UL 162

STANDARD FOR SAFETY

Foam Equipment and Liquid Concentrates

UL Standard for Safety for Foam Equipment and Liquid Concentrates, UL 162

Eighth Edition, Dated February 23, 2018

Summary of Topics

This revision of ANSI/UL 162 dated January 20, 2022 includes a correction in Table 12.1, to delete "S" as a Foam Liquid Concentrate for Type III Portable Discharge Outlets.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated July 2, 2021 and November 19, 2021.

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Standard for Foam Equipment and Liquid Concentrates

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The most recent designation of ANSI/UL 162 as an American National Standard (ANSI) occurred on January 13, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover foam producing equipment and liquid concentrates employed for the production and discharge of foam that has an expansion ratio of 20:1 or less and is used for fire extinguishment. These requirements are based on the premise that foam equipment and specified types of foam liquid concentrates with which they are intended to be used are to be investigated for use with each other.

1.2 If foam equipment covered by these requirements incorporate sprinklers, the sprinklers shall comply with the Standard for Automatic Sprinklers for Fire Protection Service, UL 199.

1.3 Requirements for the installation and use of foam equipment and liquid concentrates are included in the Standard for Low-, Medium, High-Expansion Foam, NFPA 11.

2 Units of measurement

2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

3.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

3.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

4 Glossary

4.1 For the purpose of this standard, the following definitions apply.

4.2 CLASS B FIRES – Fires in flammable and combustible liquids, gases, and greases.

4.3 CONTROL – A reduction in fire intensity of approximately 90 percent.

4.4 DISCHARGE COEFFICIENT "K" – Coefficient of discharge in the formula:

$$K = \frac{Q}{\sqrt{P}}$$

where:

Q is Flow in gallons per minute (L/s x 15.85),

p is Pressure in psi (6.89 kPa)

4.5 DISCHARGE DEVICE – Fixed, semifixed, or portable devices, such as foam chambers, fixed foam makers, monitors, nozzles, spray nozzles, and sprinklers, that direct the flow to the fire or flammable liquid surface.

4.6 FIRE TEST PAN – The fire test pan is to be square, straight sided, with a minimum area of 50 square feet (4.65 m^2). The pan is to be of steel not less than 1/4 inch (6.4 mm) thick with liquid tight welded joints and provided with 3/16 inch (4.8 mm) thick angle to reinforce the upper edge. The reinforcement is to be continuous around the perimeter of the pan and is to form a turned-out edge flush with the top edge of the pan. The top edge surface so formed is to be 1-3/4 inch (44 mm). The reinforcing angle is to be continuously welded to the outside of the pan at the top edge and tackwelded at the edge of the lower lip of the angle.

4.7 FILM FORMING LIQUID CONCENTRATE – A foam solution that has a spreading coefficient greater than zero when tested in accordance with the Film Forming Test, Section 7.

4.8 FIXED FOAM MAKER – A device that generates foam and that is intended to be installed between the supply piping of foam solution and piping leading to discharge outlets.

4.9 FOAM – A fire fighting agent made by mechanically mixing air with a solution consisting of fresh or salt water to which a foam liquid concentrate has been added.

4.10 FOAM CHAMBER – A device that:

a) May include an integral foam maker,

b) Is intended for fixed installation on flammable or combustible liquid storage tanks, and

c) Produces foam and introduces it into the storage tanks.

4.11 FOAM EXPANSION VALUE – The ratio of final foam volume to original foam solution volume before adding air.

4.12 FOAM QUALITY – A measure of a foam's physical characteristics, expressed as the foam's:

a) 25 percent drain time, and

b) Expansion value.

4.13 FOAM SOLUTION – A mixture of a proportioned or premixed foam liquid concentrate dissolved in either fresh or salt water.

4.14 FULL-SCALE EQUIPMENT – Field installed components, such as proportioners and foam makers, that are intended to extinguish fires.

