# NFPA 16 Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems 1995 Edition

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

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

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NFPA 16

Standard for the

# Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems

1995 Edition

This edition of NFPA 16, *Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, was prepared by the Technical Committee on Foam-Water Sprinklers and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 14–16, 1994, in Toronto, Ontario, Canada. It was issued by the Standards Council on January 13, 1995, with an effective date of February 7, 1995, and supersedes all previous editions.

The 1995 edition of this document has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

## Origin and Development of NFPA 16

The first standard involving foam-water sprinkler systems was published in 1954 by the National Board of Fire Underwriters (now American Insurance Association) and was titled *Standard for Combined Foam- and Water-Spray Systems*. The NFPA Technical Committee on foam-water sprinklers was established in 1959 with assistance from the NBFU. The first edition of this standard was published in 1962.

Various updates to the standard were completed in 1968, 1974, 1988, and 1990. Changes were made to recognize the use of new foam concentrates and to improve the language and format of the document.

The 1995 edition includes clarification of the scope of the standard, improvements to the hydraulic design criteria, and recognition of a fourth proportioning method.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

**Committee Scope:** This Committee shall have primary responsibility for documents on the protection of hazards by systems designed to function as both sprayed foam and water discharge, as from a sprinkler system.

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# Deluge Foam-Water Sprinkler and
# Foam-Water Spray Systems
### 1995 Edition

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

Information on referenced publications can be found in Chapter 7 and Appendix B.

## Foreword

The uses of foam (or mechanical foam, as it was first called) for fire protection have expanded greatly since it was first used in the 1930s. Original applications of this agent utilized a proteinaceous-type liquid foam-forming concentrate delivered in water solution to a turbulence-producing foam generator or nozzle that then directed the mechanically formed foam to a burning fuel tank or area of burning flammable fuel. (Details of these and similar applications are found in NFPA 11, *Standard for Low-Expansion Foam*, NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting Operations*, and NFPA 403, *Standard for Aircraft Rescue and Fire Fighting Services at Airports*.) As the technology for using this agent developed over the years, new systems and new devices for applying the foam to the hazard being protected and new foam-forming liquid concentrates were proven useful for fire protection purposes. The application of foam from overhead sprinkler-type systems using specially designed foam-making nozzles capable of either forming a foam from protein-type foam concentrate solutions or delivering a satisfactory water discharge pattern where supplied with water only was an early development (circa 1954) in foam fire protection. Protein, fluoroprotein, and aqueous film-forming concentrates or film-forming fluoroprotein foam concentrates (as defined in NFPA 11, *Standard for Low-Expansion Foam*) are suitable for use with foam-water sprinklers. This latter type of foam concentrate also has been found to be suitable for use with standard sprinklers of the type referred to in NFPA 13, *Standard for the Installation of Sprinkler Systems*, where the system is provided with the necessary foam concentrate proportioning equipment. Care should be exercised to ensure that the choice of concentrate and discharge device are listed for use together.

This standard is based on available test data and design experience concerning the design information, installation recommendations, operating methods, and maintenance needs for the types of foam-water sprinkler systems described above and foam-water spray systems utilizing protein, fluoroprotein, or aqueous film-forming foam or film-forming fluoroprotein foam concentrates. These systems possess the common ability to either discharge foam in a spray form or discharge water in a satisfactory pattern for fire protection purposes.

## Chapter 1 General Information

**1-1 Scope.**

**1-1.1** This standard contains minimum requirements for the design, installation, and maintenance of deluge foam-water sprinkler systems. These systems shall be designed with the required density for either foam or water application as the controlling factor, depending on the design purpose of the system. It is not the intent of this standard to specify where foam-water sprinkler protection is required. The determination of where foam-water sprinklers are required shall be made in accordance with such applicable standards as NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 409, *Standard on Aircraft Hangars*.

**1-1.2** This standard shall not apply where separate foam-water sprinkler or closed-head foam-water sprinkler systems are to be installed. Such sprinkler systems shall be in accordance with NFPA 11, *Standard for Low-Expansion Foam*, NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, NFPA 13, *Standard for the Installation of Sprinkler Systems*, or NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*.

**1-2 Purpose.** The purpose of this standard is to provide a reasonable degree of protection for life and property from fire through installation requirements for foam-water deluge sprinkler systems and foam-water spray systems based on sound engineering principles, test data, and field experience.

Nothing in this standard is intended to restrict new technologies or alternate arrangements, provided the level of safety prescribed by the standard is not lowered.

**1-2.1** Unless otherwise noted, it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

**1-3 Definitions.**

**Approved.** Acceptable to the authority having jurisdiction.

NOTE: The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

**Authority Having Jurisdiction.** The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions

and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**Density.** The unit rate of application to an area, expressed in [gpm/ft$^2$ (L/min)m$^2$]. The term "density" as used in this standard refers to the application of water in some cases and the application of foam solution in other cases.

**Discharge Devices.** There are four principal types of discharge devices that are installed at the discharge outlets of the systems covered by this standard. Care shall be exercised to ensure that the choice of foam concentrate and discharge device are listed for use together.

*Foam-Water Spray Nozzles.** These are also air-aspirating discharge devices, but they differ in design from foam-water sprinklers. They distribute foam, or water, in a special directional pattern peculiar to the particular nozzle.

*Foam-Water Sprinklers.** These discharge devices are specially designed, open-type, air-aspirating sprinklers consisting of an open barrel body foam maker that terminates in a deflector to shape the pattern of the foam or water issuing from the assembly. These devices produce water discharge patterns highly comparable to those of standard sprinklers.

NOTE: See NFPA 13, *Standard for the Installation of Sprinkler Systems*, where discharging at the same rates of flow.

*Non-Air-Aspirated Spray Nozzles.* These discharge devices are open, directional spray nozzles. Where supplied with an approved foam solution such as AFFF, they discharge foam in a pattern peculiar to the discharge device.

NOTE: See NFPA 11, *Standard for Low-Expansion Foam*, for specifics on application rates.

*Standard Sprinklers.* These discharge devices are the standard sprinklers, without heat-responsive elements, referred to in NFPA 13, *Standard for the Installation of Sprinkler Systems*, and they are non-air-aspirating. Where they are supplied with aqueous film-forming foam (AFFF) air foam solution or film-forming fluoroprotein (FFFP) air foam solution, a foam discharge pattern is produced closely conforming to the water discharge pattern of these sprinklers.

**Foam.** Foam is an aggregation of air-filled bubbles of lower specific gravity than flammable liquids or water. In the case of systems covered by this standard, it extinguishes fires by resisting flame and heat attack as it falls from an overhead sprinkler-type system, where it is formed initially, to a burning flammable or combustible liquid surface, where it flows freely, progressively removing heat and forming an air-excluding continuous blanket or film over the fuel, thus sealing volatile combustible vapors from access to air or reignition. The foam produced by these systems possesses characteristics of lower expansion, higher fluidity, and more rapid foam solution drainage than foams useful in other circumstances.

NOTE: See NFPA 11, *Standard for Low-Expansion Foam;* NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting Operations;* NFPA 403, *Standard for Aircraft Rescue and Fire Fighting Services at Airports;* and NFPA 412, *Standard for Evaluating Aircraft Rescue and Fire Fighting Foam Equipment,* for further information.

**Foam Concentrates.** There are four principal types of liquid foam-forming concentrates useful for incorporation in the systems covered by this standard.

*Aqueous Film-Forming Foam (AFFF) Concentrates.* These foam concentrates consist of a fluorinated surfactant with suitable foam stabilizers and additives. Foams formed from these concentrates act as a barrier to exclude air or oxygen and develop aqueous films on the fuel surface capable of suppressing the evolution of fuel vapors. Current formulations are available for use at recommended nominal concentrations of 3 percent or 6 percent by volume of the solution discharge of the system.

*Film-Forming Fluoroprotein (FFFP) Foam Concentrates.* These foam concentrates use fluorinated surfactants to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors. This type of foam also utilizes a protein base, plus stabilizing additives and inhibitors. The foam usually is diluted with water to a 3 or 6 percent solution.

*Fluoroprotein-Foam Concentrates.* These concentrates are very similar to protein-foam concentrates as described above but with a synthetic fluorinated surfactant additive. They form an air-excluding foam blanket and also can deposit a vaporization-inhibiting film on the surface of a liquid fuel. These concentrates are used at recommended nominal concentrations of 3 percent and 6 percent of the solution discharge of the system.

*Protein-Foam Concentrates.* These foam concentrates consist primarily of products from a protein hydrolysis plus stabilizing additives and inhibitors. Current formulations are available for use at recommended nominal concentrations of 3 percent or 6 percent by volume of the solution discharge of the system.

**Foam Solution.** A mixture consisting of a foam concentrate in suitable proportions in either fresh or salt water.

**Foam-Water Spray System.** A foam-water spray system is a special system that is pipe-connected to a source of foam concentrate and to a water supply and equipped with foam-water spray nozzles for extinguishing agent discharge (foam followed by water or in reverse order) and distribution over the area to be protected. System operation arrangements parallel those for foam-water sprinkler systems as described in the definition of Foam-Water Sprinkler System.

