NFPA No.

16

FOAM-WATER SPRINKLER AND SPRAY SYSTEMS 1968

One Dollar

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

4M-6-68-WP-SM
Printed in U.S.A.

National Fire Protection Association
International

Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

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

NFPA No. 16 — 1968

1968 Edition of No. 16

The 1968 edition of this standard incorporates revisions to the last previous (1962) text. The revisions were adopted by the National Fire Protection Association at its Annual Meeting on May 21, 1968.

Original History of No. 16

A Standard for Combined Foam and Water Spray Systems was originally published in 1954 by the National Board of Fire Underwriters (now American Insurance Association). In 1959, the National Fire Protection Association, with the cooperation of the National Board and other interested groups, established a Committee on Foam-Water Sprinklers to update and expand the coverage, and the first official NFPA standard was adopted in 1962. This 1968 edition incorporates revisions developed by the Committee during 1967-68. The paragraphs changed include: 1017, 1044, 2053, 2054, 2074, 2125, 4011, 4033, 4041, 4043, 4044, 4045, 4046, 4051, 7011, and A-2052(a). Some editorial updating has also been accomplished.

SCOPE: Protection of hazards by systems designed to function as both sprayed foam and water discharge as from a sprinkler system.

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Foreword

This Standard is a minimum standard for the design, installation, and use of special Foam-Water Sprinkler and Foam-Water Spray Systems in fire protection service where discharge alternately of air foam in spray form and water in like form from piped systems is indicated. In some instances, the application of foam may be the primary design purpose, with discharge of water as a secondary consideration. In others, water discharge may be the controlling consideration, with discharge of air foam as the secondary object.

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

NFPA No. 16 — 1968

Section 1. General Information

1010. Definitions.

1011. AIR FOAM (MECHANICAL FOAM). Air foam (mechanical foam) is an aggregation of air-filled bubbles of lower specific gravity than oil or water. This foam is a mechanically made fire-fighting foam produced in the cases of the special systems covered by this Standard, by discharging a solution consisting of fresh or salt water to which a foaming agent has been added through specially designed discharge outlets (foam-water sprinklers or foam-water spray nozzles) with which the systems are equipped. The foam produced by these devices generally has greater fluidity and more rapid water dropout than foam produced by equipment presently covered in the NFPA Standard for Foam Extinguishing Systems (No. 11).

1012. AIR-FOAM FOAMING AGENTS. These are hydrolyzed, protein-base, "low-expansion" compounds. They are produced in two concentrations, one for use in a nominal proportion of 3 per cent in water and a second for use in a nominal 6 per cent proportion. Foaming agents are frequently referred to as "air-foam liquids"; sometimes as "stabilizers"; sometimes as "foam compounds"; sometimes as "air-foam-forming concentrates" and sometimes as "air-foam liquid concentrates." In the interest of uniformity with other standards of the National Fire Protection Association, the name *"air-foam liquid concentrates"* will be used herein.

1013. AIR-FOAM SOLUTION. A mixture consisting of an air-foam liquid concentrate in suitable proportions in either fresh or salt water.

1014. DISCHARGE DEVICES. Discharge devices are the specially designed, open-type heads installed at the discharge outlets of the protective systems covered by this Standard. They consist of a body which (1) encloses an air-foam maker and (2) carries a deflector to shape the air

foam or water issuing from the assembly. These devices are made in two patterns identified by the names "foam-water sprinklers" and "foam-water spray nozzles," respectively. The two patterns differ importantly only in the design of their deflectors with resulting differences in the patterns of extinguishing-agent discharge (air foam or water).

NOTE: The term "discharge devices," where used herein, will refer collectively to both foam-water sprinklers and foam-water spray nozzles. The individual names will be used where specific reference is required.

*1015. FOAM-WATER SPRINKLERS. Foam-water sprinklers have deflectors designed to produce water-discharge patterns closely comparable to those of "standard" sprinklers (nomenclature from the NFPA Standard for the Installation of Sprinkler Systems, No. 13) when discharging at the same rates of flow. They will generate air foam when supplied with air-foam solution under pressure and will distribute the foam in a pattern essentially similar to that of water discharging therefrom. Minor contraction of the pattern occurs when discharging foam in comparison with the pattern when discharging water.

*1016. FOAM-WATER SPRAY NOZZLES. Foam-water spray nozzles will generate air foam in the same manner as described for foam-water sprinklers when supplied with air-foam solution under pressure and will distribute the resulting foam, or water in the absence of foam solution, in a special directional pattern peculiar to the particular nozzle.