4.15 INDUCTION – A method that uses the venturi principle to introduce a proportionate quantity of foam concentrate into a water stream.

a) Pressure Induction – This method employs the water supply to pressurize the foam concentrate storage tank. At the same time, water flowing through an adjacent venturi or orifice creates a

pressure differential. The difference between the water supply pressure and this lower pressure area forces the foam concentrate to flow through a fixed or metering orifice into the water stream.

b) Vacuum Induction – This method utilizes the negative pressure created by water passing through a venturi to draw the liquid concentrate from the storage tank or container through a pick-up tube and mix it with the water stream.

c) Pump-and-Motor Induction – By means of an auxiliary pump, foam compound is injected into the water stream passing through an inductor. The resulting foam solution is then delivered to a foam maker. The proportioner may be inserted in the line at any point between the water source and foam maker.

4.16 FOAM LIQUID CONCENTRATE – A protein or synthetic based liquid that is intended to be diluted with fresh water, salt water, or a mixture of both fresh and salt water to a concentration (volume of concentrate/volume of solution). Different types of low expansion foam liquid concentrates are designated as follows:

a) Aqueous Film Forming Foam (AFFF) – A foam liquid concentrate that has a fluorinated surfactant base plus stabilizing additives.

b) Protein – A foam liquid concentrate that has a hydrolyzed protein base plus stabilizing additives; and shall be formulated such that it does not contain intentionally added per- and/or poly-fluorinated substances (“PFAS”).

c) Fluoroprotein – A foam liquid concentrate that is similar to protein, but with one or more fluorinated surfactant additives.

d) Film Forming Fluoroprotein (FFFP) – A foam liquid concentrate that has both a hydrolyzed protein and fluorinated surfactant base plus stabilizing additives.

e) Synthetic Fluorine Free Foam (SFFF) – A foam liquid concentrate that has a base other than fluorinated surfactant or hydrolyzed protein; and shall be formulated such that it does not contain intentionally added per- and/or poly-fluorinated substances (“PFAS”).

f) Alcohol Resistant – A foam liquid concentrate intended to extinguish both hydrocarbon and polar solvent (water miscible) fuel fires. To be identified as alcohol resistant, a liquid concentrate shall comply with the fire tests indicated in Class B Fire Tests – Sprinklers and Spray Nozzles, Section 11, or Class B Fire Tests – Topside Discharge Devices, Section 12, using both heptane and isopropyl alcohol test fuels.

4.17 MONITOR – A device that includes a nozzle and is intended to deliver a large foam stream and is mounted on:

a) A stationary support at grade level or on an elevated platform, or

b) A vehicle.

4.18 MONITOR, MANUALLY OPERATED – A monitor that includes manual controls for adjusting elevation and sweep and may include manual controls for adjusting rotation.

4.19 MONITOR, HYDRAULICALLY POWERED OSCILLATING – A monitor that includes an integral hydraulic circuit that automatically controls the sweeping motion of the monitor over a specified angle; includes manual override controls for adjusting the sweeping motion; manual controls for adjusting elevation; and may include manual controls for adjusting rotation, sweep angle, and sweep speed.

4.20 NOZZLE – A portable device intended to discharge foam solution. A nozzle may be either aspirating or nonaspirating and may pick up foam liquid concentrate directly from a container (self-inducting) or utilize a foam solution produced at some point before introduction into the nozzle.

4.21 PROPORTIONER – A device intended to provide continuous introduction of foam liquid concentrate at the recommended ratio into a water stream to form a foam solution.

4.22 SALT WATER – Synthetic seawater complying with the Standard Specification for Substitute Ocean Water, ASTM D1141-90 or the equivalent.

4.23 SPECIAL FIRE EQUIPMENT (SMALL SCALE EQUIPMENT) – Foam nozzles or foam makers, used for the Class B Fire Tests, that produce foam:

a) At the flow rate required for the Class B Fire Tests and

b) Having a foam quality approximating that produced using full-scale equipment.