**Foam-Water Sprinkler System.** A foam-water sprinkler system is a special system that is pipe-connected to a source of foam concentrate and to a water supply and equipped with appropriate discharge devices for extinguishing agent discharge and for distribution over the area to be protected. The piping system is connected to the water supply through a control valve that usually is actuated by operation of automatic detection equipment installed in the same

areas as the sprinklers. When this valve opens, water flows into the piping system, foam concentrate is injected into the water, and the resulting foam solution discharging through the discharge devices generates and distributes foam. Upon exhaustion of the foam concentrate supply, water discharge follows and continues until shut off manually. Systems can be used for discharge of water first, followed by discharge of foam for a specified period, and then followed by water until manually shut off. Existing deluge sprinkler systems that have been converted to the use of aqueous film-forming foam or film-forming fluoroprotein foam are classified as foam-water sprinkler systems.

**Listed.** Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**Proportioning.** The continuous introduction of foam-water concentrate at the required ratio into the water stream to form foam solution.

**Rate.** The total flow of solution per unit of time, which is expressed in gpm (L/min) in this standard.

**Shall.** Indicates a mandatory requirement.

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

### 1-4 System Design.

**1-4.1** Automatic operation shall be provided and supplemented by auxiliary manual tripping means.

*Exception: Manual operation only shall be permitted where acceptable to the authority having jurisdiction.*

**1-4.2** Systems shall deliver foam for a specified period at given densities (gal/min/ft$^2$) [(L/min)/m$^2$] to the hazards they protect, either prior to water discharge or following water discharge, depending upon system design purpose.

**1-4.3** Following completion of discharge of foam to the hazards protected, these special systems shall discharge water until manually shut off.

**1-4.4** Authorities having jurisdiction shall be consulted as to the means by which a reserve supply of foam concentrate shall be made available. The purpose of a reserve supply of concentrate is to have available the means for returning systems to service-ready condition following system operation. The reserve supply shall be listed for use with system components. (*See Section 2-3.*)

### 1-5 Applicability.

**1-5.1** Foam-water sprinkler and foam-water spray systems shall discharge foam or water from the same discharge devices. Because of this dual extinguishing agent discharge characteristic, these systems shall be selectively applicable to combination Class A and Class B hazards, in accordance with NFPA 10, *Standard for Portable Fire Extinguishers.*

NOTE: Caution should be exercised where auxiliary extinguishing equipment is used with these systems. Some extinguishing agents are incompatible with some foams.

**1-5.2** Foam-water deluge systems are especially applicable to the protection of most flammable liquid hazards. They shall be permitted to be used for any of the following purposes or combinations thereof:

(a) **Extinguishment.** The primary purpose of such systems is the extinguishment of fire in the protected hazard. For this purpose, suitable foam-solution discharge densities [gpm/ft$^2$ or (L/min)/m$^2$] shall be provided by system design and use of selected discharge devices and by provision of adequate supplies of air-water at sufficient pressures to accomplish the system design. Foam-discharge rates shall be sufficient to provide similar rates of water discharge from the system until shut off during the design period and following depletion of foam concentrate supplies.

(b) **Prevention.** Prevention of fire in the protected hazard is a supplemental feature of such systems. Manual operation of a system to discharge foam or water selectively from the discharge devices in case of accumulations of hazardous materials from spills in such occupancies as garages, aircraft hangars, petrochemical plants, paint and varnish plants, or from other causes in the protected area, will afford protection against ignition pending clean-up measures. In such cases, manual system operation can provide for foam coverage in the area with water discharge manually available.

(c) **Control and Exposure Protection.** Control of fire to allow controlled burning of combustible materials where extinguishment is not practicable and exposure protection to reduce heat transfer from an exposure fire can be accomplished by water spray or foam, or both, from these special systems, with the degree of accomplishment related strongly to the fixed discharge densities provided by the system design.

**1-5.3** Foam of any type shall not be considered a suitable extinguishing agent on fires involving liquefied or compressed gases (e.g., butane, butadiene, propane) on materials that will react violently with water (e.g., metallic sodium) or that produce hazardous materials by reacting with water, or on fires involving electrical equipment where the electrical nonconductivity of the extinguishing agent is of primary importance.

**1-5.4** Some types of foam are not suitable for use on fires in water-soluble solvents and polar solvents. Foam concentrates are available for the protection of such hazards. Foam concentrate manufacturers shall be consulted for applicability.

### 1-6 Approvals.

**1-6.1** Prior to designing a system for consideration, the authority having jurisdiction shall be consulted. All plans and specifications pertinent to the installation shall be approved by the authority having jurisdiction prior to installation, and such authority shall be consulted as to devices and materials used in system construction and in selection of the foam concentrate to be provided for system use. All equipment and concentrates shall be approved for the particular application intended.

**1-6.2** The provisions of this standard are not intended to be applied retroactively. Where the system is being altered, extended, or renovated, the requirements of this standard shall apply only to the work being undertaken.

**1-7 Units.** Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter and bar units, which are not part of but are recognized by SI, commonly are used in international fire protection. These units are listed in Table 1-7 with conversion factors.

**Table 1-7 SI Units and Conversion Factors**

| Name of Unit | Unit Symbol | Conversion Factor |
|---|---|---|
| liter | L | 1 gal = 3.785L |
| liter per minute per square meter | $(L/min)/m^2$ | 1 $gpm/ft^2$ = 40.746 $(L/min)/m^2$ |
| millimeter per minute | mm/min | 1 $gpm/ft^2$ = 40.746 mm/min |
| cubic decimeter | $dm^3$ | 1 gal = 3.785 $dm^3$ |
| pascal | Pa | 1 psi = 6894.757 Pa |
| bar | bar | 1 psi = 0.0689 bar |
| bar | bar | 1 bar = 105 Pa |

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

**1-7.1** If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. A given equivalent value shall be considered to be approximate.

**1-7.2** SI units have been converted by multiplying the quantity by the conversion factor and then rounding the result to the appropriate number of significant digits.

## Chapter 2 System Components

**2-1 Approved Devices and Materials.** All component parts including foam concentrates shall be listed for the use intended.

*Exception: Where listed components are not manufactured, the components shall be of an approved type.*

**2-2* Discharge Devices.** Discharge devices shall be permitted to be air-aspirating, such as foam-water sprinkler and foam-water spray nozzles, or they shall be permitted to be non-air-aspirating, such as standard sprinklers.

**2-2.1** Discharge devices and foam concentrates shall be listed for use together.

**2-2.2** Non-air-aspirating devices shall be used only with concentrates, such as AFFF or FFFP, that have been tested and listed for use in these devices.

**2-3 Foam Concentrates.**

**2-3.1*** Foam concentrates shall be listed for use with the foam concentrate proportioning equipment and the discharge devices with which a given system is equipped. Replacement supplies of foam concentrates shall be listed for use with system components. Different types and brands of foam concentrates could be incompatible and shall not be mixed in storage.

**2-3.2** The quantities of foam concentrates to be provided for foam-water sprinkler and spray systems shall be sufficient to maintain the discharge densities for the application time period used as a base in system design. (*See 1-4.4, 4-3.2, and 4-3.3.*)

**2-3.3** There shall be a readily available supply of foam concentrate sufficient to meet the design requirements of the system and to put the system back in service after operation. This supply shall be permitted to be in separate tanks or compartments, in drums or cans on the premises, or available from an outside source within 24 hours.

**2-4 Foam Concentrate Proportioning Means.**

**2-4.1** Positive-pressure injection is the preferred method for introduction of foam concentrates into the water flowing through the supply piping to the system.

**2-4.2*** Positive-pressure injection methods shall mean one of the following:

(a) Foam concentrate pump discharging through a metering orifice into the protection system riser, with the foam pressure at the upstream side of the orifice exceeding the water pressure in the system riser by a specific design value;

(b) A balanced-pressure proportioning system (demand-type proportioner) utilizing a foam concentrate pump discharging through a metering orifice into a proportioning controller (venturi) or orifice in the protection system riser, with the foam, liquid, and water pressures automatically maintained equal by the use of a pressure-control valve;

(c) Pressure-proportioning tanks with or without a diaphragm to separate the water and foam concentrate.

**2-4.3** Orifice plates shall have "tell-tale" indicators giving orifice diameters and indicating flow direction if flow characteristics vary with flow direction.

NOTE: See A-2-4.2 for formula for calculation of size of orifices used in metering foam concentrates.

**2-4.4** Where special conditions warrant, other proportioning methods shall be permitted to be used, such as around-the-pump proportioners and in-line inductors.

**2-5* Foam Concentrate Pumps.** The design and materials of construction for foam concentrate pumps shall be suitable for use with the type of foam concentrate used in the system. Special attention shall be paid to the type of seal or packing used.

**2-5.1** Where pumps utilizing cast-iron or ductile iron components are used, the pumps shall remain flooded with concentrate to minimize corrosion, foaming, or sticking.

**2-5.2** Foam concentrate pumps shall have adequate capacities to meet the maximum system demand. To ensure positive injection of foam concentrate, the discharge pressure ratings of pumps at the design discharge capacity shall be in excess of the maximum water pressure available under any condition at the point of foam concentrate injection.

**2-5.3** Provision shall be made to shut off the foam concentrate pump after the foam supply is exhausted.

**2-6 Power Supply.** The power supply for the drivers of foam concentrate pumps shall be installed in accordance with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, and NFPA 70, *National Electrical Code®*

**2-6.1** Power supplies shall be arranged such that disconnecting power to the protected facility during a fire shall not disconnect the power supply to the foam concentrate feeder circuit.

**2-6.2** Controllers for foam concentrate pumps shall be as follows:

(a) Electric drive foam concentrate pumps greater than 30 horsepower: listed fire pump controller;

(b) Electric drive foam concentrate pumps greater than 15 horsepower but not exceeding 30 horsepower: listed fire pump controller or limited service fire pump controller;

(c) Electric drive foam concentrate pumps less than 15 horsepower: listed limited service controller;

(d) Diesel engine drive foam concentrate pumps: listed fire pump controller.