1017. FOAM-WATER SPRINKLER SYSTEM. A foam-water sprinkler system is a special system, pipe-connected to a source of air-foam liquid concentrates and to a water supply and is equipped with foam-water sprinklers for extinguishing-agent discharge and for distribution over the area to be protected. The piping system is connected to the water supply through an automatic valve which is actuated by operation of an automatic detection equipment installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system; air-foam liquid concentrate is injected into the water; and the resulting air-foam solution discharging through the foam-water sprin-

*Asterisks indicate that additional information is published in the Appendix.

klers generates and distributes air foam. Upon exhaustion of the air-foam liquid concentrate supply, water discharge will follow the air foam and continue until shut off manually. Sytems may be used for discharge of water first, followed by discharge of air foam for a definite period and this followed by water until manually shut off.

1018. FOAM-WATER SPRAY SYSTEM. A foam-water spray system is a special system, pipe-connected to a source of air-foam liquid concentrate and to a water supply and is equipped with foam-water spray nozzles for extinguishing-agent discharge (air foam or water sequentially in that order or in reverse order) and distribution over the area to be protected. System-operation arrangements parallel those for foam-water sprinkler systems as described in the foregoing paragraph.

1019. DENSITY. This term refers to the unit rate of liquid application to an area and is expressed in gallons per minute per square foot. The term "density" is used in this Standard with reference to application of water in some cases and in others to application of air-foam solution.

1020. Scope.

1021. This Standard covers the minimum requirements for foam-water sprinkler systems and foam-water spray systems, either of which combine, in a single system, provision for the alternate discharge of air foam and water from discharge devices specially designed to produce definite discharge patterns.

1022. Accordingly, systems may be designed with the required density for either foam or water application as the controlling factor, depending on the design purpose of the protection.

1023. The devices covered herein are intended primarily for use in combined foam-water sprinkler or foam-water spray systems and may not be applicable where separate foam, water-sprinkler, or water-spray fixed systems are to be installed. This Standard is not applicable for these separate systems and reference should be made to either the NFPA Standard for Foam Extinguishing Systems (No. 11), the NFPA Standard for the Installation of Sprinkler Systems (No. 13) or the NFPA Standard on Water Spray Fixed Systems for Fire Protection (No. 15).

1030. System Description.

1031. These fire protection systems are equipped with special-design, open-pattern discharge devices which may be either foam-water sprinklers or foam-water spray nozzles, or both, depending upon the hazard and the design intent.

1032. System-piping connections are made to (1) a supply of fresh or salt water under pressure; (2) a supply of air-foam liquid concentrate; and (3) suitable proportioning equipment serving as a means of delivery of the required amount of liquid concentrate into the water flowing to the protective system.

1040. System Design Plan.

1041. These special systems shall be designed primarily for automatic operation, supplemented by auxiliary manual tripping means.

1042. Systems shall deliver air foam for a definite period at given densities (gallons per minute of air-foam solution per square foot) to the hazards which they protect, either prior to water discharge or following water discharge, depending upon system-design purpose.

1043. Following completion of discharge of air foam to the hazards protected, these special systems shall discharge water until manually shut off.

1044. Authorities having jurisdiction shall be consulted as to the means by which a reserve supply of air-foam liquid concentrate shall be made available. The purpose of a reserve supply of concentrate is to have available the means for returning systems to service-ready condition following system operation (see Paragraph 2054).

1050. Applicability.

1051. Systems of this type will discharge foam or water from the same discharge devices with which the systems are equipped and, in view of this dual extinguishing-agent discharge characteristic, foam-water sprinkler and spray systems are selectively applicable in combination Class A and Class B hazards.*

*As defined in the NFPA Standard for the Installation of Portable Fire Extinguishers (No. 10).

NOTE: Any auxiliary extinguishing equipment shall have extinguishing-agent discharge compatible with air foam. Certain wetting agents are incompatible with some foams. Dry-chemical extinguishing agents may, in general, exhibit the same reaction.

1052. Foam-water sprinkler and foam-water spray systems are especially applicable to the protection of flammable-liquid hazards. They may be used for any of the following purposes or combinations thereof:

a. EXTINGUISHMENT. The primary purpose of such systems is the extinguishment of fire in the protected hazard. For this purpose, suitable foam-solution discharge densities (gallons per minute per square foot) shall be provided by system design and use of selected discharge devices; by provision of adequate supplies of air-foam liquid concentrate; and by provision of adequate water supplies at suitable pressures to accomplish the system-design, foam-discharge rates for the design period and following depletion of air-foam liquid concentrate supplies, to provide similar rates of water discharge from the system until shut off.

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

c. CONTROL AND EXPOSURE PROTECTION. Control of fire, to permit controlled burning of combustible materials where extinguishment is not practicable, and exposure protection to reduce heat transfer from an exposure fire may be accomplished by water spray and/or foam from these special systems, the degree of accomplishment being related largely to the fixed discharge densities provided by the system design.

1053. Foam is not considered a suitable extinguishing agent on fires involving liquefied or compressed gases, e.g., butane, butadiene, propane, etc., nor on materials which will react violently with water (e.g., metallic sodium) or which produce hazardous materials by reacting with water, nor on fires involving electrical equipment where the electrical nonconductivity of the extinguishing agent is of first importance.

