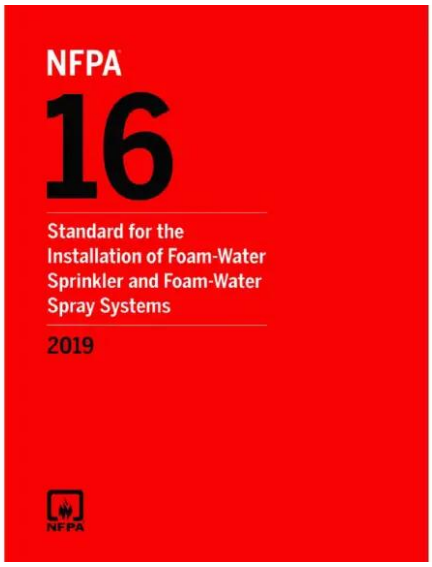

NFPA 16 (2019)

Complete Standard Reference

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

Kord Fire Protection

KORD FIRE PROTECTION

Complete NFPA 16 Reference Guide

NFPA 16 (2019)

Standard for the Installation of

Foam-Water Sprinkler and

Foam-Water Spray Systems

Complete Standard Reference Document

Prepared by: Kord Fire Protection
Date: 2026

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Chapter 1 — Administration

Overview

Chapter 1 establishes the administrative framework governing how NFPA 16 is applied, enforced, and maintained. This chapter serves as the foundational governance structure, defining the scope of applicability, enforceability of requirements, units of measurement, and the relationship between the standard and the Authority Having Jurisdiction (AHJ).

Purpose: To ensure consistent, predictable application of the standard across all adopting jurisdictions.

Key Topics: Scope, enforceability, retroactivity, equivalency provisions, and dual-unit measurement systems.

1.1 Scope

NFPA 16 covers the design, installation, inspection, testing, and maintenance of foam-water sprinkler and foam-water spray systems. These specialized fire suppression systems combine water delivery with low-expansion foam concentrate proportioning to provide enhanced fire extinguishment, particularly for hazards involving flammable and combustible liquids (Class B fires).

Key Scope Limitations:

- Applies only to **low-expansion foam** systems (expansion ratio less than 200:1)
- Covers both foam-water sprinkler and foam-water spray systems
- Applies to Class A and Class B hazard protection
- Does not cover high-expansion foam systems (covered by other NFPA standards)
- Does not cover non-automatic foam application systems

System Types Within Scope:

1. Wet pipe foam-water sprinkler systems
2. Dry pipe foam-water sprinkler systems
3. Preaction foam-water systems
4. Foam-water deluge systems
5. Foam-water spray systems

1.2* Purpose

The purpose of NFPA 16 is to provide requirements for the installation of foam-water sprinkler and foam-water spray systems to protect life and property from fire and similar emergencies. The standard is intended to:

- Establish minimum requirements for system design and installation
- Ensure reliable system operation when needed
- Provide a framework for AHJ approval and enforcement
- Balance fire protection effectiveness with practical installation considerations

The standard recognizes that foam-water systems are typically installed in higher-hazard occupancies where conventional water-only systems may be insufficient for fire control and extinguishment.

1.3 Application

NFPA 16 applies to the installation of new foam-water systems and modifications, alterations, additions, and relocation of existing systems. The standard is not intended to apply to:

- Existing systems that are maintained in accordance with the edition under which they were originally approved
- Systems installed in accordance with an approved alternative design
- Temporary foam-water systems used during construction

Retroactivity Considerations:
Existing installations are generally grandfathered under the edition of the standard in effect at the time of original installation. However, when existing systems are modified, altered, or have their occupancy changed, the modifications must comply with the current adopted edition.

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. 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.

Key Retroactivity Principles:

- Existing systems remain compliant under their original edition
- Modifications trigger compliance requirements for the modified portions
- Change of occupancy may trigger full compliance requirements
- AHJ has authority to require upgrades for existing systems

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.