**2-6.3** A service disconnecting means in the feeder circuit to limited service controllers shall be permitted where approved by the authority having jurisdiction, provided the disconnecting means is supervised for the proper position. Supervision for proper position shall be by one of the following means:

(a) Central station, proprietary, or remote station signaling electrical supervision service;

(b) Local electrical supervision through the use of a signaling service that will cause the sounding of an audible signal at a constantly attended location;

(c) Locking of the disconnect in the correct position with monthly recorded inspections.

**2-7 Foam Concentrate Storage Tanks.**

**2-7.1** Storage tanks for foam concentrates shall be constructed of materials suitable for the liquid, solidly mounted, and permanently located.

**2-7.2** Storage temperatures at which foam concentrates are listed shall be considered the temperature limits where locating storage tanks.

**2-7.3 Atmospheric-Type Storage Tanks.**

**2-7.3.1** Storage tanks shall have capacities to accommodate the needed quantities of foam concentrate plus adequate space for thermal expansion. Foam concentrate outlets from the tanks shall be located to prevent sediment from being drawn into the system.

**2-7.3.2** The quantity of foam concentrates shall be determined by adding the volume of the sediment pocket to the quantity needed for system operation.

**2-7.3.3*** Tanks shall be equipped with suitable conservation-type vents of adequate capacity, access handholes, or manholes located to provide for inspection of interior tank surfaces, connections for pump suction, relief and testing lines, protected sight gauges or other liquid level devices, and adequate filling and draining connections.

**2-7.3.4** Tank discharge outlets shall be located to furnish a positive head on the pump suction.

**2-7.4* Pressure-Type Storage Tanks.** Pressure proportioning tanks shall have means for filling, for gauging the level of foam concentrates, and for drainage, cleaning, and inspection of interior surfaces and of the concentrate holding bladder or diaphragm, if provided. These tanks shall be stamped to be identified as ASME unfired pressure vessels.

**2-8 Location of System-Control Equipment.**

**2-8.1** Equipment items such as storage tanks and proportioners for foam concentrate, pumps for water and foam concentrates, and control valves for water, foam concentrates, and foam solution shall be located as near as practical to the hazard or hazards they protect but shall not be exposed to a fire in a manner that is likely to impair system performance.

**2-8.2*** Automatically controlled valves shall be as close to the hazard protected as accessibility allows, so that a minimum of piping is needed between the automatic control valve and the discharge devices.

**2-9 Detection Equipment.** Detection equipment shall be installed, tested, and maintained in accordance with NFPA 72, *National Fire Alarm Code.*

**2-10 Alarms.**

**2-10.1*** A local alarm, actuated independently of waterflow to indicate operation of the automatic detection equipment, shall be provided on each system.

*Exception: An alarm shall not be required on manually operated systems.*

**2-10.2*** Where an alarm is installed, the authority having jurisdiction shall be consulted regarding the alarm service to be provided and regarding the need for electrical fittings designed for use in hazardous locations in electric alarm installations.

NOTE: See NFPA 70, *National Electrical Code*, Chapter 5, particularly Article 500.

**2-10.3** A suitable trouble alarm shall be provided for each system to indicate the failure of automatic detection equipment (including electric supervisory circuits) or other such devices or equipment upon which the system operation is dependent.

**2-10.4** Alarm systems shall meet the applicable requirements of NFPA 72, *National Fire Alarm Code.*

**2-11 Strainers for Water and Foam Concentrates.**

**2-11.1** Strainers shall be listed for fire protection service and shall be capable of removing from the water all solids of sufficient size to obstruct the discharge devices. Strainers shall be installed to be accessible for cleaning during an emergency. Space shall be provided for basket removal.

**2-11.2** Strainers shall be installed in the main water supply lines feeding orifices (or water passages) smaller than $\frac{3}{8}$ in. (9.6 mm). Strainers shall be installed on systems having larger orifices where warranted by water supply conditions. Perforations of $\frac{1}{8}$ in. (3.2 mm) usually are suitable.

**2-11.3*** Strainers shall be installed in foam concentrate lines upstream of foam concentrate pumps. Where listed strainers of the pump size are not available, strainers having a ratio of open basket area to inlet pipe size of at least 10 to 1 shall be used.

**2-12 Piping, Valves, Pipe Fittings, and Hangers.**

**2-12.1** Piping, valves, pipe fittings, and hangers, including corrosion protection coatings, shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

**2-12.2*** Piping, fittings, and valves shall be of a material compatible with the particular foam concentrate, foam solution, or water used, as applicable.

**2-12.3*** Rubber-gasketed fittings shall be permitted to be used to connect pipe in fire-exposed areas where the foam-water deluge system is automatically controlled. Fire-exposed areas in which these fittings are located shall be protected by automatic foam-water deluge systems or other approved means.

**2-13* Test Connections.** A test connection shall be provided to conduct periodic tests of the proportioning system. At a minimum, connections shall flow at the actual system discharge.

*Exception: Test connections shall not be required if periodic full discharge tests are practical.*

## Chapter 3 Water Supplies

**3-1* Types of Water.** Water supplied to deluge foam-water sprinkler systems and foam-water spray systems shall be free of constituents not compatible with air foam concentrates.

**3-2 Water Supply Capacity and Pressure.**

**3-2.1** Water supplies for deluge foam-water sprinkler systems and foam-water spray systems shall be of capacity and pressure capable of maintaining foam discharge or water discharge, or both, at the design rate for the required period of discharge over the entire area protected by systems expected to operate simultaneously.

**3-2.2** Where the water supply is dependent on public water sources, attention shall be given to the pollution hazard introduced by the use of foam concentrate and any cross connections shall be cleared with public health agencies concerned.

**3-2.3** Water supplies shall be capable of supplying the systems at the design discharge capacity for at least 60 minutes.

*Exception: Water supplies for aircraft hangars shall be in accordance with NFPA 409, Standard on Aircraft Hangars.*

## Chapter 4 System Design and Installation

**4-1 General.** This chapter contains the minimum design criteria for foam-water sprinkler systems. Where occupancy standards specify more stringent criteria they shall take precedence.

**4-2 Plans and Specifications.** The design and installation of deluge foam-water sprinkler and spray systems shall be entrusted to experienced and responsible persons. Before such systems are installed, complete working plans and specifications shall be prepared. Working plans shall be drawn to scale, show all essential details, and be capable of being reproduced easily. Working plans and specifications shall provide information on the discharge densities and period of discharge, hydraulic calculations, details of tests of available water supply, detailed layout of the piping and of the automatic detection equipment, type of discharge devices to be installed, location and spacing of discharge devices, pipe-hanger installation details, location of draft curtains, an accurate and complete layout of the buildings or hazards to be protected, and other pertinent data necessary to provide a clear explanation of the proposed design.

(a) In addition to the items specified in Section 4-1, plans and specifications shall indicate the quantity of foam concentrate to be stored, including the quantity in reserve, the concentration designation, and the minimum anticipated temperature of the concentrate at the point of proportioning.

(b) The specifications shall indicate the specific tests to be conducted.

(c) Complete plans and detailed data describing pumps, drivers, controllers, power supply, fittings, suction and discharge connections, and suction conditions shall be submitted by the engineer or contractor to the authority having jurisdiction for approval before installation.

(d) Charts showing head delivery, efficiency, and brake horsepower curves of pumps shall be furnished by the contractor.

**4-3 Design Guides.**

**4-3.1*** Foam-water sprinkler and foam-water spray system designs shall conform to all the applicable requirements of the following standards of the National Fire Protection Association.

NFPA 11, *Standard for Low-Expansion Foam*

NFPA 13, *Standard for the Installation of Sprinkler Systems*

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

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

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

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 70, *National Electrical Code*

NFPA 72, *National Fire Alarm Code*

NOTE: See NFPA occupancy standards, where applicable.

*Exception: Where otherwise specified.*

**4-3.2*** The design discharge density shall be in accordance with the applicable occupancy standard for water or foam-water systems but in no case less than 0.16 gpm/ft$^2$ [65 L/min/m$^2$]. Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to conventional foams necessitate the use of alcohol-resistant foams. In all cases, the manufacturer of the foam concentrate and the foam-making equipment shall be consulted regarding limitations and for recommendations based on listings or specific fire tests.

**4-3.3** The foam solution discharge shall be designed for a period of 10 minutes based on the density [gpm/ft$^2$ (L/min)/m$^2$] as specified in 4-3.2 over the entire system area.

**4-3.4** Where the actual system discharge exceeds the minimum as specified in 4-3.3, a proportionate reduction in the duration of foam discharge time shall be permitted, but in no case shall the duration be less than 7 minutes.

**4-4 Foam Concentrate Lines.**

**4-4.1*** Where foam concentrate lines to the protective system injection points are run underground or where they run aboveground for more than 50 ft (15 m), these lines shall be maintained full, and a means of checking the tightness of the system shall be provided.

**4-4.2** The temperature of the foam concentrate lines and components shall be maintained within the storage temperature limits specified for the foam concentrate.

**4-5 Operating-Means Design.**

**4-5.1*** In automatic systems, the detection equipment shall be connected to a means for tripping water deluge valves and other system-control equipment. Supplemental manual means for this purpose also shall be provided.