1054. Air foam produced from solutions of standard types of liquid concentrate in water are not recommended for use on fires in water-soluble solvents. Special "alcohol-type" liquid concentrates are available for production of air foams for protection of such hazards but these foams are generally not considered acceptable for this method of application.

1060. Approvals.

1061. Prior to designing a system under consideration, the authority having jurisdiction shall be consulted. All plans and specifications pertinent to the installation shall be approved by the authority having jurisdiction prior to installation and such authority shall be consulted as to devices and materials used in system construction and in selection of the air-foam liquid concentrate to be provided for system use. All equipment shall be approved for the particular application intended. Before asking final system approval, the installing company shall comply with the requirements of Paragraph 5050.

Section 2. System Components

2010. Approved Devices and Materials.

2011. The authority having jurisdiction shall be consulted as to approved devices, materials, and air-foam liquid concentrates.

2020. Component Parts.

2021. All component parts (including air-foam liquid concentrates) of foam-water sprinkler and foam-water spray systems shall be coordinated to provide complete systems capable of discharging either foam or water and primarily operable by automatic means with supplementary auxiliary manual tripping means.

2030. Foam-Water Sprinklers.

2031. Shall be of approved makes and types having water passages not less than ¼ inch in any cross-section dimension.

2032. Table 1 shows the range of the water discharge rates of approved foam-water sprinklers.

TABLE 1

FOAM-WATER SPRINKLER WATER DISCHARGE RATES

Pressure at Sprinkler Inlet (Pounds per Square Inch)	Range of Discharge Rates (Gallons per Minute)
20	12-16
30	14-18
40	16-20
50	18-22
75	22-26
100	25-30

2040. Foam-Water Spray Nozzles.

2041. Shall be approved makes and types having water passages not less than ¼ inch in any cross-section dimension.

2042. These discharge devices in approved forms are available in a number of patterns with variations in discharge capacity.

2050. Air-Foam Liquid Concentrates.

2051. Air-foam liquid concentrates shall be of types found acceptable for use with the concentrate-proportioning equipment and with the discharge devices with which a given system is equipped. Original supplies of liquid concentrates and replacement supplies shall be checked by appropriate tests or otherwise to determine acceptability.

2052. Air-foam liquid concentrates meeting the requirements of Paragraph 2051 are available in 3 per cent and 6 per cent concentrations and for ordinary or low temperatures.

2053. The quantities of air-foam liquid concentrates to be provided for foam-water sprinkler and spray systems shall be sufficient to maintain the discharge densities for the application time period used as a base in system design. (See Paragraphs 1044, 4022 and 4023.)

NOTE: See Paragraph 1054 concerning "alcohol-type" concentrates.

2054. There shall be a readily available supply of air foam liquid concentrate sufficient to meet the design requirements of the system to put the system back in service after operation. This supply may be in separate tanks or compartments, in drums or cans on the premises, or available from an approved outside source within 24 hours.

2060. Air-Foam Liquid-Concentrate Proportioning Means.

2061. Positive pressure-injection methods are recommended for introduction of air-foam liquid concentrates into the water flowing through the supply piping to the systems, except that where water-supply conditions require pumps, around-the-pump proportioners may be used.

2062. Positive pressure-injection methods include the use of: *(a) air-foam liquid-concentrate pump discharging through a metering orifice into the protection-system riser with the foam-liquid pressure at the upstream side of the orifice exceeding the water pressure in the system riser by a specific design value; *(b) a balanced-pressure proportion-

*Asterisks indicate that additional information is published in the Appendix.

ing system (demand type proportioner) utilizing an air-foam concentrate pump discharging through a metering orifice into a proportioning controller (venturi) or orifice in the protection system riser with the foam liquid and water pressures automatically maintained equal by the use of a pressure-control valve; *(c) pressure-proportioning tanks with or without a diaphragm to separate the water and foam-liquid concentrate.

2063. Proportioning equipment described in preceding Paragraphs 2061 and 2062 shall be of approved types.

2064. Orifice plates should have "tell-tale" indicators giving orifice diameters and indicating flow direction if flow characteristics vary with flow direction.

NOTE: See Appendix A-2062(a) for formula for calculation of size of orifices used in metering air-foam liquid concentrates.

2070. Pumps.

2071. Air-foam liquid-concentrate pumps and water pumps shall be of types acceptable to the authority having jurisdiction. They shall have adequate capacities to meet the maximum needs of the systems on which they are used. (See Paragraph 3020 for water-supply requirements.) To insure positive injection of concentrates, the discharge pressure ratings of pumps at the design discharge capacity shall be suitably in excess of the maximum water pressure available under any condition at the point of concentrate injection.

2072. Air-foam liquid-concentrate pumps shall be of the centrifugal type and have adequate capacity for the service.

2073. Air-foam liquid-concentrate pumps shall have reliability equivalent to that of approved fire pumps. Pumps shall be suitable for use with the air-foam liquid concentrates to be used where pump installation is to be made.