Technical Compliance Requirements:

- Alternative materials, methods, or designs must demonstrate equivalent safety
- Engineering analysis, testing data, or field experience may support equivalency
- Final approval authority rests with the AHJ
- Documentation of equivalency must be maintained

Common Equivalency Applications:

- New foam concentrate formulations not tested under exact standard conditions
- Alternative proportioning methods with equivalent performance data
- Novel detection or activation systems
- Modified system configurations for unique hazards

1.6 Units

This standard expresses numerical values for measurements using either the International System of Units (SI) or the US Customary System. Values in SI and US Customary units are not necessarily exact equivalents.

Dual-Unit Format:

- Primary units appear first (typically US Customary)
- SI equivalents appear in parentheses
- Values in parentheses are for information and guidance
- Designers must use primary units without relying on parenthetical conversions for critical calculations

Table 1.6 — Units

US Customary Unit	SI Unit
inch (in.)	millimeter (mm)
foot (ft)	meter (m)
square foot (ft²)	square meter (m²)
gallon per minute (gpm)	liter per minute (L/min)
pound per square inch (psi)	bar
degree Fahrenheit (°F)	degree Celsius (°C)

Chapter 2 — Referenced Publications

Overview

Chapter 2 serves as the bibliographic foundation for NFPA 16, listing all external standards, codes, manuals, and technical documents referenced throughout the standard. This chapter eliminates ambiguity about which version of a referenced standard governs a particular requirement.

Purpose: To create a unified reference framework ensuring consistent application of all cited requirements.

2.1 General

The publications or portions thereof listed in this chapter are referenced in this standard and shall be interpreted considered as part of the requirements of this standard.

Key Principle: Mandatory references carry the force of the standard. Non-mandatory references (cited only in annexes) provide supplementary information but do not create enforceable requirements.

2.2 NFPA Publications

Mandatory NFPA References:

Standard	Title	Application
NFPA 10	Portable Fire Extinguishers	Portable extinguisher requirements
NFPA 11	Low-, Medium-, and High-Expansion Foam	Foam concentrate and proportioning requirements

Standard	Title	Application
NFPA 13	Installation of Sprinkler Systems	Sprinkler design fundamentals, hydraulic calculations
NFPA 14	Standpipe and Hose Systems	Standpipe integration
NFPA 15	Water Mist Fire Protection Systems	Water mist system requirements
NFPA 20	Installation of Stationary Pumps for Fire Protection	Fire pump requirements
NFPA 22	Water Tanks for Fire Protection	Tank design and installation
NFPA 24	Private Fire Service Mains	Underground and above-ground piping
NFPA 25	Inspection, Testing, and Maintenance of Water-Based Systems	ITM requirements
NFPA 72	National Fire Alarm and Signaling Code	Alarm and detection requirements
NFPA 409	Aircraft Hangars	Aircraft hangar protection
NFPA 1963	Fire Hose Connections	Fire department connection requirements

2.3 Other Publications

Mandatory Non-NFPA References:

Organization	Standard	Application
ASME	Boiler and Pressure Vessel Code, Section VIII	Pressure vessel requirements
ASTM	Various Materials Standards	Material specifications
API	Aboveground Storage Tank Standards	Fuel storage tank protection
UL	Various Listings	Equipment listing requirements

2.4 References for Extracts in Mandatory Sections

Where extracts from other standards are incorporated into NFPA 16, this section identifies the source and edition of each extract. This ensures traceability and allows users to reference the full context of incorporated requirements.

Chapter 3 — Definitions

Overview

Chapter 3 establishes the precise terminology used throughout NFPA 16. In fire protection engineering, terminology is regulatory — the definition of a term determines which requirements apply, which system type is being designed, and which performance criteria must be met.

Purpose: To ensure all stakeholders use a common vocabulary, eliminating ambiguity that could lead to non-compliant installations.

3.1 General

The definitions in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or elsewhere within this standard, they shall be defined using their ordinarily and customarily accepted meanings within the strict context in which they are used.