**4-5.2** In automatic systems, foam concentrate injection shall be activated automatically by, or concurrently with, activation of the main water supply control valve. Manual operating means shall be designed for this same purpose.

**4-5.3** Automatic detection equipment, whether pneumatic, hydraulic, or electric, shall be provided with complete supervision arranged so that failure of equipment, loss of supervising air pressure, or loss of electric energy results in clear notification of the abnormal condition.

**4-5.4** Where used in a corrosive atmosphere, the detection devices shall be of materials not subject to corrosion or protected to resist corrosion.

**4-5.5** Automatic detection equipment of the electric type and any auxiliary equipment of the electric type, if in hazardous areas, shall be designed specifically for use in such areas.

NOTE: See NFPA 70, *National Electrical Code*, Chapter 5, particularly Article 500.

**4-5.6** In automatic systems, manually operated tripping devices shall actuate the automatic control valve by mechanical, pneumatic, electric, or other approved means. The manual device shall be strong enough to prevent breakage. Manual controls shall not necessitate a pull of more than 40 lb [178 N (force)] nor a movement of more than 14 in. (356 mm) to secure operation.

**4-6 Drainage.** Facilities shall be provided for the safe removal or retention of the largest anticipated flammable liquid spill plus the free water reaching the floor from the fixed fire protection system, as well as the discharge from hose streams.

**4-7 Hydraulic Calculations.**

**4-7.1** System piping shall be hydraulically calculated and sized in order to obtain reasonably uniform foam and water distribution and to allow for loss-of-head in water supply piping. The adjustment in pipe sizes shall be based on a maximum variation of 20 percent above the specified discharge rate per sprinkler or nozzle.

**4-7.2** Pipe sizes shall be adjusted according to detailed friction-loss calculations. These calculations shall show the relationship between the water supply and the water demand.

**4-7.3** Hydraulic calculations for determining the foam solution and waterflow characteristics of systems covered by this standard shall be in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*. Piping carrying foam solution shall be sized as if carrying plain water.

**4-7.4*** The friction losses in piping carrying foam concentrate shall be calculated using the Darcy Formula, also known as the Fanning formula, as specified in A-1-3. Friction factors for use with this formula shall be selected from the graphs shown in Figures A-4-7.4(a) through (d). In calculating the Reynolds number for selecting friction factors from the graphs, the actual density (or specific gravity) of the foam concentrate to be employed in the system shall be used. The viscosity used shall be the actual viscosity of the foam concentrate at the lowest anticipated storage temperature.

**4-7.5** For purposes of computing friction loss in piping, the following "C" Factors shall be used for the Hazen and Williams formula:

**Table 4-7.5 Hazen-Williams C Values**

| Pipe or Tube | C Value |
|---|---|
| Unlined cast or ductile iron | 100 |
| Black or carbon steel | 100 |
| Galvanized (all) | 120 |
| Cement-lined cast or ductile iron | 140 |
| Plastic, listed (all) | 150 |
| Copper tube or stainless steel | 150 |

## Chapter 5 Acceptance Tests

**5-1 Flushing of Supply Piping.** Underground mains and lead-in connections to system risers shall be flushed thoroughly before connection is made to system piping in order to remove foreign materials that might have entered the underground during the course of the installations or that might have been present in existing piping. The minimum rate of flow shall be not less than the water demand rate of the system, which is determined by the system design, or not less than that necessary to provide a velocity of 10 ft/s (3 m/s), whichever is greater. For all systems, the flushing operations shall be continued for a sufficient time to ensure thorough cleaning. When planning the flushing operations, consideration shall be given to disposal of the water issuing from the test outlets.

**Table 5-1 Flow Required to Produce a Velocity of 10 ft/s (3 m/s) in Pipes**

| Pipe Size (in.) | Flow (gpm) | Flow (L/min) |
|---|---|---|
| 4 | 390 | 1476 |
| 6 | 880 | 3331 |
| 8 | 1560 | 5905 |
| 10 | 2440 | 9235 |
| 12 | 3520 | 13 323 |

**5-2 Hydrostatic Pressure Tests.**

**5-2.1** All piping, including yard piping, foam concentrate lines, and the system piping, shall be tested hydrostatically at not less than 200 psi (1379 kPa) pressure for 2 hours, or at 50 psi (345 kPa) in excess of the maximum static pressure where the maximum static pressure is in excess of 150 psi (10 bars).

*Exception: Bladder tanks shall not be included in pressure tests.*

NOTE: It is recommended that foam concentrate lines be tested using foam concentrate as the testing medium.

**5-2.2*** The amount of leakage in underground water piping shall be measured at the specific test pressure by pumping from a calibrated container. Leakage shall not exceed 2 qt/hr (1.89 L/h) per 100 joints, irrespective of pipe diameter.

NOTE: See NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, Chapter 8, "Rules for Laying Pipe."

**5-2.3** Foam concentrate piping shall be shown to be leaktight during hydrostatic pressure tests.

**5-3 System Tests Discharging Foam.**

**5-3.1*** Acceptance tests shall include the following:

(a) Foam discharge from a single system;

(b) Simultaneous foam discharge of the maximum number of systems expected to operate on a single hazard;

(c) Where full flow tests are not practical, adequate tests of system components to verify design capability shall be performed.

**5-3.2** The discharge shall be continued for a sufficient time to obtain stabilized discharge.

**5-3.3*** Where conditions allow, flow tests shall be conducted to ensure that the hazard is fully protected in conformance with the design specification and to determine the flow pressures, actual discharge capacity, consumption rate of foam-producing materials, staffing needs, and other operating characteristics.

**5-3.4 Proportioning System Testing.**

**5-3.4.1** Operation of the proportioning equipment shall be verified by flow tests. The percentage of foam concentrate in solution shall be determined. During the tests, the pressure at the discharge devices shall be at least equal to the minimum design operating pressure of the system or systems tested. Percentage of all foam concentrates injected into the water shall be within the following limits: The foam concentrate induction rate of a proportioner, expressed as a percentage of the foam solution flow (water plus foam concentrate) shall be minus 0 (zero) percent to plus 30 (thirty) percent of the manufacturer's listed induction rate or 1 (one) percentage point, whichever is less.

*Exception: Tests shall be permitted to be conducted through the test connections required in 2-13 where full-flow operational tests are not practical.*

**5-3.4.2** The rate of foam solution discharge shall be computed from hydraulic calculations utilizing recorded inlet or end-of-system operating pressure, or both. The foam concentration shall be calculated by timing a given displacement from the storage tank, a refractometric means, or a conductivity method.

**5-3.5** Systems shall be flushed thoroughly with water after operation with foam.

*Exception: Those portions of the system normally containing foam concentrate when the system is not operating.*

NOTE: Particular attention should be given to strainers or other small openings.

## Chapter 6 Periodic Inspection, Testing, and Maintenance

**6-1* Inspection, Testing, and Maintenance of Foam-Water Sprinkler Systems.** Systems shall be so arranged that periodic tests and inspections are made without discharging foam solution to the system piping in order to check operation of all mechanical and electrical components of the system. The system shall be arranged so that tests can be performed with as little loss of foam concentrate as possible.

**6-2 Testing and Inspection of Alarm and Detection Devices.** Alarm and detection devices shall be tested and inspected in accordance with NFPA 72, *National Fire Alarm Code*.

**6-3* Inspection, Testing, and Maintenance Frequency.** Foam-water sprinkler systems shall be tested and inspected in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, Chapter 8.

## Chapter 7 Referenced Publications

**7-1** The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

**7-1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11, *Standard for Low-Expansion Foam*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 1993 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1990 edition.

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1993 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 1993 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1992 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1992 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 409, *Standard on Aircraft Hangars*, 1990 edition.

## Appendix A Explanatory Material

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

**A-1-1.2** Reference also should be made to NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*.

**A-1-3 Foam-Water Spray Nozzles.** Foam-water spray nozzles combine a foam maker with a body and a distributing deflector [*see Figure A-1-3(b)*]. They generate foam in the same manner described for foam-water sprinklers, where supplied with foam solution under pressure, and distribute the resulting foam, or water in the absence of foam solution, in a special pattern peculiar to the particular head.

These nozzles are available in a number of patterns with variations in discharge capacity.