Special fire equipment may be provided by the manufacturer to produce a range of foam quality.

4.24 SPRAY NOZZLE – A device attached to piping intended to discharge foam in a fixed spray pattern.

4.25 SPRINKLER, FOAM-WATER TYPE – An air aspirating, open type sprinkler, constructed to discharge water or foam-water solutions.

4.26 STANDARD SPRINKLER – A nonair aspirating type sprinkler that complies with the Standard for Automatic Sprinklers for Fire Protection Service, UL 199, and discharges water or foam solutions.

4.27 STOVE PIPE – A device intended to provide an open area for the 1 minute free burn during the burnback test. The stove pipe shall be constructed of 28 – 18 gauge (.015 – .048 inch thickness) sheet steel. The stove pipe is to be cylindrical in shape with an inside diameter not less than 12 inch (305 mm) and length not greater than 14 inch (356 mm).

4.28 SUBSURFACE FOAM INJECTION – Discharge of foam into a storage tank below the liquid surface near the tank bottom.

4.29 TEST FUELS –

a) HEPTANE – Commercial grade hydrocarbon having the following characteristics:

Distillation –	
Minimum initial boiling point	190°F (88°C)
Maximum dry point	212°F (100°C)
Specific Gravity (60°F/60°F) (15.6°C/15.6°C)	0.67 — 0.73

b) POLAR SOLVENT FUELS – Standard Polar Test fuels are as follows:

Polar Solvent Group	Standard Test Fuel
Alcohol	Isopropyl Alcohol
Ketones	Dimethyl Ketone
Esters	N-Butyl Acetate
Carboxylic Acids	Glacial Acetic Acid
Amines	Ethylene Diamine
Aldehydes	Propionaldehyde

Polar Solvent Group	Standard Test Fuel
Ethers, except Diethyl and Methyl Tertiary Butyl Ether	Isopropyl ether
Impurities for any polar test fuel is not to exceed 1.0 percent.	

4.30 TOPSIDE APPLICATION – A method of foam discharge wherein the foam is applied onto the top of a burning fuel surface.

4.31 TORCH – A device intended to determine the sealability of a foam blanket when used as described under Class B Fire Tests. The torch shall be constructed so that the flame is not less than 4 inch (102 mm) in length and 6 inch (152 mm) in height.

4.32 TWENTY-FIVE PERCENT DRAIN TIME – The time required for a 25 percent volume of liquid foam solution to drain from the foam sample.

4.33 TYPE II DISCHARGE OUTLET – A fixed device that delivers foam onto the burning liquid and partially submerges the foam and produces restricted agitation of the surface. Examples of a Type II discharge outlet include foam chambers and foam makers.

4.34 TYPE III DISCHARGE OUTLET – A fixed or portable device that delivers foam in a manner that causes the foam to fall directly onto the surface of the burning liquid and does so in a manner that causes general agitation. Examples of a Type III discharge outlet include hose stream nozzles and monitors.

CONSTRUCTION

5 Foam Equipment

5.1 Assembly

5.1.1 Pipe joint dimensions shall comply with the Standard for Pipe Threads, General Purpose, ANSI B1.20.1-83 or other national or international pipe thread standard.

5.1.2 A Flange dimensions and bolt layouts used for pipe connections shall comply with the requirements in the Standard for Pipe Flanges and Flanged Fittings, ASME B16.5 or other national or international pipe flange standards.

5.1.3 Bolts, nuts, and studs employed for the bolting of pressure-holding castings shall comply with the applicable requirements in the Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength, ASTM A307, or other equivalent national or international bolt and stud standards; and in the Standard Specification for Carbon and Alloy Steel Nuts, ASTM A563, or other equivalent national or international nut standards.

