

Approval Standard

for

Foam Extinguishing Systems

Class Number 5130

August 2011

Foreword

The FM Approvals certification mark is intended to verify that the products described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, and materials, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, and materials, as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard describes requirements for fixed fire extinguishing systems that use an aqueous foam as the extinguishant.
- 1.1.2 FM Approvals criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facilities, audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 Foam fire extinguishing systems are classed in three general categories according to foam concentrate type, low, medium, and high expansion. All may be designed for manual or automatic control and are most often used to extinguish Class B fires. At present, FM Global does not specify any applications for medium expansion foam systems, nor for protection of Class A combustibles with high expansion foam systems.
- 1.2.2 A basic foam extinguishing system comprises a concentrate, a device to proportion the concentrate in the proper ratio into water, and a discharge device to deliver the foam to a burning liquid surface. A discharge device may assume the entire task of expanding the foam, or function primarily to distribute foam which has been partially or completely expanded by an upstream device, such as a foam maker. Compatible FM Approved detectors and detection and release controls are required for automatic operation of these systems, but are not included in the scope of this standard.
- 1.2.3 This standard requires the examination of complete systems. Complete systems shall be submitted along with design, installation, operation, and maintenance instructions for Approval. However, the manufacturer may, at any time, submit additional separate component parts or auxiliary equipment for use on his system. Purchased devices such as pumps, tanks, control valves, and sprinklers must also be submitted by the system manufacturer for evaluation as a part of his system, even though such devices may already be FM Approved and listed by FM Approvals. At minimum, a system shall consist of those component parts and auxiliary equipment considered necessary by FM Approvals for the system to operate satisfactorily. Incomplete systems shall not be FM Approved.
- 1.2.4 This standard sets performance requirements for foam extinguishing systems in product categories that are identified by the following class numbers.

Table 1.2.4 Product Categories and Class Numbers

<i>Class</i>	<i>Product Category</i>
5130	Extinguishing Systems, Fixed Foam
5133	Foam Water Sprinkler Systems
5135	Low Expansion Foam Systems
5136	Compressed Air Foam (CAF) Systems
5137	High Expansion Foam Systems

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists has also been considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of foam fire extinguishing systems (hereinafter referred to as “systems”) for the purpose of obtaining Approval. Systems having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met.

Alternatively, systems that meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
- The suitability of the product
 - The performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
 - The durability and reliability of the product.
- 1.4.2 An examination of the facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product that was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals product follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- Production or availability of the product as currently FM Approved;
- The continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the Master Agreement;
- Satisfactory re-examination of production samples for continued conformity to requirements;
- Satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product without prior authorization by FM Approvals.

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this standard is **31 January 2011** for full compliance with all requirements.



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1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/ American Society for Testing and Materials (ASTM) SI 10 - 2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*. Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this standard.

1.8 Applicable Documents

This standard is used in conjunction with the following standards, test methods, and practices as referenced in this standard:

- ASTM B 117 - 09, *Standard Practice for Operating Salt Spray (Fog) Apparatus*
- ASTM D 412, 06ae2, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension*
- ASTM D 1141 - 98(2008), *Standard Practice for the Preparation of Substitute Ocean Water*
- ASTM D 1331-89(2001), *Standard Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents*
- ASTM D 5798-10, *Standard Specification for Fuel Ethanol (Ed70-Ed85) for Automotive Spark-Ignition Engines*.
- ASTM E 729 - 96 (2007), *Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians*
- FM Approvals, Approval Standard 2000, *Automatic Control Mode Sprinklers for Fire Protection*, March 2006.
- FM Approvals, Requirements for Class 3010, *Fire Alarm Systems*
- FM Approvals, Approval Standard Class 3810, *Electrical and Electronic Test, Measuring, and Process Control Equipment*, January 2005
- FM Approvals, Assessment Standard 5138, *Assessment Standard for Proportioning Testing*, April 2011
- FM Global Property Loss Prevention Data Sheet 3-7, *Fire Protection Pumps*, September 2010
- FM Global Property Loss Prevention Data Sheet 4-0, *Special Protection Systems*, May 2010
- FM Global Property Loss Prevention Data Sheet 4-3N, *Medium- and High-Expansion Foam Systems*, September 2010
- FM Global Property Loss Prevention Data Sheet 4-7N, *Low Expansion Foam Systems*, September 2010
- FM Global Property Loss Prevention Data Sheet 7-93N, *Aircraft Hangars*, September 2004
- FM Global Property Loss Prevention Data Sheet 4-12, *Foam-Water Sprinkler Systems*, September 2010
- FM Global Property Loss Prevention Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*, June 2009
- FM Global Property Loss Prevention Data Sheet 7-32, *Ignitable Liquid Operations*, January 2010
- IEEE/ASTM SI10 - 2002, *Standard for Use of the International System of Units (SI): The Modern Metric System*.
- National Electrical Manufacturers' Association (NEMA) 250 - 2007, *Enclosures for Electrical Equipment (1000 Volts Maximum)*
- National Fire Protection Association (NFPA) 11, *Standard for Low-, Medium-, and High Expansion Foam*, 2010 Edition
- NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2011 Edition
- NFPA 20, *Standard for the Installation of Stationary Fire Pumps for Fire Protection*, 2010 Edition
- NFPA 72, *National Fire Alarm and Signaling Code*, 2010 Edition
- NFPA 409, *Standard on Aircraft Hangars*, 2011 Edition
- United States Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances (EPA OPPTS) 850.175, *Fish Acute Toxicity Test, Freshwater and Marine*
- US EPA OPPTS 870.1100, *Acute Oral Toxicity*
- US EPA OPPTS 870.1200, *Acute Dermal Toxicity*



Documents

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US EPA OPPTS 870.2400, *Acute Eye Irritation*
US EPA OPPTS 870.2500, *Acute Dermal Irritation*

1.9 Definitions

For purposes of this standard, the following terms shall apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. When the authority is FM Global, such locations are termed “FM Global Accepted.” Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Air-Aspirating Discharge Device

A discharge device which mixes air into a foam solution to create a controlled expansion of the foam at the point of discharge.

Alcohol-Resistant Foam (AR)

A foam produced from a synthetic or protein foam concentrate that resists being dissolved in liquids normally miscible with water, and that can also be used to protect liquids immiscible in water.

Application Rate

The ratio of quantity of foam discharged to the discharge time measured within ± 1 second divided by the area covered by the discharge. When a minimum application rate is indicated, reference is made to the minimum quantity of foam solution discharged and the time measured within ± 1 second per unit area of surface covered. Application rate is expressed in units of gal/min/ft² (L/min/m², which equals mm/min). The volume used to calculate application rate is that of the foam solution prior to expansion into foam for consistency among foams of different expansion ratios.

Aqueous Film-Forming Foam (AFFF)

A foam produced from a synthetic concentrate and that forms a vapor barrier film on the surface of liquids immiscible in water.

Area of Coverage

The maximum area which can be protected by a foam discharge device, based upon the minimum effective application rate for the hazard, the maximum application rate which will not cause substantial differences in the foam quality from that producing successful extinguishment in tests, and the maximum distance from the application device to the burning surface which will also not significantly effect foam quality.

Around the Pump Proportioner

See Pump Proportioner.

Aspirating High Expansion Foam Generator

A high expansion foam generator in which airflow is induced by the spraying of the concentrate solution.

Automatic Control

A device or arrangement of devices for initiating foam discharge including a panel which monitors fire detectors and releases the agent when pre-established conditions have been met, without requiring human intervention.

Automatic Foam Concentrate Control Valve

A valve controlling the flow of foam concentrate to the proportioner. The valve is automatically actuated by either hydraulic, pneumatic, or electrical power and incorporates means to supervise its position.

Automatic Sprinkler

A discharge device that is actually an FM Approved fire protection sprinkler designed for use with plain water, and that does not aspirate air into the water discharge.