2074. Provision should be made to ensure that the pumps will not be rendered inoperable as the result of running dry after the foam supply is exhausted.

2080. Power Supply.

2081. Power supply for the drivers of air-foam liquid-concentrate pumps and water pumps shall be of maximum

*See footnote page 16-11.

reliability and the supply should be supervised by a power-availability supervisory from a separate source. Compliance with the applicable requirements of the NFPA Standard for the Installation of Centrifugal Fire Pumps (No. 20), covering the reliability of power supply for fire-pump drivers, is considered as meeting the intent of this Section.

2082. Controllers governing the starting of electric-driven concentrate pumps shall be of approved types. Where control equipment listed by a nationally recognized testing laboratory for fire-protection service is not available, suitable listed industrial-control equipment with adequate interrupting capacity in accordance with the NFPA Standard for the Installation of Centrifugal Fire Pumps (No. 20) may be used.

2083. Authorities having jurisdiction shall be supplied with details of pumps, power supplies, controllers, etc., and shall be consulted regarding the foregoing.

2090. Air-Foam Liquid-Concentrate Storage Tanks.

2091. Storage tanks for air-foam liquid concentrates shall be of construction suitable for the liquid, solidly mounted, and permanently located.

NOTE: Air-foam liquid concentrates are heavier than water with specific gravities ranging from 1.1 to 1.2.

2092. Minimum storage temperatures of air-foam liquid concentrates shall be considered in locating storage tanks.

2093. Storage tanks shall have capacities to just accommodate the needed quantities of air-foam liquid concentrate plus adequate space for outage, the latter to preferably be accomplished by means of a vertical riser. Tanks meeting this requirement will have minimum surface areas in contact with air and liquid concentrates at the liquid level and thus minimize the possibility of interior corrosion of tanks. Air-foam liquid concentrate outlets from tanks should be raised above the bottoms of the tanks to provide adequate sediment pockets.

2094. The capacities of tank sediment pockets shall be taken into consideration in determining needed quantities of air-foam liquid concentrates to completely fill tanks and a portion of the riser pipe.

2095. Tanks shall be equipped with suitable conservation-type vents of adequate capacity; access handholes or manholes located to provide for visual inspection of interior tank surfaces, connections for pump suction; relief and testing lines; protected sight gages or other liquid-level devices; and adequate filling and draining connections.

2096. Tanks shall be located to furnish a positive head on the pump suction.

2097. Pressure proportioning tanks shall have means for filling, for gaging the level of liquid concentrates and for drainage, cleaning and inspection of interior surfaces, and of the concentrate holding bag, if provided.

2100. Pressure on Air-Foam Liquid-Concentrate Lines.

2101. Where air-foam concentrate lines to the protective-system injection points are run underground or where they run aboveground for more than 50 feet, air-foam liquid concentrate in these lines shall be maintained under pressure to assure prompt foam application and to provide a means of checking on the tightness of the system. Pressure may be maintained by a small auxiliary pump; or by other suitable means.

2110. Location of System-Control Equipment.

2111. Equipment items, such as storage tanks and proportioners for air-foam liquid concentrates; pumps for water and air-foam liquid concentrates; and control valves for water, liquid concentrates, and air-foam solution shall be installed where they will be accessible, especially during a fire emergency in the protected area and where there will be no exposure from the protected hazard.

2112. Automatically controlled valves shall be as close to the hazard protected as accessibility permits so that a minimum of piping is required between the automatic-control valve and the discharge devices. Consideration should be given to provisions of remotely located post-indicator or other shutoff valves to permit system water-supply control under abnormal conditions.

2120. Alarms.

2121. The authority having jurisdiction shall be consulted regarding the alarm service to be provided and re-

garding the need for electrical fittings designed for use in hazardous locations in electric-alarm installations (see National Electrical Code (NFPA No. 70; USA Standard C1-1968), Article 500 and other Articles in Chapter 5 thereof).

2122. A local alarm, actuated independently of water flow, to indicate operation of the automatic detection equipment shall be provided on each system. Central station or proprietary station water-flow alarm service is desirable but provision of this service does not necessarily waive the local-alarm requirement.

2123. Outdoor water-motor or electric-alarm gongs, responsive to system water flow, may be required by the inspection authority having jurisdiction.

2124. Under conditions where central station or proprietary station water-flow alarm service is not available, it may be advisable to connect electrical alarm units to public Fire Department Headquarters or nearest Fire Department Station or other suitable place where aid may be readily secured.*

2125. A suitable trouble alarm shall be provided for each system to indicate failure of automatic detection equipment (including electric supervisory circuits) or other such devices or equipment upon which the system operation is dependent.

*See the NFPA Standards on Central Station Protective Signaling Systems (No. 71), on Local Protective Signaling Systems (No. 72A), on Auxiliary Protective Signaling Systems (No. 72B), on Remote Station Protective Signaling Systems (No. 72C), and on Proprietary Protective Signaling Systems (No. 72D).

