

NFPA®

16

**Standard for the
Installation of Foam-Water
Sprinkler and Foam-Water
Spray Systems**

2019



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NFPA® 16

Standard for the

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

2019 Edition

This edition of NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, was prepared by the Technical Committee on Foam-Water Sprinklers and released by the Correlating Committee on Automatic Sprinkler Systems. It was issued by the Standards Council on May 5, 2018, with an effective date of May 25, 2018, and supersedes all previous editions.

This edition of NFPA 16 was approved as an American National Standard on May 25, 2018.

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 included clarification of the scope of the standard, improvements to the hydraulic design criteria, and recognition of a fourth proportioning method.

The 1999 edition combined NFPA 16 and NFPA 16A into one comprehensive document. Numerous editorial changes also were instituted.

The 2003 edition was reformatted to conform to the *Manual of Style for NFPA Technical Committee Documents* and was revised to recognize the use of different types and brands of foam concentrate.

The 2007 edition of the standard was revised to coordinate definitions and requirements for fire department connections and underground pipe with those of other documents.

The 2011 edition was updated to clarify the criteria for acceptance testing of the concentration of foam to specific tolerance ranges.

The standard clarified that the orifice indicator tabs or nameplate must be permanently marked. The 2011 edition also made the hose stream allowance consistent with NFPA 13, *Standard for the Installation of Sprinkler Systems*. In addition, the alcohol-resistant foams did not follow the Darcy-Weisbach formula because they are non-Newtonian fluids, and a change was made to consult the manufacturers regarding friction loss.

The 2015 edition of NFPA 16 updated several definitions for foam water system types, including foam-water sprinkler system, foam-water deluge system, foam-water dry pipe system, and foam-water preaction system. The strainer and galvanized piping C-factor requirements were revised to correlate with NFPA 13. Multiple changes were made to the standard from a system acceptance perspective. Language was added to the acceptance testing criteria to confirm that the proportioning system meets the actual calculated system discharge demand at the most remote four sprinklers. Finally, the Contactors Material and Test Certificate from NFPA 13 was added for correlation purposes.

The 2019 edition of NFPA 16 was reorganized in a fashion consistent with that of the 2019 edition of NFPA 13 — to present information in the order in which it is needed when planning and designing a foam water sprinkler/spray system. Technical changes include the addition of requirements for working drawings using information from both NFPA 11 and NFPA 13 to provide a comprehensive list of information. Information about the type of foam concentrate piping was extracted from NFPA 11 to be consistent with that standard. Information was also extracted from NFPA 30 to address containment, drainage, and spill control.

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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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Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard contains minimum requirements for the design, installation, and maintenance of foam-water sprinkler and spray 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 and spray protection is required. The determination of where foam-water sprinkler and spray systems are required shall be made in accordance with such applicable building and fire codes or standards such as NFPA 30 or NFPA 409.

1.1.2* This standard shall apply only to systems using low-expansion foam.

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 sprinkler and spray systems based on sound engineering principles, test data, and field experience.

1.3 Application.

1.3.1* Because of the dual extinguishing agent discharge characteristic, these systems shall be selectively applicable to combination Class A and Class B hazards.

1.3.2 Foam-water deluge systems are applicable to the protection of two-dimensional flammable liquid hazards. They shall be permitted to be used for any of the purposes or combinations thereof detailed in 1.3.2.1 through 1.3.2.3.

1.3.2.1 Extinguishment. The primary purpose of such systems is the extinguishment of fire in the protected hazard. For this purpose, foam solution discharge densities shall be provided by system design, use of selected discharge devices, and provision of supplies of water at required pressures to accomplish the system design. Foam discharge rates shall be able to provide required rates of water discharge from the system until shut off during the design period and following depletion of foam concentrate supplies.

1.3.2.2 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 cleanup measures. In such cases, manual system operation provides foam coverage in the area with water discharge manually available.

1.3.2.3 Control and Exposure Protection. Control of fire to allow controlled burning of combustible materials where extinguishment is not possible 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. The degree of accomplishment is related strongly to the fixed discharge densities provided by the system design.