Balanced Pressure Bladder Tank

A foam concentrate supply tank fitted with an internal bladder to separate water from the concentrate. Water pressure on the outside of the bladder pressurizes the concentrate inside and drives it through a modified venturi type Proportioner into the water stream at the Specified rate, based upon the pressure differential created by the venturi.

Balanced Pressure Pump-Type Proportioning

Foam proportioning using a foam concentrate pump and an automatic pressure balancing valve that is operated by water supply pressure and is located in the concentrate bypass line to the pump to balance concentrate and water pressures to a modified venturi-type proportioner.

Blower Type High Expansion Foam Generator

A high expansion foam generator in which airflow is produced by a blower driven by an electric motor, water jet, or turbine, or other device powering the blower's fan blades

CAF

See Compressed Air Foam

CAF Nozzle

The discharge device for a CAF system that is designed to distribute the pre-expanded CAF over a specified area with minimal destruction of bubbles.

Cannon

See Monitor

Class A Fires

Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

Class B Fires

Fires in ignitable liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

Class C Fires

Fires in which the ignition source is energized electrical equipment.

Compressed Air Foam

Foam produced by combining a low expansion foam solution with compressed air or an inert gas in a mixing device and typically having a very small and uniform bubble size.

Compressed Air Foam System

A foam generation and delivery system that consists of a pressurized air or inert gas source, a source of foam solution (water pump and proportioner), and a means to apply the foam. In a CAF system, the distribution piping carries already expanded foam and the discharge device only distributes the foam without further expansion. CAF systems have unique hydraulic considerations which must be addressed by the manufacturer to ensure delivery of an effective foam to the discharge device. These systems may be pre-engineered or engineered designs.

Concentration

The volume percent of a foam concentrate in water.

Concentration Ratio

See Concentration.

Discharge Device

A nozzle or other device that is used to distribute the extinguishing foam uniformly over or into a specific area, within a specific volume, or both.

Discharge Outlet

A discharge device that is permanently affixed to an ignitable liquid containment vessel or other structure to protect a defined hazard.

Discharge Duration

The time interval between the first appearance of foam at the discharge device and the time at which the foam concentrate primary supply is depleted.

Direct Injection Variable Pump Output Proportioning

Proportioning using flowmeters for both concentrate and water supply and a control system to vary foam concentrate pump flow in proportion to water supply flow.

E85

A blend of nominal 85 percent ethanol and 15 percent hydrocarbons and other additives, as defined by ASTM D 5798 and that may contain as much as 30 percent non-ethanol constituents, depending on the volatility class specified for a particular geographical region and season.

E85 Test Fuel

A blend of 70 percent ethanol and 30 percent normal heptane used as a conservative representative test fuel to qualify the fire extinguishment capabilities of foam.

Eductor

A device that uses the Bernoulli pressure reduction caused by the flow of water through a venturi to allow atmospheric pressure to drive foam concentrate into the water stream to produce a mixture of the specified concentration.

Engineered System

A fire extinguishing system design in which friction loss of piping, nozzles, and other components, and an analysis of the piping configuration, are used in hydraulic calculations to predict flows and pressures at individual nozzles.

Expansion Ratio

The ratio of the volume of expanded foam to that of the same weight of the foam solution.

Film-Forming Fluoroprotein Foam (FFFP)

A foam produced from a fluoroprotein concentrate that includes a fluorinated surfactant to form a vapor barrier film on the surface of liquids immiscible in water.

Fluoroprotein Foam

A foam similar to protein foam, but which also includes a fluorinated surfactant.

FM Approvals Certification Mark

The FM Approvals Certification Marks are detailed in Appendix B. Their use is mandatory on all units of FM Approved products. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an on-line resource of FM Approvals. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. This agreement obligates the manufacturer to allow re-examination of the product and audit of facilities and procedures at the discretion of FM Approvals. It further requires the manufacturer not to deviate from the as FM Approved configuration of the product without review by and agreement of FM Approvals. Approval is manufacturing site and product specific.