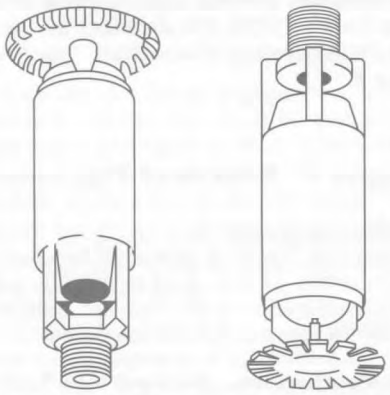


**Figure A-1-3(a) Variations in deflector shape.**

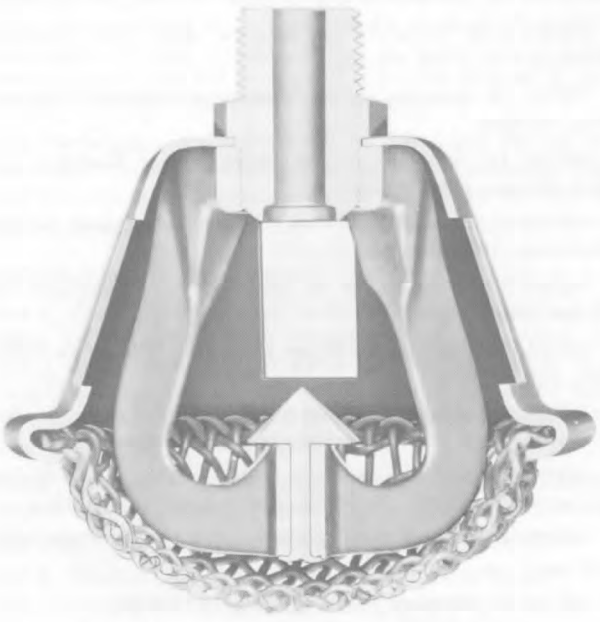

**Figure A-1-3(b) Foam-water spray nozzle.**

Darcy Formula

$$\Delta P = 0.000216 \frac{fL \rho Q^2}{d^5}$$

Reynolds Number

$$Re = \frac{50.6Q\rho}{d\mu}$$

$\Delta P$ = Friction loss (psi)
L = Length of pipe (ft)
f = Friction factor
$\rho$ = Weight density of fluid ($lb/ft^3$)
Q = Flow (gpm)
d = Pipe diameter (in.)
$\mu$ = Absolute (dynamic) viscosity (centipoise)
Re = Reynolds Number

**A-1-3 Foam-Water Sprinklers.** Foam-water sprinklers are open-type sprinklers designed:

(a) To receive foam solution (water plus liquid concentrate);

(b) To direct the solution through an integral foam maker, the nozzle action of which breaks the solution into spray and discharges it into a mixing tube where it combines with air drawn in through openings in the housing;

(c) To provide mixing chamber capacity for development of the air foam;

(d) To direct the formed foam discharging from the open end of the mixing tube against a deflector, shaped to distribute the foam in a pattern essentially comparable to the water distribution pattern of present-day "standard" sprinklers (nomenclature from current edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*), and to do so with essentially no impingement of the foam on the ceiling; and

(e) In the case of discharge of water only (i.e., in the absence of foam), to develop a water distribution pattern directly comparable to that of "standard" sprinklers.

The normal direction of discharge from foam-water sprinklers is downward. To provide a choice in installation design, foam-water sprinklers are produced for installation in the upright position and in the pendent position with the pattern of discharge in either case in the downward direction. Sprinkler deflectors shall be formed to produce the required discharge pattern, which could mean differing shapes of deflectors for each of the two positions of installation. The variation in the shape of deflectors is illustrated in Figure A-1-3(a).

**A-2-2** Table A-2.2(a) specifies the range of the water discharge rates of listed foam-water sprinklers.

**Table A-2-2(a)**
**Foam-Water Sprinkler[1] Water Discharge Rates**

| Pressure at Sprinkler Inlet ($lb/in.^2$) | Range of Discharge Rates (gpm) |
|---|---|
| 20 | 12–14 |
| 30 | 14–17 |
| 40 | 16–19 |
| 50 | 18–22 |
| 75 | 22–26 |
| 100 | 25–30 |

[1]Nominal 3/8-in. orifice.

**Table A-2-2(b)**
**Standard Sprinkler[1] Discharge Rates**

| Pressure at Sprinkler Inlet (lb/in.$^2$) | Range of Discharge Rates (gpm) |
|---|---|
| 7 | 14–16 |
| 10 | 16–19 |
| 20 | 23–26 |
| 30 | 28–32 |

[1]Nominal ½-in. orifice
For SI units: 1 psi = 0.0689 bar; 1 gpm = 3.785 L/min

**A-2-3.1** Foam concentrates meeting the requirements of 2-3.1 are available in 3 percent and 6 percent concentrations. Some foam concentrates are available for use as low as –20°F (–28°C).

**A-2-4.2** Figures A-2-4.2(a) through (d) are schematic arrangements of equipment to illustrate the principle of operation of various proportioning methods. Other arrangements or components also may be permitted to be used to accomplish the same purpose.

NOTE: The foam liquid-concentrate metering orifice can be calculated by using the formula:

$$Q_f = KCd^2\sqrt{\Delta P}$$

K = Constant of particular foam liquid concentrate (available from the manufacturer)
C = Orifice constant
d = Diameter of orifice (in.)
$\Delta P$ = Pressure differential across the orifice plate
$Q_f$ = Volume of foam liquid concentrate (gpm)

The coefficient "C" is affected by several factors that include orifice shape, viscosity of foam liquid, velocity, and ratio of orifice diameter to pipe diameter.

**A-2-5** Foam concentrate pumps should have reliability equivalent to that of approved fire pumps. Foam concentrate pumps are generally of the positive displacement variety. Centrifugal pumps might not be suitable for use with foams exhibiting high viscosity characteristics. The foam equipment manufacturer should be consulted for guidance.

**A-2-7.3.3** Where sight glasses are used to gauge the foam concentrate level, they can indicate false levels if the more viscous foam concentrates are used.

**A-2-7.4** Where sight glasses are used to gauge the foam concentrate level, they can indicate false levels if the more viscous foam concentrates are used.

**A-2-8.2** Consideration should be given to provisions of remotely located post-indicator or other shutoff valves to allow system water supply control under abnormal conditions.

**A-2-10.1** Under conditions where central station or proprietary station waterflow alarm service is not available, it might be advisable to connect electrical alarm units to public fire department headquarters, the nearest fire department station, or other suitable place where aid can be secured readily. Central station or proprietary station waterflow alarm service is desirable, but provision of this service does not necessarily waive the local alarm requirement.

**A-2-10.2** See NFPA 72, *National Fire Alarm Code*. Outdoor water-motor or electric-alarm gongs, responsive to system waterflow, might be required.

**A-2-11.3** In bladder tank systems, the pressure drop created by the strainer can upset the foam and water pressure balance and can cause lean proportioning. Therefore, foam concentrate strainers are not recommended in bladder tank systems.

**A-2-12.2** Foam solutions react with steel pipe in such a way that, over a period of time, the foam solutions lose their capability to produce a fire-resistant foam. Therefore, in a wet pipe system, there could be a delay in the discharge of effective foam until all the preprimed solution has been flushed out and fresh foam solution reaches the opened sprinklers, unless corrective steps are taken.

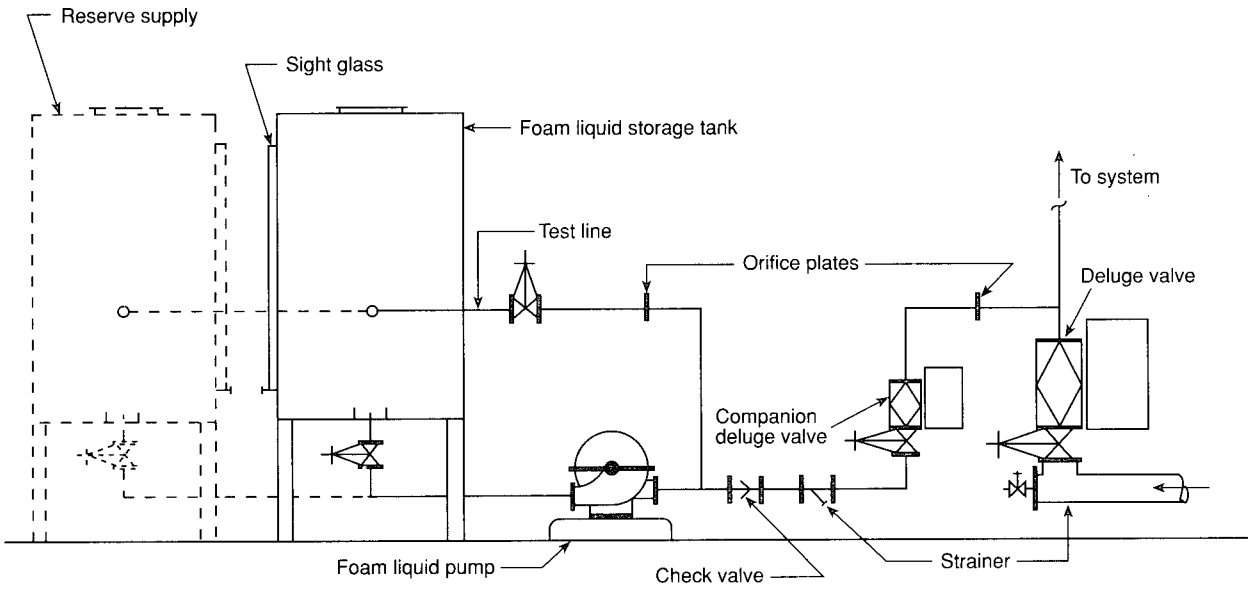


**Figure A-2-4.2(a) Schematic arrangement of foam liquid-concentrate storage tank, liquid concentrate pump, metering proportioners, and interconnecting piping.**