1.3.3 Foam of any type is not an effective 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.

1.3.4* Only alcohol-type foam shall be used on fires in water-soluble solvents and polar solvents. Manufacturers of foam concentrates that are manufactured for the protection of such hazards shall be consulted for applicability.

1.3.5* Consideration shall be given to potential contamination of water supplies, treating systems, and effluent by foam concentrate, foam, or foam solution runoff. The foam concentrate manufacturer and the appropriate authority having jurisdiction shall be consulted for guidance.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portion of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documents shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 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 1.6 with conversion factors.

1.6.1 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.

1.6.2 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.

Table 1.6 SI Units and Conversion Factors

	Name of Unit	Unit Symbol	Conversion Factor
Length	millimeter	mm	1 in. = 25.4 mm
	meter	m	1 ft = 0.3048 m
Area	square meter	m ²	1 ft ² = 0.0929 m ²
Volume	cubic meter	m ³	1 ft ³ = 0.02832 m ³
Flow	liter per minute	L/min	1 gpm = 3.7848 L/min
Pressure	bar	bar	1 psi = 0.0689 bar
Density	millimeter/minute	mm/min	1 gpm/ft ² = 40.746 mm/min
	liter/minute/m ²	(L/min)/m ²	1 gpm/ft ² = 40.746 (L/min)/m ²
Weight	kilogram	kg	1 lb = 0.4536 kg
Temperature	Fahrenheit	°F	°F = 9/5 × °C + 32
	Celsius	°C	°C = 5/9(°F - 32)

Note: For additional conversions and information, see ASTM SI10, *Standard for Use of the International System of Units (SI): The Modern Metric System*.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2017 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2019 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2016 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2014 edition.

2.3 Other Publications.

2.3.1 ASME Publications. ASME International, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels, 2017.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2012.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2009.

ASTM B315, *Standard Specification for Seamless Copper Alloy Pipe and Tube*, 2012.

ASTM SI10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 2010.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

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

3.2.4 Shall. Indicates a mandatory requirement.

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

3.2.6 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Concentration. The percent of foam concentrate contained in a foam solution. [11, 2016]

3.3.2* Discharge Device. A device designed to discharge water or foam-water solution in a predetermined, fixed, or adjustable pattern. Examples include, but are not limited to, sprinklers, spray nozzles, and hose nozzles.

3.3.3 Fire.

3.3.3.1 Class A. Fire in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

3.3.3.2 Class B. A fire in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

3.3.4* Foam. A stable aggregation of bubbles of lower density than oil or water. [11, 2016]

3.3.5 Foam-Water Density. The unit rate of foam-water solution application to an area, expressed in [L/min·m² (gpm/ft²)].

3.3.6* Foam-Water Sprinkler System. A piping network employing automatic sprinklers, nozzles or other discharge devices, connected to a source of foam concentrate and to a water supply.

3.3.6.1* Foam-Water Deluge System. A foam-water sprinkler system employing open discharge devices, which are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system, which is installed in the same areas as the discharge devices.

3.3.6.2* Foam-Water Dry Pipe System. A foam-water sprinkler system employing automatic sprinklers or nozzles that are attached to a piping system that contains air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve.

3.3.6.3* Foam-Water Preaction System. A foam-water sprinkler system employing automatic sprinklers or nozzles attached to a piping system containing air that might or might not be under pressure, with a supplemental detection system installed in the same area as the sprinklers.

3.3.6.4* Foam-Water Spray System. A foam-water sprinkler system designed to use nozzles rather than sprinklers.

3.3.6.5* Preprimed System. A wet pipe system containing foam solution.

3.3.7* Foam Concentrate. A concentrated liquid foaming agent as received from the manufacturer. [11, 2016]

3.3.7.1* Alcohol-Resistant Foam Concentrate. A concentrate used for fighting fires on water-soluble materials and other fuels destructive to regular, AFFF, or FFFP foams, as well as for fires involving hydrocarbons. [11, 2016]

3.3.7.2* Aqueous Film-Forming Foam Concentrate (AFFF). A concentrate based on fluorinated surfactants plus foam stabilizers to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors and usually diluted with water to a 1 percent, 3 percent, or 6 percent solution. [11, 2016]