3.2 NFPA Official Definitions

Authority Having Jurisdiction (AHJ): An organization, office, or individual responsible for enforcing the requirements of a code or standard. This may be a governmental authority, an insurance company, a utility, or a private entity with contractual authority.

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.

Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and whose labeling indicates compliance with appropriate standards or performance at a stated level.

3.3 General Definitions

Foam-Water Sprinkler System: An automatic sprinkler system using approved water-type sprinklers that delivers a mixture of water and foam concentrate to the fire area.

Foam-Water Spray System: A system that delivers water and foam concentrate through spray nozzles in a pattern designed to cover the protected hazard.

Foam Concentrate: The undiluted foam-making agent stored in containers and proportioned into the water stream. Types include:

- Aqueous Film-Forming Foam (AFFF)
- Alcohol-Resistant AFFF (AR-AFFF)
- Film-Forming Fluoroprotein (FFFP)
- Fluoroprotein (FP)
- Protein foam

Proportioning System: The equipment that mixes foam concentrate with water at a predetermined ratio. Methods include balanced pressure, around-the-pump, in-line eductor, bladder tank, and pump-injector systems.

Low-Expansion Foam: Foam with an expansion ratio of less than 200:1.

Expansion Ratio: The ratio of the volume of foam produced to the volume of foam solution used to produce it.

Discharge Density: The rate of foam solution application expressed in gpm/ft² or L/min·m².

Duration: The length of time the system must deliver the designed discharge density.

Wet Pipe System: A system in which piping is continuously charged with water.

Dry Pipe System: A system in which piping is charged with compressed air or nitrogen.

Preaction System: A system requiring two independent initiation events before water is delivered.

Deluge System: An open-head system that releases water to all connected nozzles simultaneously upon activation.

Preprimed System: A wet pipe foam-water system that has foam solution in the piping at all times.

Chapter 4 — General Requirements

Overview

Chapter 4 establishes the overarching requirements that apply to all foam-water sprinkler and foam-water spray systems. This chapter serves as the general framework within which the more specific requirements of Chapters 5 through 9 operate.

Purpose: To ensure every foam-water system meets fundamental safety, performance, and reliability standards.

Key Topics: System documentation, foam discharge duration, reserve supply, preprimed systems, approvals, and working plans.

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.

Detailed Requirements:

- All foam-water systems require comprehensive documentation
- System design must be approved by the AHJ before installation
- Documentation includes hydraulic calculations, foam concentrate volume calculations, piping layouts, and proportioning system details
- Manual tripping stations must be accessible and protected against accidental operation

4.2 Types of Systems

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

System Type Selection Criteria:

- **Wet Pipe:** Most common; used in heated spaces where freezing is not a concern

- **Dry Pipe:** Used in unheated spaces; air/nitrogen charged until activation
- **Preaction:** Used where accidental discharge must be minimized; requires detection plus sprinkler operation
- **Deluge:** Open-head systems for high-hazard areas requiring rapid, simultaneous application

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.

Duration Requirements:

- Minimum duration is typically 60 minutes
- Specific hazards may require longer durations
- Foam concentrate volume must support the full duration
- Water supply must be adequate for foam duration plus extended water-only discharge

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.

Reserve Supply Requirements:

- Reserve typically equals the full designed concentrate volume
- Ensures system can be restored within 24 hours after operation
- Reserve concentrate must be compatible with system components
- Storage must meet temperature and environmental requirements

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.

Preprimed System Considerations:

- Preprimed systems have foam solution in piping at all times
- Eliminates delay between activation and foam discharge
- Requires concentrate compatibility verification with all wetted components
- May require more frequent maintenance due to constant solution contact

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.

