

NFPA 11A

Standard for Medium- and High-Expansion Foam Systems

1999 Edition



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An International Codes and Standards Organization

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Medium- and High-Expansion Foam Systems

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This edition of NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, was prepared by the Technical Committee on Foam and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 16–18, 1998, in Atlanta, GA. It was issued by the Standards Council on January 15, 1999, with an effective date of February 4, 1999, and supersedes all previous editions.

This edition of NFPA 11A was approved as an American National Standard on February 4, 1999.

Origin and Development of NFPA 11A

Work on this standard commenced in 1964. Several drafts were prepared by the Medium- and High-Expansion Foam System Subcommittee and processed at committee meetings held in subsequent years. The subcommittee's draft was approved by the Foam Committee at its New York meeting in December of 1967. Thereafter, the material was published in the 1968 NFPA Technical Committee Reports for study and evaluation by the NFPA membership and others interested. It was approved as a tentative standard at the 1968 Annual Meeting.

During 1968 NFPA 11A was further revised and was submitted and adopted as a revised tentative standard at the 1969 Annual Meeting. After one more year as a tentative standard, it was officially adopted without revision at the 1970 Annual Meeting. Amendments were made in 1976 and 1981. Further amendments were made in 1982 and the title was changed to include medium-expansion foam. Amendments were made in 1987. Foam concentrate pump requirements were added to the 1994 edition.

The 1999 edition of the document is a reconfirmation. However, some editorial changes have been made to make the document more user-friendly.

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

Committee Scope: This Committee shall have primary responsibility for documents on the installation, maintenance, and use of foam systems for fire protection, including foam hose streams.

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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 Appendix A.

Information on referenced publications can be found in Chapter 5 and Appendix B.

Chapter 1 General

1-1 Scope. This standard includes minimum requirements for the installation, design, operation, testing, and maintenance of medium- and high-expansion foam systems.

Only those skilled in the field are competent to design and install this equipment. It might be necessary for many of those charged with purchasing, inspecting, testing, approving, operating, and maintaining this equipment to consult with an experienced and competent fire protection engineer in order to effectively discharge their respective duties.

1-2 Purpose. This standard is intended for the use of those responsible for purchasing, designing, installing, testing, inspecting, approving, listing, operating, or maintaining medium- and high-expansion foam systems, in order that such equipment will function as intended throughout its life.

1-3 History. High-expansion foam is an agent for control and extinguishment of Class A and Class B fires and is particularly suited as a flooding agent for use in confined spaces. Development of the use of high-expansion foams for fire-fighting purposes started with the work of the Safety in Mines Research Establishment of Buxton, England, upon the difficult problem of fires in coal mines. It was found that by expanding an aqueous surface active agent solution to a semistable foam of about 1000 times the volume of the original solution, it was possible to force the foam down relatively long corridors, thus providing a means for transporting water to a fire inaccessible to ordinary hose streams.

This work led to the development of specialized high-expansion foam-generating equipment for fighting fires in mines, for application in municipal industrial fire fighting, and for the protection of special hazard occupancies. Medium-expansion foam was developed to meet the need for a foam that was more wind resistant than high-expansion foam for outdoor applications.

1-4* Description. Medium- and high-expansion foams are aggregations of bubbles that are mechanically generated by the passage of air or other gases through a net, screen, or other porous medium that is wetted by an aqueous solution of surface active foaming agents. Under proper conditions, fire-fighting foams of expansions from 20:1 to 1000:1 can be generated. These foams provide a unique agent for transporting water to inaccessible places; for total flooding of confined spaces; and for volumetric displacement of vapor, heat, and smoke. Tests have shown that, under certain circumstances, high-expansion foam, when used in conjunction with water sprinklers, will provide more positive control and extinguishment than either extinguishment system by itself. High-piled

storage of rolled paper stock is an example. Optimum efficiency in any one type of hazard depends to some extent on the rate of application and the foam expansion and stability.

Medium- and high-expansion foams, which are generally made from the same type of concentrate, differ mainly in their expansion characteristics.

Medium-expansion foam can be used on solid fuel and liquid fuel fires where some degree of in-depth coverage is necessary — for example, for the total flooding of small enclosed or partially enclosed volumes such as engine test cells and transformer rooms. Medium-expansion foam can provide quick and effective coverage of flammable liquid spill fires or some toxic liquid spills where rapid vapor suppression is essential. It is effective both indoors and outdoors.

High-expansion foam can also be used on solid- and liquid-fuel fires, but the in-depth coverage it provides is greater than for medium-expansion foam. Therefore, it is most suitable for filling volumes in which fires exist at various levels. For example, experiments have shown that high-expansion foam can be used effectively against high-rack storage fires, provided that the foam application is started early and the depth of foam is rapidly increased. It also can be used to extinguish fires in enclosures, such as in basement and underground passages, where it might be dangerous to send personnel. It can be used to control fires involving liquefied natural gases (LNGs) and liquefied petroleum gases (LPGs) and to provide vapor dispersion control for LNG and ammonia spills.

High-expansion foam is particularly suited for indoor fires in confined spaces. Its use outdoors can be limited because of the effects of wind and lack of confinement. Medium- and high-expansion foam have the following effects on fires.