Foam

A stable aggregation of bubbles produced from an aqueous solution of foam concentrate that has a sufficiently low density and sufficient fluidity to allow it to float on top of and form a blanket on the surface of a liquid being protected.

Foam Chamber

A Type I or II discharge outlet normally installed along the perimeter of an ignitable liquid storage vessel or containment structure to ensure delivery of foam to the contents, when required.

Foam Concentrate

A concentrated aqueous liquid formulated to produce firefighting foam when mixed in the proper concentration with water and in which air can be entrained to reach the specified Expansion Ratio.

Foam Generator

A device used with high expansion foam concentrates to produce foam by spraying the concentrate solution onto a screen and forcing air through the screen.

Foam-Water Sprinkler

A discharge device that is an air-aspirating, usually-open fire protection sprinkler designed to create foam, as well as providing effective water discharge upon depletion of the foam concentrate supply.

Foam-Water Sprinkler System

A modified sprinkler system that is pipe connected to a source of foam concentrate and to a water supply. The system is equipped with appropriate discharge devices for foam-water solution discharge and for distribution over the area to be protected. Upon opening of the water control valve, water flows through the piping system and foam concentrate is proportioned and injected into the water, and the resulting solution discharges through devices that generate and distribute the foam. Upon exhaustion of the foam concentrate supply, water continues to discharge until shut off manually. These systems can be of wet pipe, dry pipe, deluge, or preaction designs, paralleling the design and using most of the components of the equivalent water-only sprinkler systems. They differ primarily in the addition of foam concentrate proportioning equipment or pre-priming of the sprinkler piping with foam-water solution. The introduction of the foam concentrate may be controlled by a detection system and can precede or follow the water-only discharge.

Foam Solution

A solution of foam concentrate in water that is named by the concentrate's name and the specified concentration.

High Expansion Foam

A foam that is produced in foam generators and has an expansion ratio greater than 200:1.

Ignitable Liquid

For the purposes of this standard, an ignitable liquid is simply a liquid that will burn. While some other organizations use different terms to identify liquids that burn, we believe that our approach is consistent with the hazard that is created by these liquids. Liquids that burn create challenging fire hazards and those hazards are not defined by the closed cup flash point of the liquid. The hazard is driven by the simple fact that the liquid burns (i.e., has a fire point).

Inductor

See Eductor.

In-Line Balanced Pressure Proportioning

Balanced foam proportioning using a concentrate pressure which is greater than the water supply working pressure under all operating conditions. Automatic pressure balancing valves operated by the water supply pressure to the proportioner are used to regulate the concentrate pressure individually to each proportioner. Concentrate pressure may be created by either a bladder tank or a concentrate pump.

Inline Eductor

An eductor that is installed upstream of the discharge device and which uses a foam concentrate supply at atmospheric pressure.

Local Application System

A fire extinguishing system designed to protect a defined area by the direct discharge of foam onto burning materials.

Lock-Out Valve

A lockable manually operated valve which can be used to isolate the foam supply from the rest of the system during maintenance and service.

Low Expansion Foam

A foam having an expansion ratio less than 20:1 and that may be produced by various devices.

Manual Control

A device or arrangement of devices for initiating system discharge that requires action by a human to release the agent.

Maximum Working Pressure

The pressure in a foam extinguishing system at the maximum available pressure of the water and foam concentrate supplies.

Minimum Working Pressure

The pressure in a foam extinguishing system below which it will not produce foam of acceptable quality.

Mixture Strength or Ratio

See Concentration.

Monitor

A fixed or portable device that is mounted on a supporting structure and delivers a large foam stream from a nozzle that may be aimed over a variety of vertical and horizontal angles.

Non-Air-Aspirating Discharge Device

A discharge device, such as a fire protection sprinkler, which delivers unexpanded foam concentrate solution to the hazard and relies on subsequent turbulence to entrain the air required for expansion.

Nozzle

A discharge device that may be either hand held or mounted on a monitor, is designed to expand the foam solution, and is capable of directing a stream of foam into a narrow targeted area.