Approval Process:

- Early AHJ consultation is critical
- All equipment must be listed and labeled for the specific application
- Foam concentrate must be compatible with proportioning equipment and discharge devices
- Alternative designs require equivalency documentation

4.7 Working Plans

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

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

4.7.3 Working plans shall include (but not be limited to):

6. Name of owner and occupant
7. Location, including street address
8. Point of compass
9. Full height cross section or schematic diagram
10. Size of supply main and whether dead end or circulating
11. Other sources of water supply with pressure or elevation
12. Make, type, model, and model number of sprinklers or discharge devices
13. Pipe type and schedule of wall thickness
14. Nominal pipe size and cutting lengths
15. Types of fittings and joints and locations of all welds and bends
16. Types and locations of hangers, sleeves, braces
17. All control valves, check valves, drain pipes, and test connections
18. Piping provisions for flushing
19. Hydraulic data nameplate information
20. Graphic representations of the scale used
21. Name and address of contractor
22. Hydraulic reference points
23. Information about backflow preventers
24. Sizes and locations of hydrants
25. Sizes, locations, and piping arrangements of fire department connections
26. Physical details of the hazard
27. Type and percentage of foam concentrate
28. Required solution application rate
29. Size and location of foam concentrate storage tank and proportioning equipment
30. Water supply requirements
31. Calculations specifying required amount of foam concentrate
32. Hydraulic calculations
33. Identification and capacity of all equipment and devices

34. Location of piping, detection devices, operating devices, discharge outlets
35. Description of any special features

4.7.7 Hydraulic Calculations

Hydraulic calculations shall be prepared on forms that include a summary sheet, detailed worksheets, and a graph sheet.

Chapter 5 — Water Supplies

Overview

Chapter 5 addresses the water supply requirements for foam-water systems. The water supply is the foundation of any water-based fire protection system, and its adequacy directly determines the system's ability to perform as designed.

Purpose: To ensure the water supply provides sufficient quantity, quality, pressure, and reliability.

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.

Water Quality Parameters:

- Hardness levels affecting foam performance
- pH compatibility with foam concentrate
- Suspended solids that could clog proportioning equipment
- Chemical contaminants that could degrade foam performance
- Biological contamination concerns

Treatment Options:

- Line strainers for suspended solids
- Water treatment systems for hardness or pH issues
- Filtration systems for chemical contaminants

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.

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.

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.

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.

Water Supply Requirements Summary:

- Minimum 60-minute duration for most occupancies
- Adequate pressure to deliver designed flow through all system components
- Flow testing within 12 months of plan submittal
- Consideration of daily and seasonal fluctuations
- Environmental considerations for foam discharge into public water systems

Chapter 6 — System Components

Overview

Chapter 6 specifies requirements for all individual components that make up a foam-water system. This chapter ensures that every component meets the performance, durability, and compatibility standards necessary for reliable system operation.

Purpose: To eliminate component failures as a cause of system malfunction by requiring listed, approved, and properly specified equipment throughout.

Key Topics: Approved devices, discharge devices, foam concentrate, proportioning means, pumps, storage tanks, piping, strainers, fire department connections, detection, valve supervision, test connections, and spare sprinklers.

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.

Approval Requirements:

- All components must be listed by recognized testing laboratories (UL, FM, LPCB)
- Listing must be for the specific application
- Alternative components require AHJ approval

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.

Discharge Device Types:

- Air-aspirating nozzles for deluge and spray systems

- Non-air-aspirating sprinklers for wet pipe, dry pipe, and preaction systems
- Devices must be listed for the specific foam concentrate type

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.

6.3.1.2* 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.

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.

6.3.4* Foam concentrates shall be stored within the listed temperature limitations.

