

413. Sprinkler discharge densities should be applied over a minimum of 5,000 square feet. The minimum area of water application is affected by the following conditions and when unsatisfactory conditions exist, the minimum area should be increased.

(a) Accessibility to exterior and interior of building.
(b) Adequacy of aisle space.
(c) Adequacy of roof vents and curtain boards.
(d) Stability of piles.
(e) Temperature rating of sprinklers.
(f) Type of sprinkler system (wet, preaction, dry).
(g) Height of pile.

414. Wet sprinkler systems should be used where possible.

42. Water Supplies.

421. Water supplies for automatic sprinklers shall be sufficient to provide the required sprinkler discharge density over the required area of application (see paragraph 423).

NOTE: Caution should be exercised in determining the amount of water needed from density and area requirements since multiplication of the two factors will result in a figure which is less than the amount of water actually required. By proper head spacing, pipe sizing, and arrangement, the water requirements can be made to approach nearly the density multiplied by the area of application. The authority having jurisdiction should be consulted.

422. Where sprinkler discharge densities as recommended in 412(a), 412(b) and 413 are not needed as a criterion for protection, water supplies should conform to Standard for Installation of Sprinkler Systems NFPA No. 13 — 1969, Table 2111, Guide to Water Supplies for Sprinkler Systems, and to the Standard for Indoor General Storage, NFPA No. 231 — 1965.

423. Total water supplies shall include provision of a minimum of 750 gallons per minute for hose streams, in addition to that required for automatic sprinklers. Water supplies should be capable of supplying the demand for sprinkler systems and hose streams for three hours.

424. Where values are high, it is advisable to provide an adequate water supply from two reliable sources.

APPENDIX C

AUTOMATIC SPRINKLER PROTECTION IN WOODWORKING PLANTS

Woodworking properties usually involve, singly or in combination, a number of factors mitigating against effective control of fire by automatic sprinklers. Such factors may include high combustibility of contents, obstruction to water distribution, high ceilings, open sides, unprotected floor openings and steeply pitched roofs. Incidentally, many of such properties are not heated, thus involving dry pipe sprinkler protection with the resultant inherent delay in the application of water on the fire. The Sprinkler Standard does not define woodworkers, nor is an occupancy classification assigned such risks.

The term "woodworking properties" may be defined so as to include buildings occupied as sawmills, planing mills, furniture factories, bobbin and shuttle mills, veneer mills, box factories, basket factories, crate factories, excelsior factories, cabinet shops, millwork shops and others; also, buildings incidental to such occupancies including dry kilns, cooling sheds, sorting sheds, stacking sheds and buildings occupied for the storage of lumber and products made of wood. It is not intended, however, that properties occupied solely for the assembly of prefabricated wooden parts or properties involving minor incidental woodworking operations be considered as woodworking properties.

Spacing

Ordinary hazard spacing (130 sq. ft.) is recommended in woodworking plants, except that in definitely established storage areas in these occupancies and in buildings used for storage such as lumber sheds, cooling sheds, dry kilns, and fuel vaults, spacing should not exceed that stated in Paragraphs 4112 and 4132, NFPA No. 13.

Pipe Schedule for Use in Woodworking Plants

Pipe sizes provided under Paragraph 3051 (extra hazard), NFPA No. 13, are recommended for all of the foregoing occupancies, with the following amendments: Number of sprinklers permitted on 6-inch pipe — 275. Number of sprinklers permitted on 8-inch pipe — 400. This piping schedule is recommended as a guide only. Particular attention should be given to balanced systems, or portions of systems, using center-central and side-central feeds. Sections of piping that are hydraulically critical should be adjusted to assure efficient performance with available water supplies.

Pipe sizing and spacing rules applying to extra hazard occupancies should be followed for areas in which painting, upholstering or similar hazardous processes are conducted.

It is also recommended that sprinkler protection be installed in spaces under combustible ground floors regardless of whether or not they are occupied. When such spaces are unoccupied and provided that they conform to Paragraph 4304 of the Sprinkler Standard, pipe sizing and spacing in accordance with standard for Ordinary Hazard Occupancy may be acceptable.

NOTE: Originally published by the American Insurance Association (formerly National Board of Fire Underwriters), July, 1962.

APPENDIX D

SUMMARY OF SPACING RULES

Maximum Distance of Deflectors Below Ceiling (Inches)				
Type of Construction	in bays*		under beams	
	comb.	noncomb.	comb.	noncomb.
Smooth Ceiling	10	12	14	16
Beam and Girder	16	16	20	20
Panel up to 300 sq. ft.	18	18	22	22
Bar Joists	10	12	—	—
Open Wood Joists—center 3′ or less (see para. 4250 for centers over 3′)	6	—	—	—

Minimum below ceiling is 3″ except 1″ below open wood joists.
Minimum below beams 1″, maximum 4″. Do not exceed maximum below ceiling.
*Not more than 4″ below beams where lines run across beams.

Maximum Coverage Per Sprinkler:

Light Hazard — 200 sq. ft. smooth ceiling and beam and girder construction
130 sq. ft. open wood joist
168 sq. ft. all other types of construction

Ordinary Hazard — 130 sq. ft. all types of construction except
100 sq. ft. high piled storage (see para. 4132)

Extra Hazard — 90 sq. ft. all types of construction

Direction of Lines: Either direction to facilitate hanging except:
Across beams for beams on girders 3′ to 7½′ on centers
Across joists for wood joists (open or sheathed) and bar joists (through or under)

Maximum Spacing Between Lines and Sprinklers:

Light and Ordinary Hazard — 15 ft. except 12 ft. for high piled storage (see para. 4112)

Extra Hazard — 12 ft.