Operable Pressure Range

The pressure range corresponding to the pressures in the water supply at the specified minimum and maximum flow rates at which the system is intended to be operable.

Operating Pressure

See Working Pressure.

Oscillating Monitor

A monitor that can be set to move the direction of its stream automatically and continuously over a range of horizontal angles by means of a water pressure driven or electrically powered device.

Polar Solvent

An ignitable liquid such as an alcohol or ketone that is miscible in water and that tends to dissolve foams and thereby reduce their fire extinguishing effectiveness.

Pre-Engineered System

A fire extinguishing system design in which a predetermined range of piping and nozzle characteristics and configurations are used to predict individual nozzle flow rates.

Premixed Foam Solution

A foam solution produced by introducing a measured amount of foam concentrate into a known amount of water in a storage vessel.

Pressure Proportioning Tank

A bladderless foam concentrate supply tank that uses water flow through a port located high in the tank to displace the concentrate in the tank through a low mounted port with an orifice. Since buoyancy is the only mechanism separating the concentrate from the water, this method is only suitable for concentrates with a minimum specific gravity of 1.15. The concentrate orifice controls its flow rate into the water stream to approximate the specified concentration in the combined stream.

Proportioner

A device similar in function to an inline eductor, except that it uses a foam concentrate supply at a pressure higher than atmospheric.

Proportioning

The continuous introduction of foam concentrate at the specified ratio into the water stream to form foam solution.

Protein Foam

A foam produced from concentrate consisting primarily of products from a protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use.

Proportioning Testing Service Provider

A commercial entity that has been successfully evaluated for competency to test installed foam systems using the test liquid or water equivalency proportioning methods.

Pump Proportioner

A system using a venturi eductor installed in a bypass line between the discharge and suction lines of a water supply pump and suitable orifices or a metering valve to control the amount of concentrate supplied in proportion to pump discharge (system water supply) pressure.

Salt Water

Manufactured artificial sea water, as defined by ASTM D 1141 – 2003, *Standard Practice for the Preparation of Substitute Ocean Water*.

Self-Educting Nozzle

A nozzle that includes a venturi to draw foam concentrate into the water stream through a short length of flexible tubing connected to a supply container, effectively incorporating a nozzle and an eductor in one device.

Semisubsurface Foam Injection

Discharge of foam at the liquid surface within an ignitable liquid storage tank from a floating hose that rises from a piped connector near the tank bottom upon system actuation.

Specified

The value of a design parameter set by the manufacturer.

Spray Nozzle

A discharge device that may be an open automatic sprinkler or specially designed nozzle attached to fixed piping and discharges water or foam in a fixed spray pattern.

Subsurface Foam Injection

Discharge of foam from an outlet near the bottom of an ignitable liquid storage tank. The foam then rises to the liquid surface due to buoyancy.

Synthetic Foam

A foam produced from concentrate consisting of foaming agents other than hydrolyzed protein.

Synthetic Seawater

See Salt Water.

System Water Supply

In most cases, the water flow and pressure available to the foam system after the point of foam concentrate introduction. For systems using a premixed foam solution it is the flow and pressure available at the connection to the discharge piping, downstream of any pump or other pressure source.

Test Liquid

A non-foaming liquid that replicates the viscosity, specific gravity, and other relevant properties of the actual foam concentrate used in a system and that is used to test the accuracy of proportioners and similar devices in an installed system.

Test Liquid Proportioning Testing

A method of evaluating the proportioning accuracy of an installed foam fire extinguishing system using a test liquid in lieu of the concentrate to minimize the difficulties in disposing of the required discharge in the annual retesting of a foam system.

Topside Discharge Device

A discharge device such as a foam water sprinkler or foam chamber that applies foam to the surface of a burning liquid from above.

Total Flooding System

A medium or high expansion foam extinguishing system designed to protect an enclosed hazard area by discharging foam to reach and maintain a minimum level 1.1 times the maximum height of or 2 ft (0.61 m) above all protected contents, whichever is greater, throughout the enclosed area sufficiently quickly and of sufficient duration to extinguish a fire. For a given foam, parameters of required depth of submergence, discharge rate, and duration must be determined by test because they are dependent upon the construction of the building, the nature of the contents, and the storage configuration.