3.3.7.3* Film-Forming Fluoroprotein Foam Concentrate (FFFP). A protein-foam concentrate that uses fluorinated surfactants to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors. [11, 2016]

3.3.7.4* Fluoroprotein Foam Concentrate. A concentrate very similar to protein-foam concentrate but with a synthetic fluorinated surfactant additive. [11, 2016]

3.3.7.5* Medium- and High-Expansion Foam Concentrate. A concentrate, usually derived from hydrocarbon surfactants, used in specially designed equipment to produce foams having foam-to-solution volume ratios of 20:1 to approximately 1000:1. [11, 2016]

3.3.7.6* Other Synthetic Foam Concentrate. A concentrate based on hydrocarbon surface active agents and listed as a wetting agent, foaming agent, or both. [11, 2016]

3.3.7.7* Protein Foam Concentrate. Concentrate consisting primarily of products from a protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use under emergency conditions. [11, 2016]

3.3.7.8 Synthetic Foam Concentrate. Concentrate based on foaming agents other than hydrolyzed proteins and including aqueous film-forming foam (AFFF) concentrates, medium- and high-expansion foam concentrates, and other synthetic foam concentrates. [11, 2016]

3.3.8* Foam Solution. A homogeneous mixture of water and foam concentrate in the correct proportions. [11, 2016]

3.3.9 Proportioning. The continuous introduction of foam concentrate at the recommended ratio into the water stream to form foam solution. [11, 2016]

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

Chapter 4 General Requirements

4.1 General System Information.

4.1.1 Foam-water deluge and preaction systems shall be provided with automatic and auxiliary manual tripping means in accordance with Section 6.10.

4.1.2 Manual operation only shall be permitted for foam-water deluge systems where acceptable to the authority having jurisdiction.

4.2 Types of Systems. Foam-water systems shall be of the wet pipe, dry pipe, deluge, or preaction type.

4.3 Foam Discharge Duration.

4.3.1 Systems shall deliver foam to the hazards they protect for a specified period at given densities, either prior to water discharge or following water discharge, depending upon system design purpose.

4.3.2 Following completion of discharge of foam solution to the hazards protected, foam-water sprinkler and spray systems shall discharge water until manually shut off.

4.4* Reserve Supply of Foam.

4.4.1 The authority having jurisdiction shall be consulted as to the means by which a reserve supply of foam concentrate shall be made available.

4.4.2* The reserve supply shall be listed for use with system components.

4.5* Preprimed Systems.

4.5.1 Wet pipe foam-water systems shall be preprimed with foam-water solution.

4.5.2 Systems shall not be required to be preprimed where recommended by the foam concentrate manufacturer and where approved by the authority having jurisdiction.

4.6 Approvals.

4.6.1 Prior to designing a system for consideration, the authority having jurisdiction shall be consulted.

4.6.2 All plans and specifications for 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 as to selection of the foam concentrate to be provided for system use.

4.6.3 All equipment and concentrates shall be approved for the particular application intended.

N 4.7 Working Plans.

N 4.7.1 Working plans shall be submitted for approval to the authority having jurisdiction before any equipment is installed or remodeled.

N 4.7.2 Deviation from approved plans shall require permission of the authority having jurisdiction.

N 4.7.3 Working plans shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor, and shall show those items from the following list that pertain to the design of the system:

- (1) Name of owner and occupant.
- (2) Location, including street address.
- (3) Point of compass.
- (4) Full height cross section, or schematic diagram, including structural member information construction of protected equipment.
- (5) Size of supply main and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and water flow test results and system elevation relative to test hydrant.
- (6) Other sources of water supply with pressure or elevation.
- (7) Make, type, model, and model number of sprinklers or discharge devices.
- (8) Pipe type and schedule of wall thickness.
- (9) Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions).
- (10) Types of fittings and joints and locations of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and types of fittings or formations to be used.
- (11) Types and locations of hangers, sleeves, braces, and methods of securing foam discharge devices when applicable.
- (12) All control valves, check valves, drain pipes, and test connections.
- (13) Piping provisions for flushing.
- (14) For hydraulically designed systems, the information on the hydraulic data nameplate.
- (15) Graphic representations of the scale used on all plans.
- (16) Name and address of contractor.