Foam Concentrate Requirements:

- Compatibility with proportioning equipment and discharge devices
- No mixing of different types or brands without manufacturer approval
- Reserve supply equal to full system demand
- Temperature-controlled storage within manufacturer specifications
- Shelf life monitoring and replacement before expiration

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:

36. A balanced-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.
37. 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.
38. An in-line balanced-pressure proportioning system utilizing a foam concentrate pump or bladder tank.
39. 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:

40. 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
41. Around-the-pump proportioners
42. In-line eductors (inductors)

Proportioning Methods:

- **Balanced Pressure:** Most common for large systems; accurate over wide flow range
- **Bladder Tank:** Compact, self-contained; limited by bladder volume
- **In-Line Eductor:** Simple, for smaller systems; limited flow/pressure range

- **Around-the-Pump:** Injects into pump suction; requires careful pump selection

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.

6.5.2 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.

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.

6.6.3 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.

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

43. Interior tank surfaces
44. Connections for pump suction, relief, and testing lines
45. Protected sight gauges or other liquid level devices
46. Filling and draining connections

6.6.4 Pressure-Type Storage Tanks

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.

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

47. Brass (red or naval)
48. Bronze

49. Stainless steel (304 or 316)
50. Other material, in accordance with the foam concentrate manufacturer's certification

6.7.2.3 Pipe carrying foam concentrate shall not be galvanized.

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.

6.8.1.1 Where listed strainers of the proper size are not available, strainers that have a ratio of open-basket area to inlet pipe size of at least 10:1 shall be used.

6.8.1.3 Perforations shall be no larger than the smallest orifice in the system and no less than 1⁄8 in. (3.2 mm).

6.9 Fire Department Connections

6.9.1* Unless the requirements of 6.9.1.1 or 6.9.1.2 are met, the fire department connection(s) shall consist of two 2½ in. (65 mm) NH internal threaded swivel fitting(s) with connections using "2.5-7.5 NH standard thread," as specified in NFPA 1963.

6.9.1.3 Fire department connections shall be equipped with listed plugs or caps, properly secured and arranged for easy removal by fire departments.

6.10 Automatic System Detection

6.10.1 Detection required for foam-water deluge systems shall be in accordance with NFPA 15.

6.10.2 Detection required for foam-water preaction systems shall be in accordance with NFPA 13.

6.11 Valve Supervision

6.11.1* Main water, foam concentrate, and foam solution valves shall be supervised by one of the following methods:

51. Central station, proprietary, or remote station signaling service
52. Local signaling service that will cause the sounding of an audible signal at a constantly attended location
53. Valves locked in the open position
54. Valves located within fenced enclosures under the control of the owner, sealed in the open position, and inspected weekly

6.11.2 Detection and actuation circuitry shall be supervised through a listed panel in accordance with NFPA 72.

6.12* Test Connections

System test connections shall be sized to accommodate both the low flow of the proportioner and the maximum anticipated flow through the proportioner.

6.13 Stock of Spare Sprinklers

6.13.1* A supply of at least six spare sprinklers shall be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced.

6.13.5 The stock of spare sprinklers shall include all types and ratings installed and shall be as follows:

55. For protected facilities having under 300 sprinklers — no fewer than six sprinklers
56. For protected facilities having 300 to 1000 sprinklers — no fewer than 12 sprinklers
57. For protected facilities having over 1000 sprinklers — no fewer than 24 sprinklers

Chapter 7 — System Design and Installation

Overview

Chapter 7 is the core technical chapter of NFPA 16, providing the detailed design criteria and installation requirements for foam-water systems. This chapter translates the general requirements into specific design parameters, calculation methodologies, and installation procedures.

Purpose: To ensure every foam-water system is designed and installed to deliver the required foam solution discharge density to the protected hazard.

Key Topics: General requirements, design criteria, equipment location, alarms, strainers, sprinkler spacing, temperature rating, deluge systems, fire department connections, and hydraulic calculations.

7.1 General

The design and installation of foam-water systems shall comply with the requirements of this chapter and applicable sections of NFPA 13.