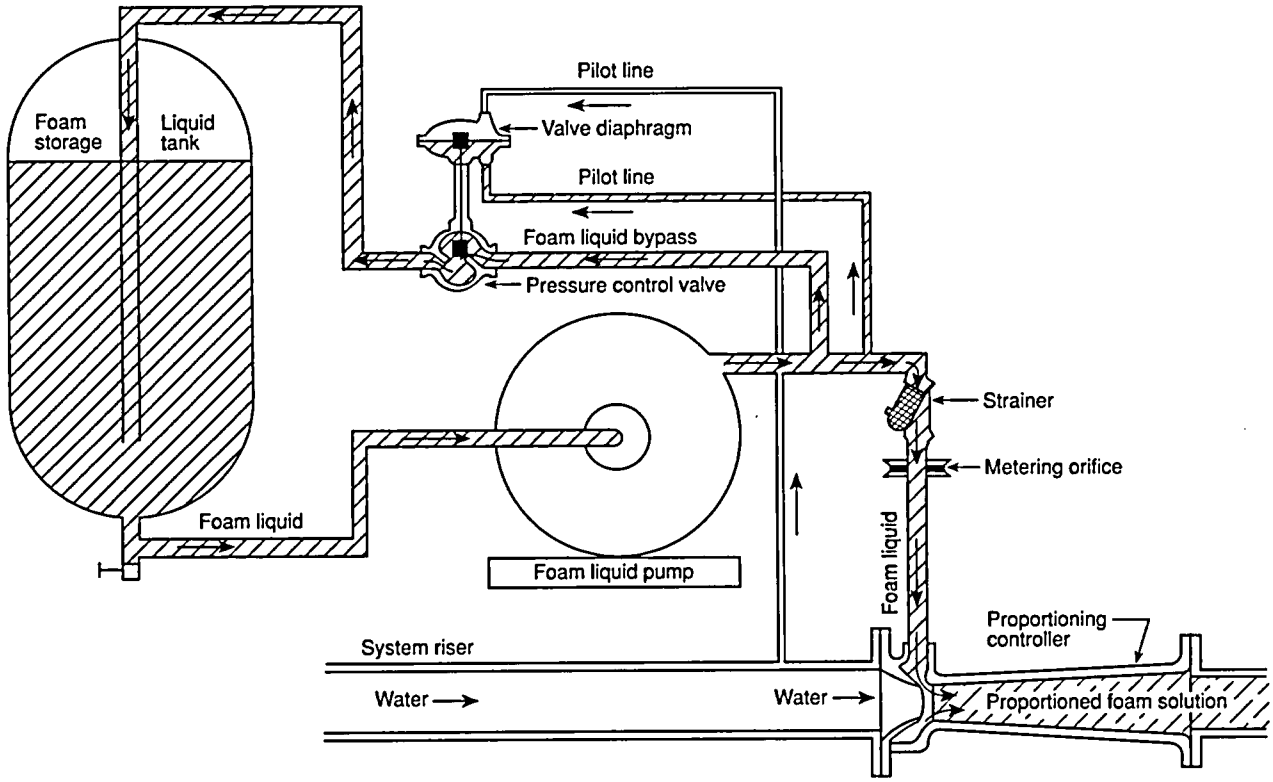


**Figure A-2-4.2(b) Balanced-pressure proportioning system.**

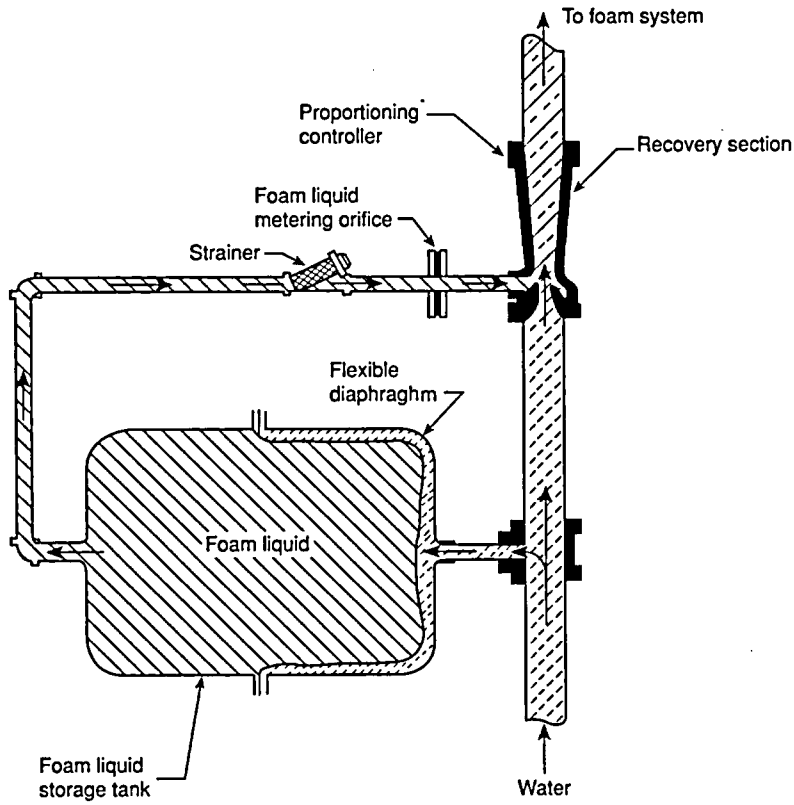


**Figure A-2-4.2(c) Pressure-proportioning tank with diaphragm.**

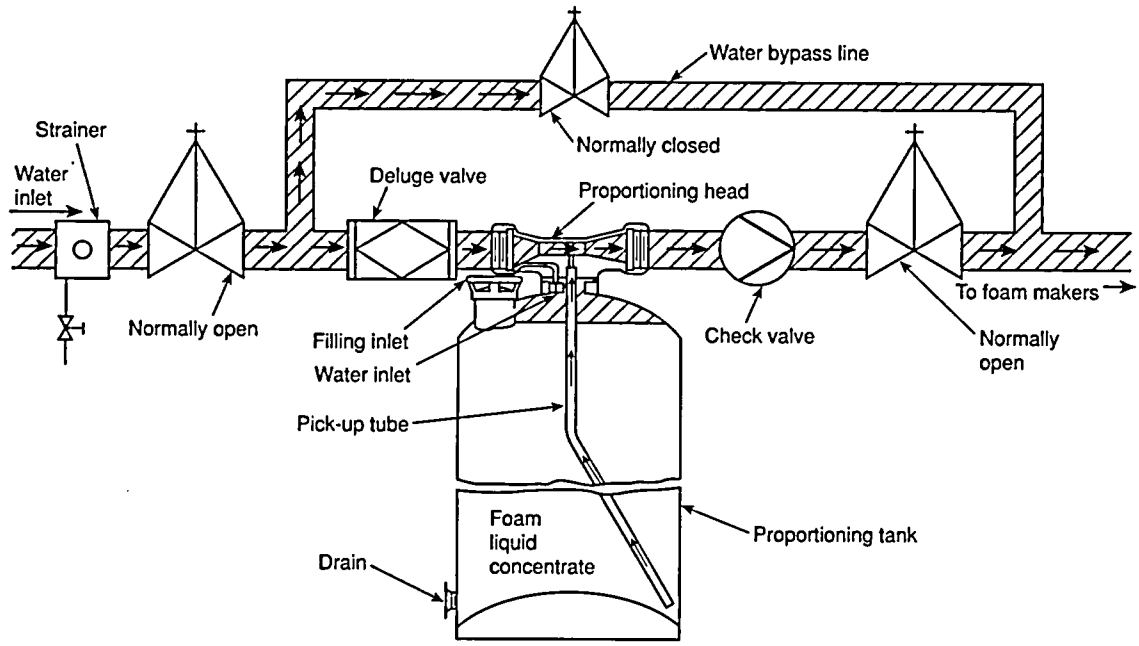


**Figure A-2-4.2(d) Pressure-proportioning tank method (pressure-proportioning tank with diaphragm). The arrangement of these devices can take a variety of forms. A single tank or a battery of tanks manifolded together can be used.**

**A-2-12.3** Rubber-gasketed fittings subject to direct fire exposure are generally not suitable. Where necessary for piping flexibility or for locations subject to earthquake, explosion, or similar hazards, such installations may be permitted. In such cases, special hanging or bracing might be necessary.

**A-2-13** In order to provide a means of periodically checking the performance of the proportioners used in foam sprinkler systems, a test connection should be provided. Typical test connections are illustrated in Figure A-2-13. Two options are possible in locating the proportioning controller in the sprinkler riser: before the main sprinkler valve or after the main sprinkler valve. If the proportioning controller is located after the main sprinkler valve, an additional supervised OS&Y valve is needed in order to isolate the sprinkler overhead during the proportioner test. The test connection should be routed to a drain area for easy disposal of the solution produced during the test. (*See Figure A-2-13.*)

**A-3-1** The fire-fighting efficiency of foams is not significantly affected where water temperature is below approximately 100°F (38°C), although some reduction in expansion occurs with very cold water. If the water temperature exceeds 100°F (38°C), however, foam stability and fire-fighting efficiency usually is reduced.

**A-4-3.1** For supervision of valves, refer to NFPA 26, *Recommended Practice for the Supervision of Valves Controlling Water Supplies for Fire Protection.*

**A-4-3.2** For protection of some flammable liquids, foam manufacturers might recommend application densities considerably higher than the minimum densities specified herein or by occupancy standards. These higher application densities are generally a result of specific fire tests performed on a particular fuel and should be considered in a system design.

**A-4-4.1** Where piping integrity is checked by pressurization from a jockey pump or other suitable means, care should be taken to prevent overpressurization of system components and piping. A suitable means of pressure relief should be provided if necessary.

**A-4-5.1** The spacing of automatic detection equipment for systems installed for protection against fire exposure might call for a different arrangement from that required for other types of systems.

**A-4-7.4** See Figures A-4-7.4(a) through (d).

**A-5-2.2** To prevent the possibility of serious water damage in case of a break, pressure should be maintained during the 2-hour test period by a small-capacity pump, with the main controlling gate closed tightly during this period.

**A-5-3.1 Acceptance Test Recommendations.**

(a) All tests should be made by the contractor in the presence of the inspector for the authority having jurisdiction.