- (17) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.
 - (18) Information about backflow preventers (manufacturer, size, type).
 - (19) Sizes and locations of hydrants, showing sizes and numbers of outlets and whether outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.
 - (20) Sizes, locations, and piping arrangements of fire department connections.
 - (21) Physical details of the hazard, including the location, arrangement, and hazardous materials involved.
 - (22) Type and percentage of foam concentrate.
 - (23) Required solution application rate.
 - (24) Size and location of foam concentrate storage tank and proportioning equipment.
 - (25) Water supply requirements.
 - (26) Calculations specifying required amount of foam concentrate.
 - (27)* Hydraulic calculations.
 - (28) Identification and capacity of all equipment and devices.
 - (29) Location of piping, detection devices, operating devices, discharge outlets, and auxiliary equipment.
 - (30) Description of any special features.
- N 4.7.4** 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.
- N 4.7.5** Where field conditions necessitate any change affecting system performance from the approved plan, revised “as installed” plans shall be supplied for approval to the authority having jurisdiction.
- N 4.7.6** Charts that specify head, delivery, efficiency, and brake horsepower curves of pumps shall be furnished by the contractor.
- N 4.7.7 Hydraulic Calculations.**
- N 4.7.7.1 General.** Hydraulic calculations shall be prepared on forms that include a summary sheet, detailed worksheets, and a graph sheet.
- N 4.7.7.2 Summary Sheet.** The summary sheet shall contain the following information, where applicable:
- (1) Date
 - (2) Location
 - (3) Name of owner and occupant
 - (4) Building number or other identification
 - (5) Description of hazard
 - (6) Name and address of contractor or designer
 - (7) Name of approving authority
 - (8) System design requirements, as follows:
 - (a) Design area of foam application [ft^2 (m^2)]
 - (b) Minimum rate of foam
 - (c) Area of sprinkler operation [ft^2 (m^2)]
 - (9) Total foam requirements as calculated, including allowance for inside hose, outside hydrants
- N 4.7.7.3 Detailed Worksheets.** Detailed worksheets or computer printouts shall contain the following information:
- (1) Sheet number
 - (2) Foam-water sprinkler or discharge device description and discharge constant (K)
 - (3) Hydraulic reference points
 - (4) Flow [gpm (L/min)]
 - (5) Pipe size
 - (6) Pipe lengths, center-to-center of fittings
 - (7) Equivalent pipe lengths for fittings and devices
 - (8) Friction loss of pipe [psi/ft (bar/m)]
 - (9) Total friction loss between reference points
 - (10) Elevation head between reference points [psi (bar)]
 - (11) Required pressure at each reference point [psi (bar)]
 - (12) Notes to indicate starting points or reference to other sheets or to clarify data shown
- N 4.7.7.4 Graph Sheet.** A graphic representation of the complete hydraulic calculation shall be plotted on semi-exponential graph paper ($Q^{1.85}$) and shall include the following:
- (1) Water supply curve
 - (2) Foam system demand
 - (3) Hose allowance, where applicable

Chapter 5 Water Supplies

5.1* Water Quality.

5.1.1 Water supplied to foam-water systems shall be compatible with the foam concentrate to be used.

5.1.2 Water that contains solids likely to clog orifices in discharge devices but that is otherwise acceptable for making foam shall be permitted to be used after passing through line strainers.

5.2 Water Supply Capacity, Pressure, and Duration.

5.2.1 Water supplies for deluge foam-water sprinkler systems and foam-water spray systems shall be automatic.

Δ 5.2.1.1 Water supplies shall have the capacity and a pressure to maintain foam or water discharge, or both, at the required design rate for the required duration over the area protected by the systems that are expected to operate simultaneously.

N 5.2.1.1.1 The flow and pressure of a public water supply shall be determined from waterflow test data or other approved method.

N 5.2.1.1.1.1 Water supply fluctuations shall be addressed in the design of water-based fire protection systems, as required by the authority having jurisdiction.

N 5.2.1.1.1.2 Safety factors shall be addressed in the design of water-based fire protection systems, as required by the authority having jurisdiction.