General Design Principles:

- System design must be approved by the AHJ
- Hydraulic calculations must account for foam solution properties
- All components must be compatible with foam concentrate
- Installation must follow manufacturer instructions and standard requirements

7.2 Design Criteria

Design Parameters:

- **Discharge Density:** Minimum rates based on hazard classification
- **Area of Operation:** Area where designed number of sprinklers operates simultaneously
- **Duration:** Minimum 60 minutes for most occupancies
- **Application Rate:** Foam solution application rate per unit area

Hazard Classification Impact:

- Light Hazard: Lower density requirements
- Ordinary Hazard: Moderate density requirements
- Extra Hazard: Higher density requirements
- Specific hazards: Manufacturer-recommended densities

7.3 Equipment Location

Foam proportioning equipment and foam concentrate storage shall be located to:

- Allow access for inspection, testing, and maintenance
- Protect equipment from physical damage
- Maintain concentrate within specified temperature range
- Provide adequate ventilation
- Include spill containment

7.4 Alarms

Foam-water systems shall be provided with:

- Waterflow alarms
- Supervisory signals for control valve positions
- Trouble signals for system impairments
- Foam concentrate level monitoring
- Alarm transmission to continuously attended location

7.5 Strainers

Strainers shall be installed where required to protect proportioning equipment and discharge devices from debris and contaminants.

Strainer Requirements:

- Sized to handle maximum system flow
- Capable of removing solids that could obstruct system components
- Accessible for cleaning and maintenance
- Perforations no larger than smallest system orifice

7.6 Sprinkler Spacing and Location

Sprinkler spacing and location shall comply with NFPA 13 requirements, modified for foam-water application.

Spacing Considerations:

- Maximum spacing limits per sprinkler listing
- Coverage area limitations
- Distance from walls and obstructions
- Foam solution discharge pattern requirements
- Obstruction rules modified for foam application

7.7 Temperature Rating

Sprinkler temperature ratings shall be selected based on the ambient temperature conditions in the protected area.

Temperature Classification:

Classification	Temperature Rating	Color Code
Ordinary	135–170°F (57–77°C)	Orange/Red
Intermediate	175–225°F (79–107°C)	Yellow/Green
High	250–300°F (121–149°C)	Blue
Extra High	325–375°F (163–191°C)	Purple

7.8 Foam-Water Deluge Systems

Foam-water deluge systems shall be designed and installed in accordance with this section and NFPA 15.

Deluge System Requirements:

- Open-head nozzles on open piping
- Deluge valve for system control
- Automatic detection system for initiation
- Manual initiation station
- Simultaneous discharge to all nozzles

7.9 Fire Department Connection

The fire department connection shall be sized and located to allow fire department pumpers to supplement the water supply.

FDC Requirements:

- Minimum two 2½ in. (65 mm) connections
- Listed plugs or caps
- Accessible location visible from fire apparatus access route
- Check valves to prevent backflow
- Configuration allowing foam injection by fire department

7.10 Hydraulic Calculations

Hydraulic calculations shall account for foam solution properties, which differ from water in viscosity, density, and friction characteristics.

Calculation Requirements:

- Friction loss correction for foam solution viscosity
- Verification of adequate pressure at all discharge devices
- Proportioning equipment operating range verification
- Water supply adequacy confirmation
- Documentation on approved forms with summary sheet, detailed worksheets, and graph sheet

Chapter 8 — Acceptance Tests

Overview

Chapter 8 specifies the acceptance testing requirements that must be completed before a foam-water system is placed in service. Acceptance testing verifies that the installed system meets the design specifications and the requirements of NFPA 16.

Purpose: To ensure the system will perform as designed when called upon to suppress a fire, and to identify and correct any deficiencies before the system is relied upon.

Key Topics: Flushing, hydrostatic tests, foam discharge tests, proportioning system testing, instructions, and signage.

8.1* Flushing of Supply Piping

All supply piping shall be flushed before system installation to remove debris, sediment, and contaminants.

Flushing Requirements:

- Flush to clear water at maximum achievable velocity
- Document flushing procedures and results
- Flush after any piping modifications

8.2 Hydrostatic Pressure Tests

All system piping shall be hydrostatically tested to verify integrity and leak-tightness.

