

# NFPA®

# 11

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Standard for  
Low-, Medium-, and  
High-Expansion Foam

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## 2021



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## NFPA® 11

### Standard for

## Low-, Medium-, and High-Expansion Foam

### 2021 Edition

This edition of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, was prepared by the Technical Committee on Foam. It was issued by the Standards Council on November 2, 2020, with an effective date of November 22, 2020, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at [www.nfpa.org](http://www.nfpa.org) for more information.

This edition of NFPA 11 was approved as an American National Standard on November 22, 2020.

### Origin and Development of NFPA 11

NFPA committee activity in this field dates from 1921, when the Committee on Manufacturing Risks and Special Hazards prepared standards on foam as a section of the general *Standard on Protection of Fire Hazards, Incident to the Use of Volatiles in Manufacturing Processes*. Subsequently the standards were successively under the jurisdiction of the Committee on Manufacturing Hazards and the Committee on Special Extinguishing Systems, prior to the present committee organization. The present text supersedes the prior editions adopted in 1922, 1926, 1931, 1936, 1942, 1950, 1954, 1959, 1960, 1963, 1969, 1970, 1972, 1973, 1974, 1975, 1976, and 1978. It also supersedes the 1977 edition of NFPA 11B.

The 1983 edition was completely rewritten to include all the material formerly contained in NFPA 11B, *Standard on Synthetic and Combined Agent Systems*. The standard was revised in 1988 and again in 1994 to state the requirements more clearly and to separate mandatory requirements from advisory text.

The standard was revised for the 1998 edition to include requirements for foam systems for marine applications and to provide guidance relating to the environmental impact of foam system discharges.

The 2002 edition was revised to address mixing of foam concentrates and to clarify requirements related to foam concentrate pumps. Requirements for medium- and high-expansion foam systems were included.

The 2005 edition was reorganized to provide the requirements for low-, medium-, and high-expansion foam, to better incorporate the requirements of NFPA 11A.

The 2010 edition added a new chapter to address compressed air foam systems. Unenforceable terms were removed to comply with the *Manual of Style for NFPA Technical Committee Documents*.

For the 2016 edition, the committee addressed several areas of concern. The piping requirements were reorganized and clarified, issues regarding acceptance criteria for annual foam concentrate testing were addressed, environmentally friendly methods of testing foam proportioners were recognized, and seal-only protection was permitted for composite roofs that meet specific criteria.

The 2021 edition contains multiple revisions to address the use of synthetic fluorine free foam (SFFF), including a new definition for SFFF. New definitions and explanatory annex material have been provided for cone roofs and external floating roofs. In Chapter 4, requirements that listed the types of foams permitted to be used on hydrocarbon fuels have been deleted, as the standard already requires foams to be listed for the flammable or combustible liquid they are protecting. Metric conversions throughout the standard have been updated as necessary to provide more usable numbers for metric users.

The 2021 edition also includes multiple new chapters and annexes. The requirements of NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, have been



consolidated into a new Chapter 6. A new Chapter 13 replaces the existing maintenance requirements with more comprehensive requirements for inspection, testing, and maintenance, including minimum requirements and frequency. A new Annex H provides summaries of current research and testing for the use of synthetic fluorine free foam (SFFF). A new Annex I outlines a testing protocol for a rim seal fire test for nonmetallic floating roof structures.

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*This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.*

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 installation, maintenance, and use of foam systems for fire protection, including foam hose streams.



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## NFPA 11

## Standard for

## Low-, Medium-, and High-Expansion Foam

2021 Edition

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**NOTICE:** An asterisk (\*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

## Chapter 1 Administration

## 1.1\* Scope.

**1.1.1** This standard covers the design, installation, operation, testing, and maintenance of low-, medium-, and high-expansion and compressed air foam systems for fire protection.

**1.1.2\*** It is not the intent of this standard to specify where foam protection is required.

## 1.2 Purpose.

**1.2.1** This standard is intended for the use and guidance of those responsible for designing, installing, testing, inspecting, approving, listing, operating, or maintaining fixed, semifixed, or portable low-, medium-, and high-expansion and compressed air foam fire-extinguishing systems for interior or exterior hazards.

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

**1.2.3** Low-, medium-, and high-expansion foam and compressed air foam systems are intended to provide property protection and not life safety.

**Δ 1.3 Application.** This standard is not applicable to the following types of systems:

- (1) Chemical foams and systems (considered obsolete)
- (2) Combined agent systems
- (3) Mobile foam apparatus (See NFPA 1901.)
- (4) Class A foam and systems (See NFPA 1150.)