N 5.2.1.2* Water Supply Evaluation. The water flow rate and pressure of a public water supply shall be determined from waterflow test data or other approved method. [14:10.1]

N 5.2.1.2.1 Daily and seasonal flow and pressure fluctuation data shall be provided by the water purveyor, and the fire protection design must account for both high and low variations. [14:10.1.1]

N 5.2.1.2.2 Where these data are not available, design shall be based on the available water flow data. [14:10.1.1.1]

N 5.2.1.2.3* Procedure. Where a waterflow test is used for the purposes of system design, the test shall be conducted no more than 12 months prior to working plan submittal unless otherwise approved by the authority having jurisdiction. [14:10.2]

5.2.2* 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.

5.2.2.1 Cross-connections shall be reviewed by public health agencies concerned.

5.2.3 Duration.

5.2.3.1* Water supplies shall be designed to meet the fixed fire protection demand plus 250 gpm (946 L/min) for inside and outside hose streams for at least 60 minutes, unless otherwise specified in the occupancy standards.

5.2.3.2 Water supplies for aircraft hangars shall be in accordance with NFPA 409.

Chapter 6 System Components

6.1 Approved Devices and Materials.

6.1.1 All component parts, including foam concentrates, shall be listed for the use intended.

6.1.2 Where listed components are not manufactured, the components shall be of an approved type.

6.2 Discharge Devices.

6.2.1 Discharge devices and foam concentrates shall be listed for use together.

6.2.2 Discharge devices for foam-water deluge and spray 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.

6.2.3 Discharge devices for foam-water wet pipe, dry pipe, and preaction systems shall be automatic in operation and shall be non-air-aspirating.

6.3 Foam Concentrate.

6.3.1* Foam concentrates shall be listed for use with the foam concentrate proportioning equipment and with the discharge devices with which a given system is equipped.

6.3.1.1 Replacement supplies of foam concentrates shall be listed for use with system components.

6.3.1.2* Different types and/or brands of foam concentrates shall not be mixed for storage. Different brands of the same type of concentrate shall not be mixed unless data are provided by the manufacturer and accepted by the authority having jurisdiction, to prove that the brands are compatible. Foams generated separately from protein, fluoroprotein, FFFP, and AFFF concentrates shall be permitted to be applied to a fire in sequence or simultaneously.

6.3.2 The quantities of foam concentrates to be used shall be based on flow rates and duration times for the application time period as specified in Chapter 7.

6.3.2.1 The foam concentrate used in a preprimed system shall be in addition to the quantity specified in 6.3.2.

6.3.3* There shall be a reserve supply of foam concentrate to meet the design requirements of the system and to put the system back in service within 24 hours after operation.

N 6.3.3.1 Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to conventional foams necessitate the use of alcohol-resistant foams.

N 6.3.3.2 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.

N 6.3.4* Foam concentrates shall be stored within the listed temperature limitations. [11:4.3.2.4.2]

6.4 Foam Concentrate Proportioning Means.

6.4.1 Balanced-pressure or positive-pressure injection shall be the preferred methods for introduction of foam concentrates into the water flowing through the supply piping to the system.

6.4.2* Balanced-pressure injection methods shall be one of the following:

- (1) A balance-pressure proportioning system utilizing a foam concentrate pump discharging through a metering orifice into a proportioning controller with the foam concentrate and water pressures automatically maintained as equal by the use of a pressure balancing valve.
- (2) A balanced-pressure proportioning system utilizing a pressure proportioning tank with a diaphragm or bladder to separate the water and foam concentrate discharging through a metering orifice into a proportioning controller.
- (3) An in-line balanced-pressure proportioning system utilizing a foam concentrate pump or bladder tank. A pressure regulating device placed in the pump return line shall maintain constant pressure in the foam concentrate supply line at all design flow rates. This constant pressure shall be greater than the maximum water pressure under all operating conditions.
- (4) 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.

6.4.3 Other listed methods for foam proportioning shall be permitted as follows:

- (1) Balanced positive-pressure injection systems utilizing a foam concentrate pump and drive motor that vary the foam concentrate pump output to match water flow rates while maintaining the correct percentage of foam concentrate
- (2) Around-the-pump proportioners
- (3)* In-line eductors (inductors)

6.4.4* The exposed orifice plate indicator tab or nameplate shall have stamped, etched, engraved, or other permanent markings giving orifice diameters and an indication of the flow direction if flow characteristics vary with flow direction.