Test Requirements:

- Test pressure: 200 psi (1.4 MPa) or 50 psi (0.35 MPa) above highest operating pressure, whichever is greater
- Duration: Minimum 2 hours
- No pressure loss permitted
- Repair leaks and retest

8.3 System Tests Discharging Foam from Foam-Water Deluge and Spray Systems

Foam-water deluge and spray systems shall be tested by discharging foam solution to verify proper operation.

Test Requirements:

- Verify foam discharge from representative nozzles
- Confirm proportioning accuracy
- Verify alarm and monitoring operation
- Document test results

8.4* Proportioning System Testing

The proportioning system shall be tested to verify accurate proportioning at multiple flow rates.

Test Procedure:

58. Establish water flow at minimum designed flow rate
59. Measure foam concentrate flow rate and calculate proportioning ratio
60. Repeat at intermediate flow rates
61. Repeat at maximum designed flow rate
62. Verify proportioning ratio within ±1 percentage point at all test points

8.5 Instructions

Written instructions for system operation, inspection, testing, and maintenance shall be provided to the system owner.

Instruction Requirements:

- System operation procedures
- Emergency procedures
- Inspection and testing schedules
- Maintenance procedures
- Foam concentrate handling and replacement

8.6* Hydraulic Design Information Sign

A sign shall be posted at the system control valve location indicating hydraulic design information.

Sign Content:

- System type
- Design density
- Area of operation
- Duration
- Foam concentrate type and percentage

8.7* General Information Sign

A general information sign shall be posted at each system control valve.

Sign Content:

- System identification
- Area protected
- Alarm notification method
- Emergency contact information

Chapter 9 — Inspection, Testing, and Maintenance

Overview

Chapter 9 establishes the ongoing inspection, testing, and maintenance requirements for foam-water systems after they are placed in service. Foam-water systems have unique maintenance requirements beyond those of water-only systems.

Purpose: To ensure the system remains in reliable operating condition throughout its service life.

Key Topics: ITM requirements, alarm and detection testing, and inspection frequency.

9.1* Inspection, Testing, and Maintenance of Foam-Water Sprinkler Systems

Foam-water sprinkler systems shall be inspected, tested, and maintained in accordance with NFPA 25, with additional foam-specific requirements.

Foam-Specific ITM Requirements:

- Foam concentrate quality verification
- Proportioning system accuracy testing
- Concentrate storage condition inspection
- Material compatibility verification
- Concentrate expiration date monitoring

9.2 Testing and Inspection of Alarm and Detection Devices

Alarm and detection devices shall be tested in accordance with NFPA 72.

Testing Requirements:

- Waterflow switch testing
- Tamper switch testing
- Pressure switch testing
- Concentrate level monitoring testing
- Communication path testing

9.3* Inspection, Testing, and Maintenance Frequency

Monthly Inspections:

- Control valve position verification
- Alarm device operation check
- Concentrate container visual inspection
- Equipment area inspection

Quarterly Inspections:

- All monthly items plus:
- Detailed proportioning equipment inspection
- Pressure regulator verification
- Supply piping inspection
- Temperature monitoring

Annual Inspections:

- Comprehensive component inspection
- Proportioning accuracy testing
- Water supply verification
- Concentrate quality verification
- ITM program review

Three-Year and Five-Year Tests:

- Internal piping inspection
- Dry pipe valve testing
- Concentrate container testing
- Elastomeric component replacement

Annex A — Explanatory Material

Overview

Annex A provides supplementary explanatory material that supports understanding of the mandatory requirements in Chapters 1-9. This material is informational and not enforceable.

A.1 Chapter 1 Explanatory Material

The scope limitations in Section 1.1 are based on the performance characteristics of low-expansion foam systems. Medium- and high-expansion foam systems have different design and installation requirements addressed in other NFPA standards.