Section 3. Water Supplies

3010. Types of Water.

3011. Authorities having jurisdiction shall be consulted concerning water supplies.

3012. Water supplied to Foam-Water Sprinkler Systems and Foam-Water Spray Systems may be fresh or salt, hard or soft, without affecting the quality or volume of foam produced. The water should be clean and free of constituents not compatible with air-foam liquid concentrates.

3013. There may be unusual circumstances where the only available water is (1) discolored but free of solids or (2) contains minerals, silt, organic matter, or trade or process wastes which may affect foam quality. These waters shall be proven acceptable by test of foam-making capabilities.

3014. Water containing solids of size likely to clog orifices in discharge devices but otherwise acceptable from the foam-making standpoint, may be supplied to systems after passing through line strainers.

3020. Water-Supply Capacity and Pressure.

3021. Water supplies for foam-water sprinkler systems and foam-water spray systems shall be of capacity and pressure capable of maintaining foam discharge and/or water discharge at the design rate for the required period of discharge over the entire area protected by systems expected to operate simultaneously.

WARNING: If water supply is dependent on public water sources, attention must be given to the pollution hazard introduced by the use of air-foam liquid concentrate and any cross connections cleared with Public Health Agencies concerned.

3022. Water supplies shall be capable of operating the entire system at rated capacity for at least 60 minutes and, if there are exposures or other unfavorable conditions, an increase in supply may be required.

3030. Water Temperature.

3031. Air-foam production is not sensitive to variations in water temperature between 40°F and 100°F. Elevated water temperatures may result in production of foam which is susceptible to early breakdown.

3040. Strainers. (For Water and Air-Foam Liquid Concentrates.)

3041. Strainers shall be capable of removing from the water all solids of sufficient size to obstruct the discharge devices. In addition, the strainers shall be capable of continued operation without serious increase in head loss for a period estimated to be ample when considering the type of protection provided, the condition of the water, and similar local circumstances. Strainers should be installed so as to be accessible for cleaning during an emergency. Dual-type strainers, or equivalent, may be necessary if water supplies are badly contaminated.

3042. Strainer designs preferably should incorporate flushout connections of sufficient size to permit flushing at velocities of 10 feet per second through the strainer basket.

3043. Strainers shall be installed in the main water-supply lines feeding orifices (or water passages) smaller than $\frac{3}{8}$ inch. Strainers shall be installed on systems having larger orifices where water-supply conditions warrant. The largest dimension of the screen opening shall be 1/16 inch less than the diameter of the smallest orifice to be protected.

3044. Strainers shall be installed in air-foam liquid concentrate lines at the entrance to metering orifices or proportioning devices.

Section 4. System Design and Installation

4010. Plans and Specifications.

4011. The designing and installation of foam-water sprinkler and spray systems should be entrusted to none but fully experienced and responsible persons. Before such systems are installed, complete working plans and specifications shall be submitted for approval to the authority having jurisdiction. Working plans shall be drawn to scale, show all essential details, and be so made that they can be easily reproduced to provide the necessary copies. Information required includes the design purpose of the system; discharge densities and period of discharge; hydraulic calculations; details of tests of available water supply; detailed layout of the piping and of the automatic detection equipment; type of discharge devices to be installed; location and spacing of discharge devices; pipe-hanger installation details; location of draft curtains; an accurate and complete layout of the buildings or hazards to be protected; and other pertinent data to provide a clear explanation of the proposed design.

4012. In addition to the items listed in Paragraph 4011, plans and specifications shall indicate the quantity of air-foam liquid concentrate to be stored, including the quantity in reserve; and the concentration designation, either 3 per cent or 6 per cent.

4013. The specifications should include the specific system and other tests that may be required to meet the approval of the authority having jurisdiction and indicate how cost of testing is to be borne.

4014. 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.

4015. Charts showing head delivery, efficiency and brake horsepower curves of pumps shall be furnished by the contractor.

4020. Design Guides.

4021. Foam-water sprinkler and foam-water spray system designs shall conform to all the applicable requirements

of the following standards of the National Fire Protection Association except where otherwise specified herein:

Title	NFPA Standard Numbers
Centrifugal Fire Pumps	No. 20
Foam Extinguishing Systems	No. 11
Sprinkler Systems	No. 13
Standpipe and Hose Systems	No. 14
Supervision and Care of Valves Controlling Water Supplies for Fire Protection	No. 26
Water Tanks for Private Fire Protection Service	No. 22
Water-Spray Fixed Systems for Fire Protection	No. 15
Outside Protection	No. 24
National Electrical Code	No. 70
Central Station Protective Signaling Systems	No. 71
Local Protective Signaling Systems	No. 72A
Auxiliary Protective Signaling Systems	No. 72B
Remote Station Protective Signaling Systems	No. 72C
Proprietary Protective Signaling Systems	No. 72D
Aircraft Hangars	No. 409

NOTE: Components of the electrical portions of these protective systems, where installed in locations subject to hazardous vapors or dusts shall be of types approved for use therein.