**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 portions 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 documentation 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 and Formulas.** 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 unit, which is not part of but is recognized by SI, is commonly used in international fire protection. Conversion factors for this unit are found in Table 1.6.

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

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

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



**N** Table 1.6 Conversion Factors

	Name of Unit	Unit Symbol	Conversion Factor
Length	millimeter	mm	1 in. = 25 mm
	meter	m	1 ft = 0.3048 m
Area	square millimeters	mm <sup>2</sup>	1 in. <sup>2</sup> = 645.2 mm <sup>2</sup>
	square meter	m <sup>2</sup>	1 ft <sup>2</sup> = 0.0929 m <sup>2</sup>
Volume	milliliter	mL	1 fl oz = 29.57 mL
Fluid capacity	liter	l	1 fl oz = 0.02957 L
	liter	l	1 gal = 3.785 L
Flow	liter per minute	L/min	1 gpm = 3.7848 L/min
Pressure	bar	bar	1 psi = 0.0689 bar
Discharge Density	millimeter/minute	mm/min	1 gpm/ft <sup>2</sup> = 40.746 mm/min
	liter/minute/m <sup>2</sup>	(L/min)/m <sup>2</sup>	1 gpm/ft <sup>2</sup> = 40.746 (L/min)/m <sup>2</sup>
Weight	kilogram	kg	1 lb = 0.4536 kg
Temperature	Fahrenheit	°F	°F = 9/5 x °C + 32
	Celsius	°C	°C = 5/9(°F - 32)
Velocity	meters per second	mps	1 fps = 0.3048 mps
Gauge (sheet steel)	millimeter	mm	10 gauge = 3.4 mm
			12 gauge = 2.8 mm
			14 gauge = 1.98 mm
			16 gauge = 1.57 mm
			22 gauge = 0.78 mm
			24 gauge = 0.63 mm

Note: For additional conversions and information, see IEEE/ASTM SI10.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2019 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*, 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 70®, *National Electrical Code®*, 2020 edition.

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

NFPA 220, *Standard on Types of Building Construction*, 2021 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2021 edition.

NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*, 2017 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2021 edition.

NFPA 1961, *Standard on Fire Hose*, 2020 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2019 edition.

## 2.3 Other Publications.

**2.3.1 API Publications.** American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005-4070.

API STD 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*, 7th edition, 2016.

API STD 650, *Welded Tanks for Oil Storage*, 12th edition, 2013, addendum 3, 2018.

**2.3.2 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME Boiler and Pressure Vessel Code, 2019.

ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*, 2013.

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250*, 2015.

ASME B16.3, *Malleable Iron Threaded Fittings: Classes 150, and 300*, 2016.

ASME B16.4, *Gray Iron Threaded Fittings Classes 125, and 250*, 2016.

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24 Metric/Inch Standard*, 2017.

ASME B16.9, *Factory-Made Wrought Butt welding Fittings*, 2012.

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*, 2016, Errata, 2017.

ASME B16.15, *Cast Copper Alloy Threaded Fittings Classes 125, and 250*, 2013.

ASME B16.24, *Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500*, 2016.

ASME B16.25, *Butt welding Ends*, 2017.

ASME B31.1, *Power Piping*, 2018.

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

ASTM A53/A53M *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2018.



ASTM A135/A135M, *Standard Specification for Electric Resistance-Welded Steel Pipe*, 2009, reapproved 2014.

ASTM A234/A234M, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High-Temperature Service*, 2018.

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2018.

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped-, Zinc-Coated-, (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2013.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2015.

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

ASTM C582, *Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment*, 2009, reapproved 2016.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2015a.

ASTM D1331, *Standard Test Methods for Surface and Interfacial Tension of Solutions of Paints, Solvents, Solutions of Surface-Active Agents, and Related Materials*, 2014.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2019b.

IEEE/ASTM SI10, *American National Standard for the Use of the International System of Units: The Modern Metric System*, 2016.

**2.3.4 AWS Publications.** American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.

AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification*, 2014.

**2.3.5 IEEE Publications.** IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 45, *Recommended Practice for Electric Installations on Shipboard*, 2002.

**2.3.6 IMO Publications.** International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom.

*Safety of Life at Sea*, SOLAS Regulations II-2/4.3 and 4.3.5.

**2.3.7 ISO Publications.** International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 7-1, *Pipe Threads Where Pressure-Tight Joints Are Made on the Threads — Part 1: Dimensions, Tolerances and Designation*, 1994, technical corrigendum 1, 2007.