6.5* Foam Concentrate Pumps.

6.5.1 Materials.

6.5.1.1* The design and materials of construction for foam concentrate pumps shall be approved for use with the type of foam concentrate used in the system.

6.5.1.2 Special attention shall be paid to the type of seal or packing used.

6.5.2 Rated Capacities.

6.5.2.1 Foam concentrate pumps shall have rated capacities at or in excess of the maximum system demand.

6.5.2.2 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.

6.5.3 Overpressurization.

6.5.3.1* Foam concentrate pumps capable of overpressurizing the system shall be provided with means of pressure relief from the discharge to the supply side of the pump to prevent excessive pressure and temperature.

6.5.3.2 Overpressure shall not exceed the working pressure of the foam concentrate piping system.

6.5.4 Flushing.

6.5.4.1* Foam concentrate pumps shall have means for flushing.

6.5.4.2 Foam concentrate pumps shall be provided with a drain cock or valve.

6.5.5 Foam concentrate pumps shall be automatic-starting upon system actuation.

6.5.6 Pumps shall be listed for this service in accordance with NFPA 20.

6.6 Foam Concentrate Storage Tanks.

6.6.1 Storage tanks for foam concentrate shall be constructed of materials compatible with the liquid, shall be solidly mounted, and shall be permanently located.

6.6.2 The storage temperatures for which foam concentrates are listed shall be considered the temperature limits for location of storage tanks.

6.6.3 Atmospheric-Type Storage Tanks.

6.6.3.1 Storage tanks shall have capacities to accommodate the needed quantities of foam concentrate plus space for thermal expansion.

6.6.3.2 Foam concentrate outlets from the tanks shall be located to prevent sediment from being drawn into the system.

6.6.3.3 When determining the quantity of foam concentrates, the volume of the sediment pocket shall be added to the quantity needed for system operation.

6.6.3.4* Tanks shall be equipped with conservation-type vents, access handholes, or manholes that are located to provide for inspection of the following:

- (1) Interior tank surfaces

- (2) Connections for pump suction, relief, and testing lines
- (3) Protected sight gauges or other liquid level devices
- (4) Filling and draining connections

6.6.3.5 Tank discharge outlets shall be located to furnish a positive head on the pump suction.

6.6.4 Pressure-Type Storage Tanks.

6.6.4.1* 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.

6.6.4.2 These tanks shall be stamped to be identified as meeting the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1.

6.7 Piping, Valves, Pipe Fittings, and Hangers.

6.7.1 Piping, valves, pipe fittings, and hangers, including corrosion-protection coatings, shall be in accordance with NFPA 13.

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

■ 6.7.2.1* Foam concentrate pipe and valves shall be made of one of the following materials:

- (1) Brass (red or naval)
- (2) Bronze
- (3) Stainless steel (304 or 316)
- (4) Other material, in accordance with the foam concentrate manufacturer's certification of compatibility with the foam concentrate and as approved by the AHJ

[11:4.7.1.1]

■ 6.7.2.2 Carbon steel pipe shall be permitted to be used in accordance with the manufacturer's certification of compatibility with the foam concentrate and as approved by the AHJ.

■ 6.7.2.3 Pipe carrying foam concentrate shall not be galvanized. [11:4.7.1.3]

■ 6.7.2.4 Foam concentrate pipe shall conform to one of the following standards:

- (1) ASTM A312
- (2) ASTM B43
- (3) ASTM B315
- (4) Other standards as allowed by 6.7.2.1(4), 6.7.2.2, and 6.7.2.3

[11:4.7.1.4]

■ 6.7.2.5* Foam solution pipe shall be in accordance with NFPA 13.

6.7.3* Rubber-gasketed fittings shall be permitted to be used to connect pipe in fire-exposed areas where the foam-water system is automatically controlled.

6.7.3.1 Fire-exposed areas in which these fittings are located shall be protected by automatic foam-water systems or other approved means.

6.8 Strainers for Foam Concentrate.

■ 6.8.1 Strainers shall be provided for foam concentrate lines only where required by the manufacturer's written recommendations.