(b) Before asking final approval of the protective equipment by the authority having jurisdiction, installation companies should furnish a written statement to the effect that the work covered by its contract has been completed and all specified flushing of underground, lead-in, and system piping has been successfully completed, together with specified hydrostatic pressure tests and system-foam discharge tests.

(c) The samples of the contractor's material and test certificates for aboveground and underground piping that appear in Chapter 1 of NFPA 13, *Standard for the Installation of Sprinkler Systems*, can be useful to the contractor as a guide in filing written statements as described in A-5-3.1(b).

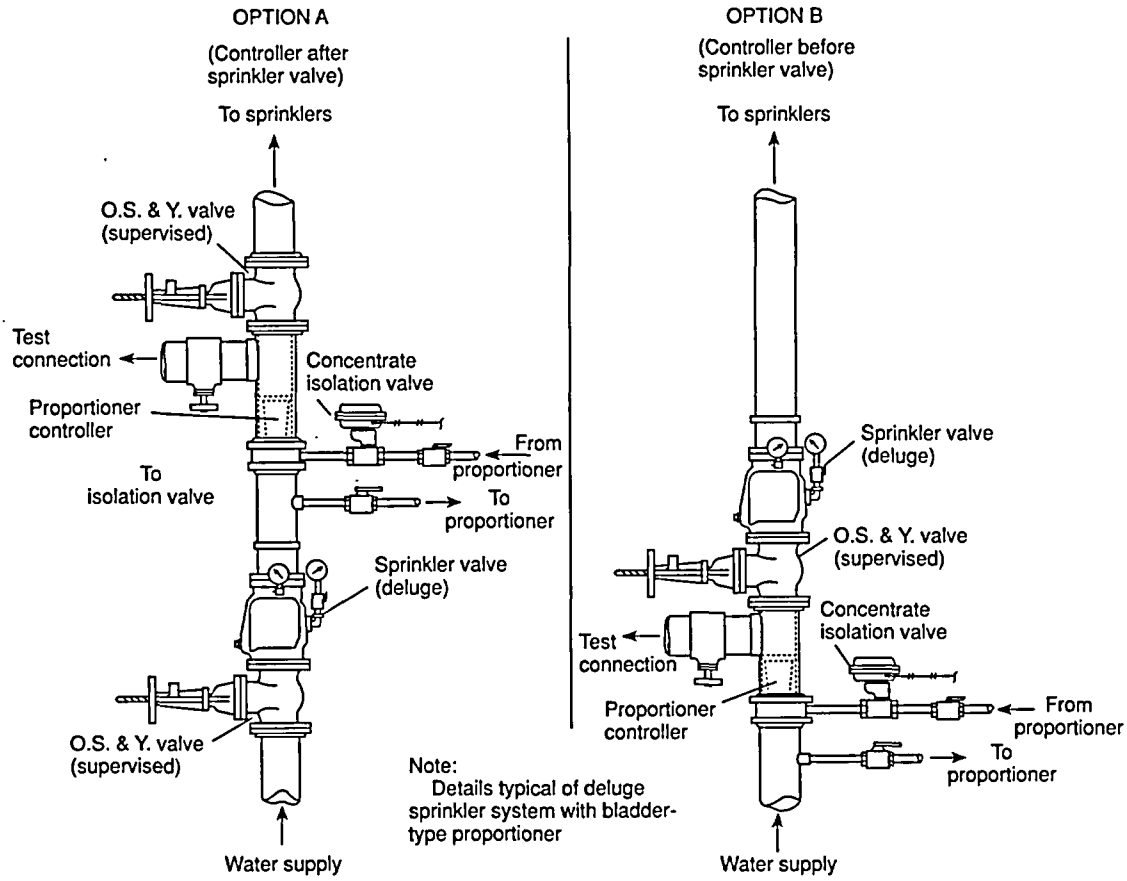


**Figure A-2-13 Test connection detail.**

**A-5-3.3** Foams produced from foam-water discharge outlets are generally of lower expansion and faster drainage than from other foam-producing devices. Laboratory listing and test data demonstrate that satisfactory fire control and extinguishment of petroleum fuels can be achieved using foam-water sprinklers producing foam characteristics as follows:

Protein foam and fluoroprotein foam

Expansion: 3-8

25 percent D.T.: 15 sec min

NOTE: These data apply to foam characteristics determined by the method specified in A-6-1.1.1 of NFPA 11, *Standard for Low-Expansion Foam.*

Aqueous film-forming foam

Expansion: 3-8

25 percent D.T.: 60 sec min

NOTE: These data apply to foam characteristics determined by the method specified in A-6-1.1.2 in NFPA 11, *Standard for Low-Expansion Foam.*

Numerical values developed by use of the two test methods referenced above are not directly comparable, so care should be taken to use the proper test method. In general, AFFF drains much more rapidly than protein and fluoroprotein foams, necessitating use of the alternate method.

**A-6-1** In order to provide a means of periodically checking the performance of the proportioners used in foam sprinkler systems, a test connection should be provided. Typical test connections are indicated in Figure A-2-13. Two options are possible in locating the proportioning controller in the sprinkler riser: before the main sprinkler valve or after the main sprinkler valve. If the proportioning controller is located after the main sprinkler valve, an additional supervised OS&Y valve is needed in order to isolate the sprinkler overhead during the proportioner test. This is done to eliminate the problems caused by air cushions in wet-pipe sprinkler systems or the servicing delays caused where charging and draining preaction or deluge sprinkler systems. The test connection should be routed to a drain area for easy disposal of the solution produced during the test.

The manufacturer's test procedures should be followed closely.

**A-6-3** An inspection contract with the installer of the equipment for service tests and operation at regular intervals is recommended and could be required by the authority having jurisdiction.

Samples of foam liquid concentrate should be referred to the manufacturer to check its condition annually.

Samples should be submitted in accordance with the manufacturer's recommended sampling procedure.

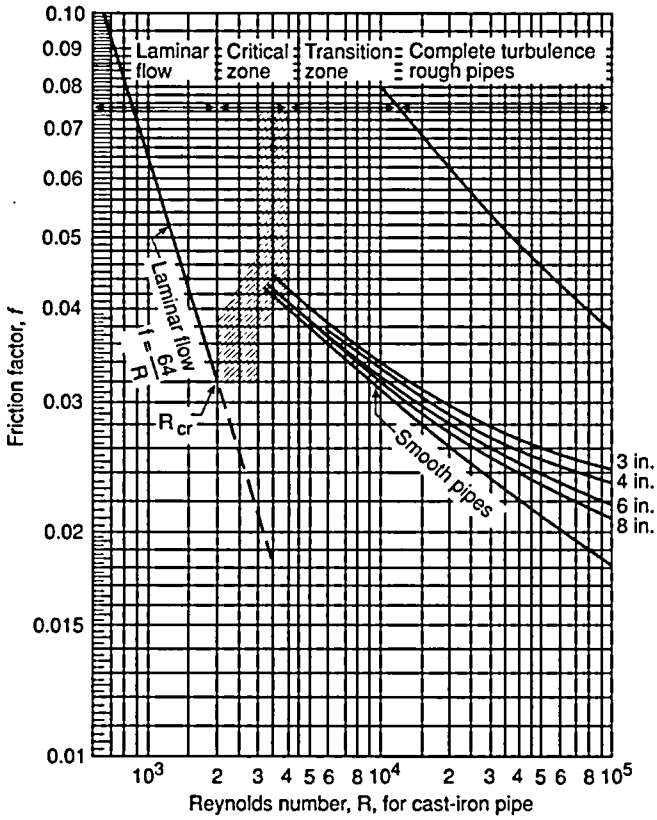


Figure A-4-7.4(a) Moody diagram cast iron pipe.

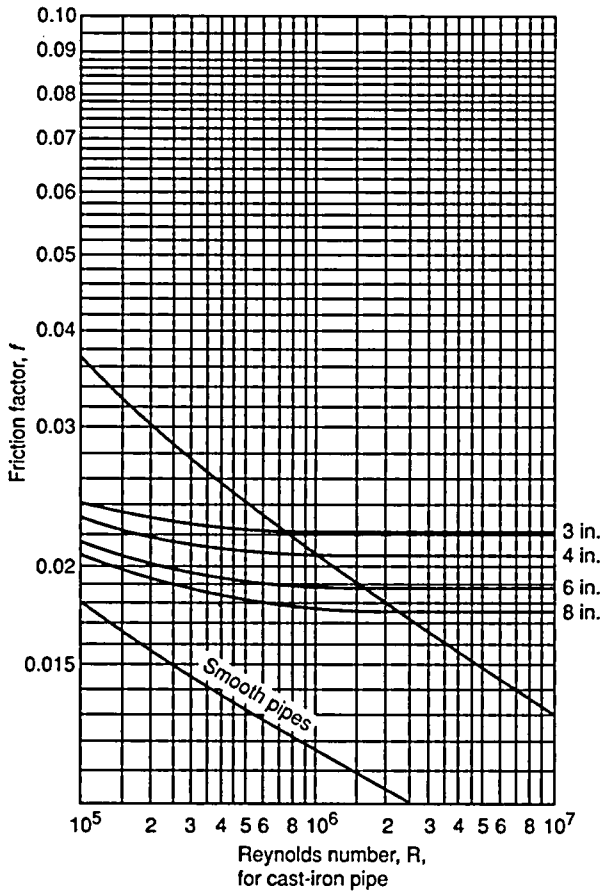


Figure A-4-7.4(b) Moody diagram cast iron pipe.