The retroactivity provisions recognize that existing systems were designed and installed to meet the requirements in effect at the time. Requiring retroactive compliance would be impractical and could create unnecessary expense without commensurate safety benefits.

A.3 Chapter 3 Explanatory Material

Foam Technology History:
Foam concentrates have evolved significantly since their initial development. Early protein-based foams were effective but had limitations with certain fuels. The development of fluorosurfactants led to AFFF and FFFP, which provided faster fire knockdown and better burnback resistance. Recent environmental concerns have driven the development of fluorine-free foams (AFFF-K).

Discharge Device Types:

- **Air-Aspirating Nozzles:** Draw air into the foam solution stream to create expanded foam. Required for effective foam application in deluge and spray systems.
- **Non-Air-Aspirating Sprinklers:** Distribute foam solution without aspiration. Suitable for wet pipe, dry pipe, and preaction systems where the foam solution provides adequate fire control.

Foam Concentrate Types:

- **Protein Foam:** Derived from natural protein sources. Good for hydrocarbon fires but limited on polar solvents.
- **Fluoroprotein (FP):** Protein foam with fluorosurfactant addition. Improved burnback resistance.
- **AFFF:** Aqueous film-forming foam. Fast fire knockdown through aqueous film formation.
- **AR-AFFF:** Alcohol-resistant AFFF. Effective on polar solvents through polymer film formation.
- **FFFP:** Film-forming fluoroprotein. Combines FP and AFFF characteristics.

Annex B — Foam Solution Concentration Determination

Overview

Annex B provides testing procedures for determining the concentration of foam solution. This is critical for verifying proportioning system accuracy during acceptance testing and periodic maintenance.

B.1 General

Two methods are provided for determining foam solution concentration:

63. Conductivity Method
64. Refractive Index Method

The method selected should be appropriate for the foam concentrate type and the accuracy required.

B.2 Conductivity Method

The conductivity method measures the electrical conductivity of the foam solution, which varies with concentrate concentration.

Equipment Required:

- Conductivity meter calibrated for the specific foam concentrate
- Temperature compensation capability
- Calibrated standards

Procedure:

65. Collect foam solution sample at the point of use
66. Measure sample temperature
67. Measure conductivity
68. Compare to calibration curve for the specific concentrate
69. Determine concentration percentage

Limitations:

- Requires concentrate-specific calibration
- Affected by water quality variations
- Not suitable for all concentrate types

B.3 Refractive Index Method

The refractive index method measures the bending of light as it passes through the foam solution, which varies with concentrate concentration.

Equipment Required:

- Refractometer calibrated for the specific foam concentrate
- Temperature compensation capability

Procedure:

70. Collect foam solution sample
71. Place sample on refractometer prism
72. Read refractive index

73. Convert to concentration percentage using calibration chart

Advantages:

- Quick and portable
- Minimal sample required
- Suitable for field use

Annex C — Informational References

Overview

Annex C lists additional references that provide supplementary information but are not mandatory requirements of the standard.

C.1 NFPA Publications

Additional NFPA publications of interest:

- NFPA 18 — Dry Chemical Powder Fire Extinguishing Systems
- NFPA 30 — Flammable and Combustible Liquids Code
- NFPA 409 — Aircraft Hangars
- NFPA 418 — Manufactured Home Carports, Garages, and Attached Structures

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C.2 Other Publications

- FM Approvals Data Sheet 5130 — Foam-Water Sprinkler Systems
- UL Regulatory Information 3 — Foam-Water Sprinkler Systems
- API Standards for Storage Tank Design

C.3 Informational References

Additional resources for foam-water system design and installation:

- Foam concentrate manufacturer technical manuals
- Proportioning equipment manufacturer installation guides
- Industry best practice documents
- Research reports and technical papers

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This document is intended for reference and educational purposes. For enforceable requirements, consult the official NFPA 16 (2019) standard and your local Authority Having Jurisdiction.

ℹ Kord Fire Protection

For questions regarding this document or foam-water system design, contact Kord Fire Protection.

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