Type I Discharge Outlet

A discharge outlet designed to deliver the extinguishing foam gently onto a liquid surface with no submergence or agitation.

Type II Discharge Outlet

A discharge outlet designed to deliver the extinguishing foam onto a liquid surface with minimal submergence or agitation.

Type III Discharge Outlet

A discharge outlet designed to deliver the extinguishing foam onto a liquid surface with significant submergence or agitation.

Water Equivalency Proportioning Testing

A method of evaluating the proportioning accuracy of an installed foam fire extinguishing system using water in lieu of the concentrate to minimize the difficulties in disposing of the required discharge in the annual retesting of a foam system.

Wood Crib

A square stack of alternate layers of kiln-dried spruce or fir in nominal 2x4 inch trade size and equal lengths placed at right angles to the preceding layer and spaced to allow air flow between the members. Each layer consists of the same number of evenly spaced members placed on edge, except for the top layer, which has fewer evenly spaced members placed on their sides. The outer members of all layers are placed flush with the ends of the members of the adjacent layers. All members are carefully nailed in place to avoid splitting the wood. Wood cribs are a standard test fuel for Class A fire tests. For the purposes of this standard, the high expansion foam Class A fire extinguishment test wood crib shall consist of members 87.125 in. (2213 mm) long arranged in 10 layers of 21 on edge, with a top layer of 14 on side.

Working Pressure

The water supply pressure to a foam extinguishing system at a condition of zero flow.

2. GENERAL INFORMATION

2.1 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to:

Hydraulics Group Manager
FM Approvals, Hydraulics Laboratory
743A Reynolds Road
West Glocester, RI 02814 U.S.A.

The manufacturer shall provide the following preliminary information with any request for Approval consideration:

- A complete list of all models, types, sizes, and options for the products being submitted for Approval consideration;
- Assembly drawings, component drawings, materials list, anticipated marking format, nameplate format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures;
- The number and location of manufacturing facilities;
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level; and
- All documents shall be provided with English translation.

2.2 Requirements for Samples for Examination

- 2.2.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing based on a determination by FM Approvals following review of the preliminary information.
- 2.2.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.2.3 The manufacturer shall submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals.
- 2.2.4 It is the manufacturer's responsibility to either provide or have available for witness testing at their facility any necessary test fixtures, such as those that may be required to evaluate the system.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The Approval test program requirements shall define the limits of the Approval investigation.

3.2 Physical or Structural Construction Features

3.2.1 Components versus Systems

Foam concentrates are the central component of foam extinguishing systems. Approval of a system is based upon its ability to proportion a concentrate accurately into water and to produce and deliver a foam from the resulting foam solution, the quality of which is within the limits of expansion ratio and 25 percent drainage time of foams demonstrating successful performance in fire extinguishing tests. Foam concentrate fire extinguishing performance shall be tested for each concentrate at all concentration ratios specified by the manufacturer. These tests shall be conducted at the minimum specified application rate and on heptane fires to qualify for general hydrocarbon liquid protection, as well as on any specific polar solvent liquids specified by the manufacturer. Further, unless the manufacturer specifies that a concentrate is suitable for use with fresh water only, then extinguishment tests shall be performed with foam produced from both salt and fresh water.

Foam concentrate component FM Approvals are granted only for use in FM Approved foam extinguishing systems that have been performance tested specifically with that concentrate. FM Approvals for systems using FM Approved concentrates are granted separately, subsequent to the component Approval of the concentrate. Component FM Approved concentrates need only be listed separately from the systems with which they are FM Approved if the concentrate and system manufacturer are different corporate entities, or if the concentrate manufacturer so specifically requests.

Foam concentrates shall only be FM Approved at the nominal concentration ratio(s) at which they are fire tested.

Similarly, mechanical components for foam systems shall only be component FM Approved for use in FM Approved systems with which they have been performance tested.