5.1.4 The load on any bolt shall not exceed the minimum tensile strength specified in the Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength, ASTM A307 or other equivalent national or international bolt and stud standards, when the equipment is pressurized to the hydrostatic test pressure as determined by the Equipment Pressurization Test, Section 17. The area of the application of pressure shall be calculated as follows:

a) If a full-face gasket is used, the area of force application is that extending out over the area circumscribed by the center line of the bolts.

b) If an “O” ring seal or ring gasket is used, the area of force application is that extending out of the center line of the “O” ring or gasket.

5.1.5 An internal operating part whose removal may become necessary during anticipated maintenance or repair shall be accessible, removable, and replaceable without damage to the equipment.

5.1.6 The construction of an operating part shall not permit it to be reassembled other than as intended if the part may be disassembled during anticipated field servicing.

5.1.7 A foam chamber shall be constructed so that it can be permanently attached to a storage tank, such as by bolting or welding.

5.1.8 A foam chamber assembly for use on a tank containing a liquid subject to evaporation shall include a breakable seal located and arranged to prevent entrance of vapors into outlets and pipe lines.

5.1.9 A foam chamber shall be provided with inspection openings to permit maintenance, and replacement of the vapor seal.

5.1.10 A foam-water sprinkler shall be of the open type and shall comply with the applicable requirements of the Standard for Automatic Sprinklers for Fire Protection Service, UL 199.

5.1.11 A standard sprinkler used to discharge a foam solution shall comply with the applicable requirements of the Standard for Automatic Sprinklers for Fire Protection Service, UL 199.

5.1.12 A foam-water sprinkler and a spray nozzle shall be constructed to reduce the risk of clogging caused by foreign matter in the foam solution or water passing through the sprinkler and nozzle. A passageway for foam solution or water shall have a cross-sectional dimension not less than 0.21 inch (5.3 mm).

5.1.13 A hydraulically powered oscillating monitor's integral hydraulic circuit, which includes parts that bear against, rotate within, or slide on stationary parts, and that must be free to move during intended operation, shall have corrosion resistance equivalent to brass, bronze, or austenitic stainless steel.

5.2 Materials

5.2.1 A casting shall be smooth and free of scale, lumps, cracks, blisters, sand holes, and defects of any nature that may make it unfit for the use for which it is intended. A casting shall not be plugged or filled, but may be impregnated to remove porosity.

5.2.2 Materials used in the construction of foam equipment shall resist galvanic corrosion and corrosion caused by atmospheric conditions as determined by the 10-Day Moist Ammonia Air Stress Cracking Test, Section 18; or the Salt Spray Corrosion Test, Section 19, as applicable.

5.2.3 A plastic or other nonmetallic part, other than an "O" ring, gasket, hose, or bladder material, shall comply with the requirements for:

a) Operation as specified in the air oven aging test, 22.1.1 and 22.1.2.

b) Moisture absorption and exposure to light, as specified in the light and water test, 21.2.1 and 21.2.2.

c) Flammability, as specified in 5.2.4.

d) Exposure to foam liquid concentrate, as specified in the liquid concentrate test, 22.2.1.

5.2.4 With reference to flammability, external plastic materials shall be classified as Type HB, V-2, V-1, V-0, or 5V, when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

5.2.5 An elastomeric part shall comply with requirements of the Elastomeric Parts Tests Other Than Hose, Section 20, or the Rubber Materials Test – Hose, Section 21.

5.2.6 A part that bears against, rotates within, or slides on stationary parts, and that must be free to move during intended operation, shall:

a) Be made of corrosion resistant material, such as bronze, chrome-plated bronze, monel metal, and the like, or

b) If made of materials lacking corrosion resistant properties, be fitted with bushings, inserts, or other parts made of corrosion resistant materials at those points where freedom of motion is required.

5.2.7 An interior bolt or screw shall be made of bronze or of other material having the strength and resistance to corrosion at least equal to that of bronze.

5.2.8 A vapor seal may be of glass or of built-up assemblies of other breakable, membrane formable materials.

5.3 Rated pressure

5.3.1 Foam equipment that is subjected to pressure shall be constructed of pressure retaining components and have a minimum rated working pressure of 175 psi (1.2 MPa).