4022. The design discharge rates for water or air-foam solution shall provide densities of not less than 0.16 gallons per minute per square foot of protected area.

4023. The foam discharge shall continue for a period of 10 minutes. Where the system has been designed to have delivery rate higher than that specified in the foregoing, proportionate reduction in the discharge period may be made, except that in aircraft hangars the discharge period shall not be less than 7 minutes.

4024. SIZE OF SYSTEM — The size of a single system should be kept as small as practicable, giving consideration to water supplies and other factors affecting reliability of the protection. Segregated hazards (those so separated from other hazards as not to be subject to the spread of fire from such other hazards) should be protected by separate systems.

4030. Piping, Valves, Pipe Fittings, and Hangers.

4031. Applicable parts of Chapter 3 of the NFPA Standard for the Installation of Sprinkler Systems (No. 13) shall be consulted for requirements applicable to piping, valves, pipe fittings, and hangers, including corrosion-protection

coatings (galvanizing or other means). In these open-head systems, galvanized pipe and fittings shall be used for normal occupancies. Corrosive atmospheres may require other coatings. Since the systems herein covered are required to be hydraulically designed, the pipe-size tables of the NFPA Standard for the Installation of Sprinkler Systems (No. 13) are not applicable.

4032. Piping carrying air-foam liquid concentrate shall be black steel or cast iron.

4033. Authorities having jurisdiction shall be consulted regarding pipe fittings to be used in system assembly in fire areas. All fittings shall be of a type specifically approved for fire protection systems and of a design suitable for the working pressures involved. Fittings shall be of steel, malleable iron, or ductile iron in dry sections of piping exposed to possible fire.

4040. Operating-Means Design.

4041. Automatic operation of these special systems shall be provided for by automatic detection equipment, installed in the protected areas and connected to and circuited with means for tripping water-supply valves and other system-control equipment. Supplemental manual means for accomplishment of this purpose shall also be provided.

4042. Air-foam liquid-concentrate injection shall be activated automatically by, or concurrently with, activation of the main water-supply control valve. Manual operating means shall be designed to accomplish this same purpose.

4043. Automatic detection equipment, whether pneumatic, hydraulic or electric, shall be provided with complete supervision so arranged that failure of equipment or loss of supervising air pressure or loss of electric energy will result in positive notification of the abnormal condition.

4044. The spacing of automatic detection equipment (heat detectors) for systems installed for protection against fire exposure may call for a different arrangement from that required for other types of systems.

4045. Where used in a corrosive atmosphere, the devices should be of materials not subject to corrosion or be protected to resist corrosion.

4046. Automatic detection equipment of electric type and any auxiliary equipment of electric type, if in hazardous areas*, shall be expressly designed for use in such areas.

4047. Manually-operated tripping devices may actuate the automatic control valve by mechanical, pneumatic, electric, or other approved means. The manual device shall be amply strong to prevent breakage. Manual controls shall not require a pull of more than 40 pounds (force) nor a movement of more than 14 inches to secure operation.

4050. Drainage.

4051. Facilities should be provided for the safe removal or retention of the largest anticipated flammable liquid spill, plus the free water reaching the floor from the fixed fire protection system, as well as the discharge from hose streams, and means should be provided to assure that an effective foam blanket will be retained in the protected area.

4052. Means should be provided to assure that an effective foam blanket will be retained in the protected areas. In aircraft-storage areas and other spaces where curbs are not feasible, floor design should be arranged to retain the foam blanket. (See NFPA Standard on Aircraft Hangars, No. 409.)

4060. Hydraulic Calculations.

4061. System piping shall be hydraulically calculated and sized in order to obtain reasonably uniform foam and water distribution and to allow for loss-of-head in water-supply piping. Adjustment in pipe sizes to provide uniform discharge should be based on a maximum variation of 15 per cent from the assumed average discharge per sprinkler or nozzle.

4062. Pipe sizes should be adjusted according to detailed friction-loss calculations. These calculations should show the relation between the water supply and demand. These calculations shall be submitted to the authority having jurisdiction.

4063. It is recommended that hydraulic calculations for

*See National Electrical Code (NFPA No. 70, USA Standard C1-1968), Article 500 and other Articles in Chapter 5 thereof.

determining the air-foam solution and water-flow characteristics of systems covered by this Standard be made in accordance with the recommendations appearing in the NFPA Standard for Water Spray Fixed Systems (No. 15).

NOTE: Piping carrying air-foam solution (air-foam liquid concentrate mixed with water) should be sized on the same basis as if it were carrying plain water.