Systems shall only be listed for use with concentrates and at concentration ratio(s) with which they were fire tested.

The manufacturer of a system to be FM Approved must have effective control over the configuration and manufacture of the components and the formulation of the concentrate to be included to ensure that all systems produced under the Approval will offer essentially the same performance as that originally tested.

This can be accomplished in two ways:

1. The manufacturer can be the manufacturer of all components and the concentrate and demonstrate effective quality control, or the manufacturer can enter into written agreements with component or concentrate manufacturers to control the designs and formulations per the Master Agreement, and FM Approvals shall be permitted to periodically audit this "outside" manufacturer (either on behalf of the manufacturer or as a result of component listing of the outsourced items), or
2. The manufacturer can demonstrate sufficient quality control of the critical characteristics of the outsourced components as to ensure system performance. Generally, this will include a minimum of some performance testing. System configuration and application shall be prescribed by appropriate design, installation, and operation information to be provided by the manufacturer. FM Approvals will review such

information to verify completeness and conformance to FM Global loss prevention recommendations and the limits of the Approval to be granted.

A first facilities and Procedures Audit (F&PA) shall be conducted at each manufacturing site for the concentrate and system components.

3.2.2 Operating Range

All system components shall operate within the temperature ranges of 35 F to 120 F (1.7 C to 49 C). If the manufacturer specifies a lower minimum or higher maximum installation temperature, system and component evaluations will be based upon the resulting greater range.

3.2.3 Materials

3.2.3.1 All components shall be made of corrosion resistant materials suitable for their intended use.

3.2.3.2 Elastomeric Components – Elastomeric components used in the system shall be compatible with the concentrate. Compatibility shall be determined by successful performance at maximum and minimum installation temperatures while exposed to the agent. At minimum, tensile strength, ultimate elongation, and hardness of samples of un-reinforced materials shall not be changed by more than 15 percent from new condition by a 60 day exposure to the agent at the maximum storage temperature.

3.2.4 Control

3.2.4.1 For normal operation, a system shall be either automatically controlled or operable from a manual control that is easily accessible to the hazard, or both. If the normal manual means of actuation utilizes electric power, the source of that power shall be completely independent of any electric power source used for automatic operation. Alternatively, a power source used for both normal manual and automatic operation shall be provided with an independent back-up, such as a battery. Whether normally operated automatically or manually, all systems shall also be provided with an alternate means of fully mechanical manual emergency control. Fully mechanical manual emergency controls shall not require an electric power source but may make use of water supply pressure to operate the release. These emergency controls shall be located at or near the device being controlled.

3.2.4.2 Control panels shall comply with NFPA Standard 72, *National Fire Alarm Code*, and FM Approvals requirements for Classes 3010, *Fire Alarm Systems*, and 3810, *Electrical and Electronic Test, Measuring, and Process Control Equipment*. Control panels need not be submitted as a part of a system. However, system design shall be such that the system is operable by at least one FM Approved detection and release panel.

3.2.5 Strength

All component parts subject to full system operating pressure shall be designed for a minimum working pressure of 175 psi (12 bar). Components protected from exposure to full system operating pressure by a pressure relief device may be designed for the reduced pressure, subject to satisfactory evaluation of the protection device or system.

3.2.6 Pressure Vessels

Bladder tanks and other pressurized containers shall conform to the appropriate regulations for the installation location. In the U.S.A., DOT regulations are appropriate for cylinders which are shipped pressurized and the ASME unfired pressure vessel code for cylinders filled after installation. The following documents shall be submitted for each diameter of each cylinder design to demonstrate compliance with the relevant design standard:

- Calculation of wall thicknesses per the method specified in the standard, with appropriate supporting references, as necessary.
- Certificate of chemical analysis of materials.
- Certificate of physical properties of materials.