5.3.2 A tank that is subjected to air, gas, or water pressure, or to a combination thereof, shall be designed, constructed, tested, inspected, and marked in accordance with Section VIII, Division 1 of the or other national or international pressure vessel code.

6 Foam Liquid Concentrates

6.1 Induction methods

6.1.1 A liquid concentrate shall be formulated so that it may be introduced into water flowing under pressure in pipe lines, by pressure induction, vacuum induction, or pump and motor (combined with balancing valves) induction method.

6.2 Containers

6.2.1 A container for liquid concentrate shall be of not less than 1 gallon (3.8 L) capacity and shall be equivalent in durability, strength, and corrosion resistance to a container constructed of steel not less than 0.0209 inch (0.56 mm) thick. A container shall be fitted with a tamper seal or use indicator and shall be provided with a pour opening having an inside diameter not less than 1-1/2 inches (38.1 mm).

6.2.2 A container shall comply with the requirements of the Drop Test, Section 23.

6.2.3 A nonmetallic container shall comply with the requirements of the Nonmetallic Container Tests, Section 24.

PERFORMANCE

6A Combustion Ion Chromatography

6A.1 For a foam liquid concentrate formulated such that it does not contain intentionally added per- and/or poly-fluorinated substances (PFAS), the concentration of permissible PFAS concentration is <1mg/L Total Organic Fluorine (TOF) when measured by combustion ion chromatography.

7 Film Forming Test

7.1 A film forming foam liquid concentrate shall have a spreading coefficient (see 7.5) greater than zero when tested as described in 7.2 – 7.5.

7.2 The surface tension of the foam solution and the interfacial tension of the foam solution and cyclohexane are to be determined using a tensiometer as described in the Standard for Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents, ASTM D1331-89.

7.3 The surface tension of the foam solution is to be determined on samples of the foam liquid concentrate mixed with both distilled water and synthetic sea water in the concentration recommended by the manufacturer. The determinations are to be conducted with the samples conditioned at 70 ±5°F (21 ±3°C).

7.4 The interfacial tension of the foam solution and cyclohexane is to be determined as described in 7.2 and 7.3 except that after immersion of the tensiometer ring in the foam solution, a layer of reagent grade (not less than 99 percent) cyclohexane is to be carefully added on top of the foam solution. Contact between the tensiometer ring and the cyclohexane is to be avoided. After waiting 5 minutes, the interfacial tension is to be determined.

7.5 The spreading coefficient of the foam liquid concentrate is to be calculated as follows:

$$SC = S_c - S_f - S_{cf}$$

where:

SC is Spreading coefficient, dynes/cm

S_c is Surface tension of cyclohexane, dynes/cm

S_f is Surface tension of foam solution, dynes/cm

S_{cf} is Interfacial tension of the foam solution and cyclohexane, dynes/cm

8 Hydraulic Characteristics Test

8.1 General

8.1.1 The water flow rate in gallons per minute (L/m) shall be within ±5 percent of the manufacturer's specifications when measured at:

a) The minimum inlet pressure,

b) At a pressure midway between the minimum and maximum inlet pressure, and

c) The maximum inlet pressure.

8.2 Foam chambers

8.2.1 A foam chamber shall have volumetric capacity to allow foam to:

a) Expand before being discharged, and

b) Accommodate the discharge capacity of the largest foam maker with which it is to be used.

8.2.2 A vapor seal shall rupture when the foam maker is operating at an inlet pressure of not less than 10 psi (69 kPa) and no greater than 25 psi (172 kPa).

8.2.3 The chamber and its foam maker are to be installed in a simulated portion of a flammable or combustible liquid storage tank or other test setup.

8.3 Foam-water sprinklers

8.3.1 The discharge rate of a foam-water sprinkler shall be within the range of discharge rates corresponding to the sprinkler's inlet pressure as specified in Table 8.1.