*4064. The friction losses in piping carrying air-foam liquid concentrate shall be calculated using the Darcy formula (also known as the Fanning formula). Friction factors for use with this formula shall be selected from the charts, Friction Factors for Commercial Steel and Cast-Iron Pipe (see Appendix for formula and charts). In calculating Reynolds Number for selecting friction factors from the charts, the actual density (or specific gravity) of the air-foam liquid concentrate to be used in the system shall be used. The viscosity used shall be the actual viscosity of the air-foam liquid concentrate at the lowest anticipated storage temperature.

4065. For purposes of computing friction loss in piping, the following "C" Factors shall be used for Williams and Hazens formula:

Black or Galvanized-Steel Pipe	120
Unlined Cast-Iron Pipe	100
Asbestos-Cement or Cement-Lined Cast Iron	140

*Asterisk indicates that additional information is published in the Appendix.

Section 5. Acceptance Tests

5010. Flushing of Supply Piping.

5011. Mains supplying water for systems shall be flushed out thoroughly before the system risers are connected to the mains. Water should be flowed through these mains with a velocity of at least 10 feet per second for a sufficient time to give at least two changes of water or until there is no continuing evidence of discharge of foreign materials.

5012. Where the supply will not produce the stipulated flow rate, at least the maximum flow available should be obtained by employing adequate discharge means.

5013. In connection with flushing operations, consideration shall be given to means for disposal of the water discharged. The following Table indicates the flows required in pipe sizes 4 to 12 inches to produce a velocity of 10 feet per second.

TABLE 2

FLOWS REQUIRED TO PRODUCE A VELOCITY OF TEN FEET PER SECOND IN PIPES

Pipe Size (Inches)	Flow (Gallons per Minute)
4	390
6	880
8	1560
10	2440
12	3520

5020. System Test — Discharging Water.

5021. When practicable, full flow tests with water should be made of system piping as a means of checking the head layout, discharge pattern, any obstructions and determination of relation between design criteria and actual performance, and to insure against clogging of the smaller piping and the discharge devices by foreign matter carried by the water.

5022. The maximum number of systems that may be expected to operate in case of fire should be in full operation simultaneously to give a check as to adequacy and condition of the water supply.

5030. Hydrostatic Pressure Tests.

5031. All piping, including yard piping, air-foam liquid concentrate lines and the system piping, shall be tested hydrostatically at not less than 200-pound per square inch pressure for two hours, or at 50-pound per square inch in excess of the maximum static pressure when the maximum static pressure is in excess of 150 pounds.

5032. The amount of leakage in underground piping should be measured at the specified test pressure by pumping from a calibrated container. Leakage should not exceed 2½, 3¼, 4, 5, and 6½ quarts of water per 10 joints per hour for 6-, 8-, 10-, 12-, and 16-inch pipe, respectively.

5033. Brine or other corrosive chemicals shall not be used for testing systems.

5034. To prevent the possibility of serious water damage in case of a break, pressure should be maintained during the two-hour test period by a small capacity pump, the main controlling gate being closed tight during this period.

5040. System Tests Discharging Foam.

5041. Acceptance Tests should include:

a. Foam discharge from a single system.

b. Simultaneous discharge (with foam) of the maximum number of systems expected to operate with the single system tested.

NOTE: Where discharge of entire system is not practical, adequate tests of system components shall be performed.

5042. During the tests, the pressure at the discharge devices should be at least equal to the minimum design operating pressure of the system or systems tested. Percentage of air-foam liquid concentrates injected into the water should be within the following limits: 3 per cent to 4 per cent for nominal 3 per cent concentrates and 5 per cent to 7 per cent for nominal 6 per cent concentrates.

5043. These tests shall be made to demonstrate the ability of the protective system to deliver acceptable foam (at design rates of discharge of air-foam solution) to the protected hazard. The discharge shall be continued for a sufficient time period to obtain stabilized discharge (3 minutes minimum) and preferably for a period of 5 minutes.

5044. During foam discharge tests, foam sampling and foam analysis tests should be carried out in accordance with the procedure described in the Appendix of the NFPA Standard on Foam Extinguishing Systems (No. 11).

5045. Foam delivered from foam-water-sprinkler and foam-water-spray systems shall quickly form a cohesive foam blanket and spread rapidly around obstructions. Foams discharged from such systems, and meeting these requirements, have exhibited "expansions" ranging from 4 to 8; and "25 per cent drainage-time" values, ranging from 0.30 minute to 1 minute.

5046. Systems shall be thoroughly flushed with water after operation with foam, except those portions normally containing air-foam liquid concentrate when the system is not operating. Particular attention should be given to strainers or other small openings.

5050. Acceptance Test Suggestions.

5051. All tests should be made by the contractor in the presence of the inspector for the authority having jurisdiction.

5052. Before asking final approval of the protective equipment by the authority having jurisdiction, installing companies should furnish a written statement to the effect that the work covered by its contract has been completed and all specified flushing of underground, lead-in, and system piping has been successfully completed, together with specified hydrostatic pressure tests and system-foam discharge tests.