▲ **2.3.8 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 162, *Foam Equipment and Liquid Concentrates*, 2018.

### 2.3.9 Other Publications.

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

### 2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.  
NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2020 edition.

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

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, 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 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 by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**3.2.4\* 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.

**3.2.5 Shall.** Indicates a mandatory requirement.

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

**3.2.7 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 Combustible Liquid.** Any liquid that has a closed-cup flash point at or above 100°F (38°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. [30, 2018]

**3.3.1.1 Class II Liquid.** A liquid that has a closed-cup flash point at or above 100°F (38°C) and below 140°F (60°C). [30, 2018]

**3.3.1.2 Class IIIA Liquid.** Any Liquid that has a closed-cup flash point at or above 140°F (60°C), but below 200°F (93°C). [30, 2018]

**3.3.1.3 Class IIIB Liquid.** Any liquid that has a closed-cup flash point at or above 200°F (93°C). [30, 2018]

**3.3.2\* Concentration.** The percent of foam concentrate contained in a foam solution.

**3.3.3\* Discharge Devices.** Devices designed to discharge water or foam-water solution in a predetermined, fixed, or adjustable pattern.

**3.3.3.1 Air-Aspirating Discharge Devices.** Devices specially designed to aspirate and mix air into the foam solution to generate foam, followed by foam discharge in a specific design pattern.

**3.3.3.2 Compressed Air Foam Discharge Devices.** Devices specifically designed to discharge compressed air foam in a predetermined pattern.

**3.3.3.3\* Non-Air-Aspirating Discharge Devices.** Devices designed to provide a specific water discharge pattern.

### 3.3.4 Discharge Outlet.

**3.3.4.1 Fixed Foam Discharge Outlet.** A device permanently attached to a tank, dike, or other containment structure, designed to introduce foam.

**3.3.4.2\* Type I Discharge Outlet.** An approved discharge outlet that conducts and delivers foam gently onto the liquid surface without submergence of the foam or agitation of the surface.

**3.3.4.3 Type II Discharge Outlet.** An approved discharge outlet that does not deliver foam gently onto the liquid surface but is designed to lessen submergence of the foam and agitation of the surface.

**3.3.5\* Eductor (Inductor).** A device that uses the Venturi principle to introduce a proportionate quantity of foam concentrate into a water stream; the pressure at the throat is below atmospheric pressure and will draw in liquid from atmospheric storage.

**3.3.5.1\* In-Line Eductor.** A Venturi-type proportioning device that meters foam concentrate at a fixed or variable concentration into the water stream at a point between the water source and a nozzle or other discharge device.

**3.3.6 Expansion.** The ratio of final foam volume to original foam solution volume.

**3.3.7 Film Formation.** A property of aqueous film-forming foams and film-forming fluoroproteins characterized by a posi-

tive (>0.0 dynes/cm) spreading coefficient when measured according to ASTM D1331 using cyclohexane as the hydrocarbon substrate and distilled water to make the foam solution.

### 3.3.8 Fire.

**3.3.8.1 Class A Fire.** A fire in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. [10, 2018]

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

**3.3.9 Flammable (Class I) Liquid.** Any liquid that has a closed-cup flash point that is below 100°F (38°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (3 bar) at 100°F (38°C), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. [30, 2018]

**3.3.9.1 Class IA Liquid.** Any liquid that has a closed-cup flash point below 73°F (23°C) and a boiling point below 100°F (38°C). [30, 2018]

**3.3.9.2 Class IB Liquid.** Any liquid that has a closed-cup flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C). [30, 2018]

**3.3.9.3 Class IC Liquid.** Any liquid that has a closed-cup flash point at or above 73°F (23°C) but below 100°F (38°C). [30, 2018]

**3.3.10\* Foam.** A stable aggregation of bubbles of lower density than oil or water.

**3.3.10.1 Compressed Air Foam (CAF).** Homogeneous, micro-size foam bubbles produced by the combination of water, foam concentrate, and air or nitrogen under pressure.

**3.3.11 Foam Chamber.** See 3.3.4.1, Fixed Foam Discharge Outlet.

**3.3.12\* Foam Concentrate.** A concentrated liquid foaming agent as received from the manufacturer.

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

**3.3.12.2\* 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.

**3.3.12.3\* 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.

**3.3.12.4 Film-Forming Foam.** A concentrate that when mixed at its nominal use concentration will form an aqueous film on hydrocarbon fuels.

**3.3.12.5\* Fluoroprotein Foam Concentrate.** A concentrate very similar to protein-foam concentrate but with a synthetic fluorinated surfactant additive.