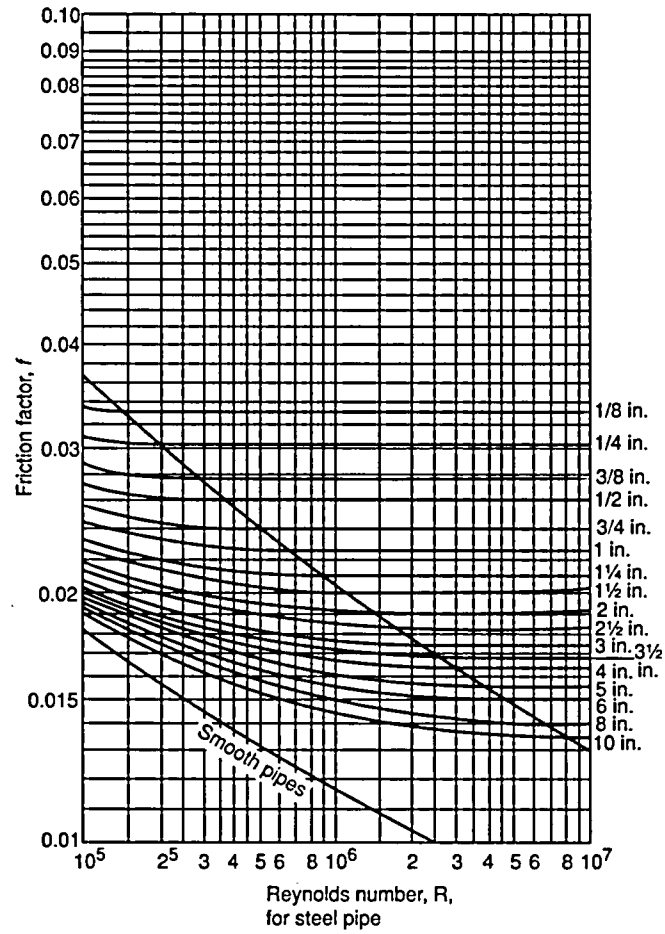


Figure A-4-7.4(c) Moody diagram steel pipe.

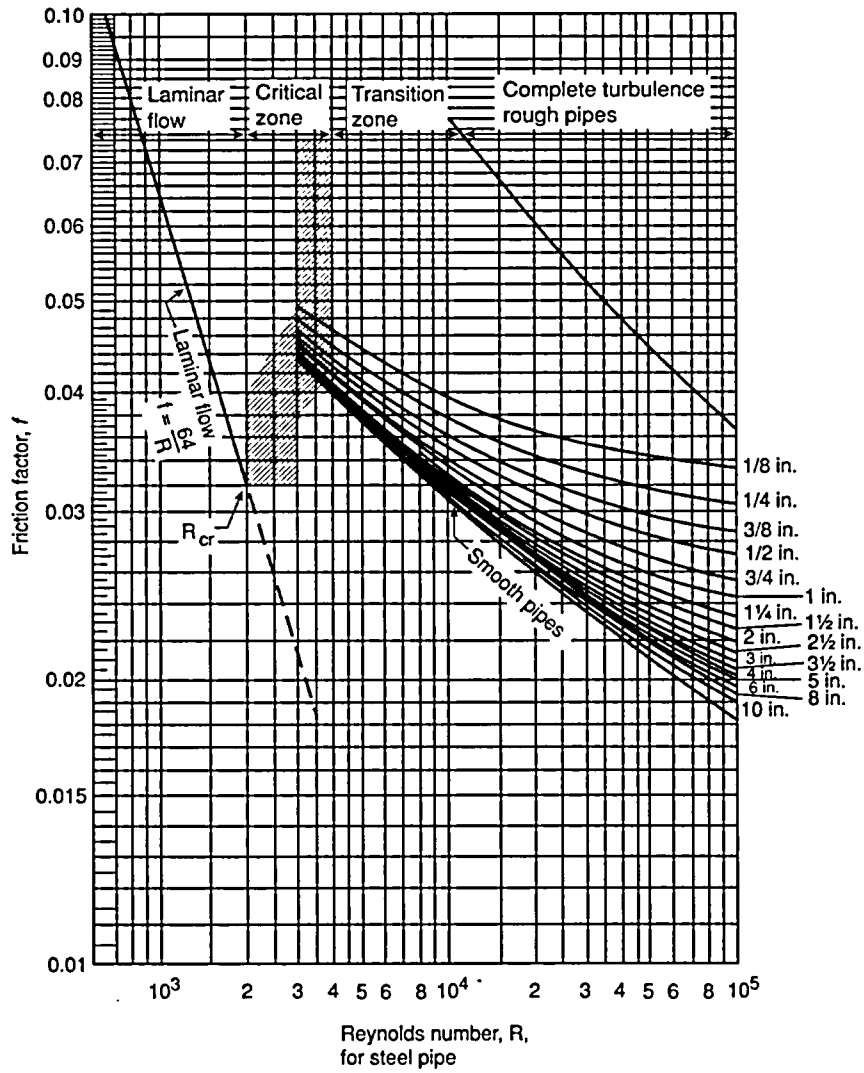


**Figure A-4-7.4(d) Moody diagram steel pipe.**

## Appendix B Referenced Publications

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

**B-1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-1901.

NFPA 11, *Standard for Low-Expansion Foam*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*, 1994 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1992 edition.

NFPA 26, *Recommended Practice for the Supervision of Valves Controlling Water Supplies for Fire Protection*, 1988 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting Operations*, 1991 edition.

NFPA 403, *Standard for Aircraft Rescue and Fire Fighting Services at Airports*, 1993 edition.

NFPA 412, *Standard for Evaluating Aircraft Rescue and Fire Fighting Foam Equipment*, 1993 edition.

**B-1.2 ASTM Publication.** American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E380, *Standard for the Use of the International System of Units (SI)*, 1991 edition.

# Index

# The NFPA Codes and Standards Development Process

Since 1896, one of the primary purposes of the NFPA has been to develop and update the standards covering all areas of fire safety.

**Calls for Proposals**
The code adoption process takes place twice each year and begins with a call for proposals from the public to amend existing codes and standards or to develop the content of new fire safety documents.

**Report on Proposals**
Upon receipt of public proposals, the technical committee members meet to review, consider, and act on the proposals. The public proposals – together with the committee action on each proposal and committee-generated proposals – are published in the NFPA's Report on Proposals (ROP). The ROP is then subject to public review and comment.

**Report on Comments**
These public comments are considered and acted upon by the appropriate technical committees. All public comments – together with the committee action on each comment – are published as the Committee's supplementary report in the NFPA's Report on Comments (ROC).

The committee's report and supplementary report are then presented for adoption and open debate at either of NFPA's semi-annual meetings held throughout the United States and Canada.

**Association Action**
The Association meeting may, subject to review and issuance by the NFPA Standards Council, (a) adopt a report as published, (b) adopt a report as amended, contingent upon subsequent approval by the committee, (c) return a report to committee for further study, and (d) return a portion of a report to committee.

**Standards Council Action**
The Standards Council will make a judgement on whether or not to issue an NFPA document based upon the entire record before the Council, including the vote taken at the Association meeting on the technical committee's report.

**Voting Procedures**
Voting at an NFPA Annual or Fall Meeting is restricted to members of record for 180 days prior to the opening of the first general session of the meeting, except that individuals who join the Association at an Annual or Fall Meeting are entitled to vote at the next Fall or Annual Meeting.

"Members" are defined by Article 3.2 of the Bylaws as individuals, firms, corporations, trade or professional associations, institutes, fire departments, fire brigades, and other public or private agencies desiring to advance the purposes of the Association. Each member shall have one vote in the affairs of the Association. Under Article 4.5 of the Bylaws, the vote of such a member shall be cast by that member individually or by an employee designated in writing by the member of record who has registered for the meeting. Such a designated person shall not be eligible to represent more than one voting privilege on each issue, nor cast more than one vote on each issue.

Any member who wishes to designate an employee to cast that member's vote at an Association meeting in place of that member must provide that employee with written authorization to represent the member at the meeting. The authorization must be on company letterhead signed by the member of record, with the membership number indicated, and the authorization must be recorded with the President of NFPA or his designee before the start of the opening general session of the Meeting. That employee, irrespective of his or her own personal membership status, shall be privileged to cast only one vote on each issue before the Association.

# Sequence of Events Leading to Publication of an NFPA Committee Document

Call for proposals to amend existing document or for recommendations on new document.

▼

Committee meets to act on proposals, to develop its own proposals, and to prepare its report.

▼

Committee votes on proposals by letter ballot. If two-thirds approve, report goes forward. Lacking two-thirds approval, report returns to committee.

▼

Report is published for public review and comment. (Report on Proposals - ROP)

▼

Committee meets to act on each public comment received.

▼

Committee votes on comments by letter ballot. If two-thirds approve, supplementary report goes forward. Lacking two-thirds approval, supplementary report returns to committee.

▼

Supplementary report is published for public review. (Report on Comments - ROC).

▼

NFPA membership meets (Annual or Fall Meeting) and acts on committee report (ROP and ROC).

▼

Committee votes on any amendments to report approved at NFPA Annual or Fall Meeting.

▼

Complaints to Standards Council on Association action must be filed within 20 days of the NFPA Annual or Fall Meeting.

▼

Standards Council decides, based on all evidence, whether or not to issue standard or to take other action, including hearing any complaints.

▼

Appeals to Board of Directors on Standards Council action must be filed within 20 days of Council action.