3.2.7 Valves

The pressure versus rate of flow through system valves shall be measured to allow accurate calculations for system design. Automatic concentrate control valves, water supply valves, and water alarm check valves shall be equipped with electrical supervision of operating position to allow remote monitoring and annunciation and a position indicator. Additionally automatic concentrate control valves must be equipped with an emergency manual operator, and a strainer in the actuation line and means to flush that line, if hydraulically operated. All automatic concentrate control valves shall be provided with a local manual reset. All valves equipped with electrical supervision shall be provided with a minimum NEMA Type 1 or IP-10 housing or enclosure if electrically operated by a solenoid. Automatic valve actuators shall be provided with tamper resistant construction to restrict access to components and protection to vents or orifices to prevent tampering or clogging that would render the valve inoperable.

3.2.8 Manifolds and Piping

Manifolds of proprietary designs used in place of standard pipe and fittings shall have minimum internal cross sectional areas no less than that of their corresponding pipe sizes.

3.2.9 Protective Covering

All valves and control devices with exterior movable parts that are vulnerable to obstruction or physical damage shall be protected by paneled enclosures or cages. This requirement shall not apply to levers, pushbuttons, and other operators requiring manual access for their function to the extent necessary to provide such access. Conduit shall be used for cables, tubing, or wires outside the enclosures. Heat detection tubing, in the areas being monitored by the tubing, shall not be installed in conduits, but shall be routed and supported in such a manner as to protect it from mechanical damage.

3.2.10 Discharge Devices

Discharge devices shall be evaluated for the intended use, including flow characteristics and area of coverage. Nozzles and other discharge devices shall be made of corrosion resistant materials that will not be deformed or otherwise be damaged by fire exposure. Fire exposure resistance shall not be required for hand-held devices or other components normally located outside of the fire area.

3.2.11 Auxiliary Equipment

Auxiliary equipment includes those devices required in a system to protect against a specific hazard. The need for these devices shall be determined by FM Approvals according to the nature of the hazard. Some of the devices listed below or others may be required for the system to earn Approval for specific applications.

3.2.11.1 Pressure Operated Switches

Pressure operated switches may be used to shut down fans, conveyors, or other electrical equipment in the protected area, and activate alarm and indicator circuits. These switches shall operate at a maximum water supply pressure of 50 psi (3.5 bar) and not release water from the system. They may have a means for alternate, manual control and shall be designed for manual resetting only.

3.2.11.2 Alarms

Alarms and/or indicators shall be provided to show that the system is operating, warn personnel of the forthcoming discharge of foam and signal the failure of any supervised equipment. Indicators which show that the system has been used and must be serviced shall operate upon actuation of the system and require manual resetting.

3.2.12 High Expansion System Configuration Requirements

3.2.12.1 Pressure Operated Release

A pressure operated release shall be provided on all doors, windows, and other openings below the intended flooding level in the protected hazard area. The release shall operate at a maximum pressure of 50 psi (3.5 bar) system water pressure. The release shall not permit the escape of water from the system. It shall automatically reset and may have a control for manual operation.

3.2.12.2 Time Delays

A delay device shall be installed on systems when safety dictates the evacuation of personnel from the hazard area. This device may either delay the operation of the system, or delay the discharge of foam after the system has been actuated. In the first arrangement, the actual discharge shall be manually controlled. A manual override shall be provided in the second arrangement to allow instant discharge.

3.2.12.3 Automatic Venting

High expansion foam systems shall use air from outside the protected space for foam generation. Air must be vented from the protected space at the same rate of flow to allow the foam generators to operate at their specified capacities. Air intake and venting devices for air movement into the foam generators and out of the protected volume shall be automatically operated at system actuation and protected from mechanical damage, corrosion, and freezing.

3.2.12.4 Watertight Electrical Equipment

Electrical equipment below the design level of flooding shall be designed for submerged operation to eliminate the risks of short circuiting of controls and shocking to personnel.

3.2.13 High Expansion Foam Stability under Sprinkler Discharge

Foam breakdown testing shall be conducted with the full range of foam concentrates, concentrations, and application rates submitted for Approval to determine the breakdown coefficient. Tests shall be conducted as described in Section 4.10, *High Expansion Foam Breakdown Due to Sprinkler Discharge*.