5053. A form appearing in the NFPA Standard for the Installation of Sprinkler Systems (No. 13), Chapter 1, having the Title "Sprinkler-Contractors Certificate Covering Materials and Tests" will be useful to the contractor as guide in filing written statements as called for in the foregoing.

Section 6. Periodic Testing

6010. Testing and Inspection of Air-Foam Liquid-Concentrate Injection Systems.

6011. Air-foam liquid-concentrate injection systems shall be so arranged that periodic tests and inspections may be made without discharging air-foam solution to the system piping in order to check operation of all mechanical and electrical components of the systems. Proportioning devices and strainers shall be checked and cleaned at the time of the inspection. The system should be so arranged that tests can be performed with as little loss of air-foam liquid concentrate as practical.

6020. Inspection of Air-Foam Liquid Concentrates.

6021. Periodic inspection should be made of air-foam liquid concentrates and their containers for evidence of excessive sludging or deterioration. Samples of liquid concentrates should be referred to their manufacturer for check of condition. Presence of specified quantities of concentrates in system-storage equipment in service-ready position and the quantities of reserve concentrates on hand should be checked with requirements for same.

6030. Tripping of Water-Control Valves.

6031. Water-supply control valves and their automatic and manual tripping means shall be arranged so that periodic maintenance checks and tests of the tripping means for response, and of the thermostatically operated water-supply control valves for readiness to open, may be made. These checks and tests shall be arranged so that they may be accomplished without discharging air-foam from system discharge devices or diminishing or diluting the air-foam liquid-concentrate supply.

Section 7. Maintenance

7010. Foam-Water Sprinkler and Foam-Water Spray Systems.

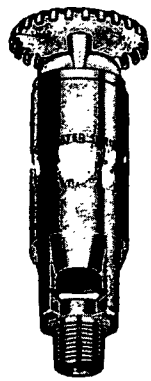
7011. These systems require competent and effective care and maintenance to assure that they will perform their purpose effectively at the time of fire. Systems should be serviced and tested periodically (at least semiannually) by men experienced in this work. These tests should include a qualitative test of the air-foam liquid concentrate. An inspection contract with the installer of the equipment for service, test, and operation at regular intervals is recommended and may be required by the authority having jurisdiction.

7012. STRAINERS — Strainers should be thoroughly inspected and cleaned after each operation or flow test. Inspection and cleaning should be performed at intervals of not more than six months.

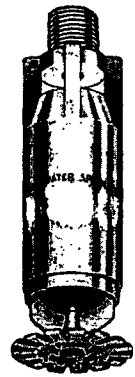
7020. Operating and Maintenance Instructions and Layouts.

7021. Operating and maintenance instructions and layouts shall be posted at control equipment and at Fire Headquarters. Selected plant personnel should be trained and assigned the task of operating and maintaining the equipment.

Appendix



Upright Mounting



Pendent Mounting

Figure A-1015.

Foam-water sprinklers are open-type sprinklers designed: (1) to receive air-foam solution (water plus liquid concentrate); (2) to direct the "solution" through an integral foam maker, the nozzle action of which breaks the "solution" into spray and discharges it into a mixing tube where it combines with air drawn in through openings in the housing; (3) to provide mixing-chamber capacity for development of the air foam; (4) to direct the formed foam discharging from the open end of the mixing tube against a deflector, shaped to distribute the foam in a pattern essentially comparable to the water-distribution pattern of present-day "standard" sprinklers (nomenclature from current edition of NFPA Standard for the Installation of Sprinkler Systems (No. 13)) and to do this with essentially no impingement of the foam on the ceiling; and, (5) in the case of discharge of water only, that is in absence of foam, to develop a water-distribution pattern directly comparable to that of "standard" sprinklers.

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

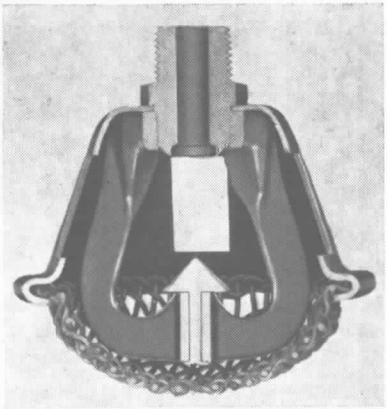


Figure A-1016.

Foam-water spray nozzles combine a foam-maker with a body and a distributing deflector. They will generate air foam in the same manner as described for foam-water sprinklers, when supplied with air-foam solution under pressure, and will distribute the resulting foam, or water in the absence of foam solution, in a special pattern peculiar to the particular head.

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

Darcy Formula

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

Reynolds Number

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

ΔP = Friction loss in p.s.i.
L = Length of pipe in feet
f = Friction factor
ρ = Weight density of fluid, pounds per cubic foot
Q = Flow in GPM
d = Pipe diameter in inches
μ = Absolute (dynamic) viscosity in centipoise
Re = Reynolds Number