(a) Where generated in sufficient volume, medium- and high-expansion foam can prevent the free movement of air, which is necessary for continued combustion.

(b) Where forced into the heat of a fire, the water in the foam is converted to steam, thus reducing the oxygen concentration by dilution of the air.

(c) The conversion of the water to steam absorbs heat from the burning fuel. Any hot object exposed to the foam will continue the process of breaking the foam, converting the water to steam, and cooling.

(d) Because of its relatively low surface tension, solution from the foam that is not converted to steam will tend to penetrate Class A materials. However, deep-seated fires might require overhaul.

(e) Where accumulated in depth, medium- and high-expansion foam can provide an insulating barrier for protection of exposed materials or structures not involved in a fire and can thus prevent fire spread.

(f) For LNG fires, high-expansion foam will not normally extinguish a fire, but it will reduce the fire intensity by blocking radiation feedback to the fuel.

(g) Class A fires are controlled when the foam completely covers the fire and burning material. If the foam is sufficiently wet and is maintained long enough, the fire can be extinguished.

(h) Class B fires involving high-flash-point liquids can be extinguished when the surface is cooled below the flash point. Class B fires involving low-flash-point liquids can be extinguished when a foam blanket of sufficient depth is established over the liquid surface.

This standard is based on test data and design experience developed for the use of medium- and high-expansion foam.

The intent of this standard is to indicate general rules applicable to any system. The limited field experience of approved systems makes it difficult to prepare specific recommendations covering the many potential uses. This standard outlines some of the factors that shall be given consideration in judging the acceptability of specific installations.

1-5 Definitions and Units.

1-5.1 Definitions.

Approved.* Acceptable to the authority having jurisdiction.

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

Foam Concentrate. Foam concentrate is a concentrated liquid foaming agent as received from the manufacturer. For the purpose of this document, “foam concentrate” and “concentrate” are used interchangeably.

(a) *Protein-Foam Concentrates.* Protein-foam concentrates consist 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. They are diluted with water to form 3 percent to 6 percent solutions depending on the type. These concentrates are compatible with certain dry chemicals.

(b) *Fluoroprotein-Foam Concentrates.* Fluoroprotein-foam concentrates are very similar to protein-foam concentrates but have a synthetic fluorinated surfactant additive. In addition to an air-excluding foam blanket, they also can deposit a vaporization-preventing film on the surface of a liquid fuel. They are diluted with water to form 3 percent to 6 percent solutions depending on the type. These concentrates are compatible with certain dry chemicals.

(c) *Synthetic-Foam Concentrates.* Synthetic-foam concentrates are based on foaming agents other than hydrolyzed proteins and include the following:

1. *Aqueous Film-Forming Foam (AFFF) Concentrates.* These concentrates are based on fluorinated surfactants plus foam stabilizers and usually are diluted with water to a 1 percent, 3 percent, or 6 percent solution. The foam formed acts as a barrier both to exclude air or oxygen and to develop an aqueous film on the fuel surface that is capable of suppressing the evolution of fuel vapors. The foam produced with AFFF concentrate is dry chemical compatible and thus is suitable for combined use with dry chemicals.
2. *Medium- and High-Expansion Foam Concentrates.* These concentrates, which are usually derived from hydrocarbon surfactants, are used in specially designed equipment to produce foams having foam-to-solution volume ratios of 20:1 to approximately 1000:1. This equipment can be air-aspirating or blower-fan type.
3. *Other Synthetic-Foam Concentrates.* Other synthetic-foam concentrates also are based on hydrocarbon surface active agents and are listed as wetting agents, foaming agents, or both. In general, their use is limited to portable nozzle foam application for spill fires within the scope of their listings. The appropriate listings shall be consulted to determine proper application rates and methods. (See NFPA 18, *Standard on Wetting Agents*.)

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

(e) *Alcohol-Resistant Foam Concentrates.* These concentrates are 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. There are three general types. One is based on water-soluble natural polymers, such as protein or fluoroprotein concentrates, and also contains alcohol-insoluble materials that precipitate as an insoluble barrier in the bubble structure.

The second type is based on synthetic concentrates and contains a gelling agent that surrounds the foam bubbles and forms a protective raft on the surface of water-soluble fuels; these foams can also have film-forming characteristics on hydrocarbon fuels.

The third type is based on both water-soluble natural polymers, such as fluoroprotein, and contains a gelling agent that protects the foam from water-soluble fuels. This foam can also have film-forming and fluoroprotein characteristics on hydrocarbon fuels.

Alcohol-resistant foam concentrates are generally used in concentrations of 3 to 10 percent solutions, depending on the nature of the hazard to be protected and the type of concentrate.

Foam Solution. A homogeneous mixture of water and foam concentrate in the proper proportion.

High-Expansion Foam.* An aggregation of bubbles resulting from the mechanical expansion of a foam solution by air or other gases with a foam-to-solution volume ratio ranging from 200:1 to approximately 1000:1.

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.

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 identified standards or has been tested and found suitable for a specified purpose.

Medium-Expansion Foam.* An aggregation of bubbles resulting from the mechanical expansion of a foam solution by air or other gases with a foam-to-solution volume ratio ranging from 20:1 to 200:1.

Shall. Indicates a mandatory requirement.

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

Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for