Stagger Sprinklers:

Light Hazard — Only with open wood joists when distance between sprinklers exceeds 12 ft.

Ordinary Hazard — Only if distance between sprinklers on lines exceeds 12 ft. except that they must always be staggered under solid beams spaced 3 to 7½ ft. on center

Extra Hazard — Always

See Sections 3630 and 4400 for rules on Sidewall Sprinklers.

APPENDIX E — REFERENCES

The following publications are referenced in the text of this Standard or are particularly pertinent to the installation of sprinkler systems in specific locations.

The Flood Problem in Fire Prevention and Protection. Available from the American Insurance Association (NBFU), 85 John Street, New York, N. Y. 10038; 222 West Adams Street, Chicago, Ill. 60606, or 465 California Street, San Francisco, Calif. 94104.

Processes, Hazards and Protection Involved in the Manufacture of Spirituous Liquors. Available from the American Insurance Association (NBFU), 85 John Street, New York, N. Y. 10038; 222 West Adams Street, Chicago, Ill. 60606, or 465 California Street, San Francisco, Calif. 94104.

Cotton Warehouses and Compresses. Available from authority having jurisdiction in states where this class of property is located.

Galvanizing of Pipe, Specifications A120, available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

American Standard Code for Pressure Piping, USAS B31.1, available from the American Society of Mechanical Engineers, 345 East 47th St., New York, N. Y. 10017. Price $4.00.

Wrought Steel and Wrought Iron Pipe, USAS B36.10, available from the American Society of Mechanical Engineers, 345 East 47th St., New York, N. Y. 10017. Price $1.50.

Recommended Good Practices for Protection of High Piled Stock. Available from the American Insurance Association (NBFU), 85 John Street, New York, N. Y. 10038; 222 West Adams Street, Chicago, Ill. 60606, or 465 California Street, San Francisco, Calif. 94104.

A.S.M.E. Boiler and Pressure Vessels Code, Section IX, Welding Qualifications — 1968. Available from The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N. Y. 10017.

APPENDIX F

The following NFPA Standards are referenced in the text of Standard No. 13 or are Standards that contain references to or supplementary material on sprinkler systems. These standards may be obtained from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass. 02110. The Standards are published in pamphlet form and in one of the Volumes of the National Fire Codes published by the Association.

Std. No.	Title
10	Installation of Portable Fire Extinguishers
10A	Maintenance and Use of Portable Fire Extinguishers
13A	Care and Maintenance of Sprinkler Systems
13E	Fire Department Operations in Properties Protected by Sprinklers and Standpipe Systems
14	Installation of Standpipes and Hose Systems
15	Water Spray Fixed Systems for Fire Protection
19	Specifications for Automotive Fire Apparatus
20	Installation of Centrifugal Fire Pumps
21	Operation and Maintenance of Steam Fire Pumps
22	Water Tanks for Private Fire Protection
24	Outside Protection (Yard Piping)
26	Supervision of Valves Controlling Water Supplies for Fire
30	Flammable and Combustible Liquids Code
33	Spray Finishing Using Flammable Materials
34	Dip Tanks Containing Flammable or Combustible Liquids
35	Manufacture of Organic Coatings
36	Solvent Extraction Plants
40	Cellulose Nitrate Motion Picture Film
42	Storage, Handling and Use of Pyroxylin Plastics in Factories
43	Pyroxylin Plastics in Warehouses, Wholesale and Retail Stores
48	Storage, Handling and Processing of Magnesium
61B	Prevention of Dust Explosions in Terminal Grain Elevators
61C	Prevention of Dust Explosions in Flour and Feed Mills and Allied Grain Storage Elevators
62	Dust Hazards of Pulverized Sugar and Cocoa
70	National Electrical Code
71	Central Station Protective Signaling Systems
72A	Local Protective Signaling Systems
72B	Auxiliary Protective Signaling Systems
72C	Remote Station Protective Signaling Systems
72D	Proprietary Protective Signaling Systems
75	Protection of Electronic Computer/Data Processing Equipment
80	Installation of Fire Doors and Windows
80A	Protection of Openings Against Fire Exposure in Fire Resistive Walls
81	Fur Storage, Fumigation and Cleaning
82	Incinerators and Rubbish Handling

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REFERENCE

National Fire Protection Association
International
60 Batterymarch Street, Boston, Mass. 02110

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection. Anyone interested may become an Associate Member; the annual dues are $30.00. National and regional societies and associations are eligible to be Organization Members; annual dues are $225. Full membership information is available on request.

This is one of a large number of publications on fire safety issued by the Association. All NFPA codes, standards, and recommended practices are prepared by NFPA Technical Committees and adopted at an Annual Meeting of the Association. They are intended to prescribe reasonable measures for minimizing losses of life and property by fire.

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TYPICAL POCKET EDITIONS OF NFPA STANDARDS

List revised as of June, 1969. Most of these standards also appear, with identical text, in the National Fire Codes, republished annually. Titles are abbreviated. For complete list of publications write NFPA.

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