Table 8.1
Foam-water sprinkler discharge rates

Pressure at sprinkler inlet,		Range of discharge rates,	
psi	(kPa)	gallons per minute	(L/min)
30	(207)	14 – 17	(53 – 65)
50	(345)	18 – 22	(68 – 84)
75	(518)	22 – 26	(84 – 101)
100	(689)	25 – 31	(95 – 118)

8.3.2 Water is to be discharged through the sample foam-water sprinkler at selected pressures. The rate of flow at each selected pressure is to be recorded.

8.3.3 The pattern of water discharge produced by a foam-water sprinkler shall comply with the 10 pan and the 16 pan distribution tests at 15 gpm (57 L/m) and the fire tests at 15 and 25 gpm (57 and 95 L/m) as specified in the Standard for Automatic Sprinklers for Fire Protection Service, UL 199.

9 Hydraulically Powered Oscillating Monitor Cycling Test

9.1 A hydraulically powered oscillating monitor shall withstand the effects of cycling for two hours without visible damage or a reduction in performance.

9.2 Water or foam solution, as applicable, is to be discharged for two hours through representative hydraulically powered oscillating monitor and nozzle configurations resulting in automatic sweeping motion of the monitor. When the monitor includes adjustable sweep angles and/or sweep speeds, the two hour duration shall be equally divided amongst the combination of sweep angles and sweep speeds.

10 Foam Quality Tests

10.1 General

10.1.1 Foam produced using the specific combination(s), as specified by the manufacturer, of foam liquid concentrate, fresh water, and full-scale equipment shall have:

a) A 25 percent drain time not more than 1 minute shorter (or not more than 10 percent shorter, if this is a greater amount) nor more than 2 minutes longer (or not more than 20 percent longer, if this is a greater amount) than the 25-percent drain time obtained using special fire test equipment selected by the manufacturer for use in the fire tests. In addition, in no case shall the 25 percent drain time for the full scale equipment be:

1) Less than 30 seconds, or

2) Less than the drain time value obtained from the special fire test equipment, whichever is less.

b) A foam expansion value not more than one expansion unit below (or more than 10 percent below, if this is a greater amount) nor more than two expansion units above (or not more than 20 percent above, if this is a greater amount) the value obtained using special fire test equipment selected by the manufacturer for use in the fire tests. (See 10.3.2 for the formula for calculating foam expansion unit.)

Exception: Subsurface injection equipment shall have a foam expansion value not more than one-half expansion unit below nor more than one expansion unit above the value obtained using special fire test equipment.

10.2 Twenty-five percent drain time test

10.2.1 To determine compliance with the requirements of 10.1.1, a sample of the foam is to be obtained by directing foam discharging from generating equipment onto a foam slider (see 10.2.3). For subsurface injection equipment, the foam sample is to be obtained from a valved test connection on the discharge side of the foam maker. The samples are to be gently bled off into the test container while the bulk of the foam is discharged to waste. Equivalent means of producing a sample may also be used.

10.2.2 The foam is to be discharged at the following pressures:

a) Minimum inlet,

b) Normal inlet, and

c) Maximum inlet.

Exception: Foam is to be discharged from subsurface injection equipment at the minimum and maximum back pressure for both the minimum and maximum inlet pressure.

10.2.3 A foam slider is to be used to collect foam for determining foam quality. A typical "slider" is illustrated in Figure 10.1 and consists of a sheet of smooth metal, plastic, or wood held on a frame at an angle of 45 degrees to the floor. Foam reaching the "slider" surface is to be guided into a foam sample container placed at the bottom of the sheet. To prevent foam agitation in the container, excessive overflowing of foam solution should be avoided.

Exception: For subsurface injection equipment, the foam is to be collected downstream of the foam generator. A foam slider is not to be used.

10.2.4 The foam container used with the foam slider shown in Figure 10.1 is to be the 1600 mL cylindrical container as illustrated in Figure 10.2.

Figure 10.1

Typical foam slider

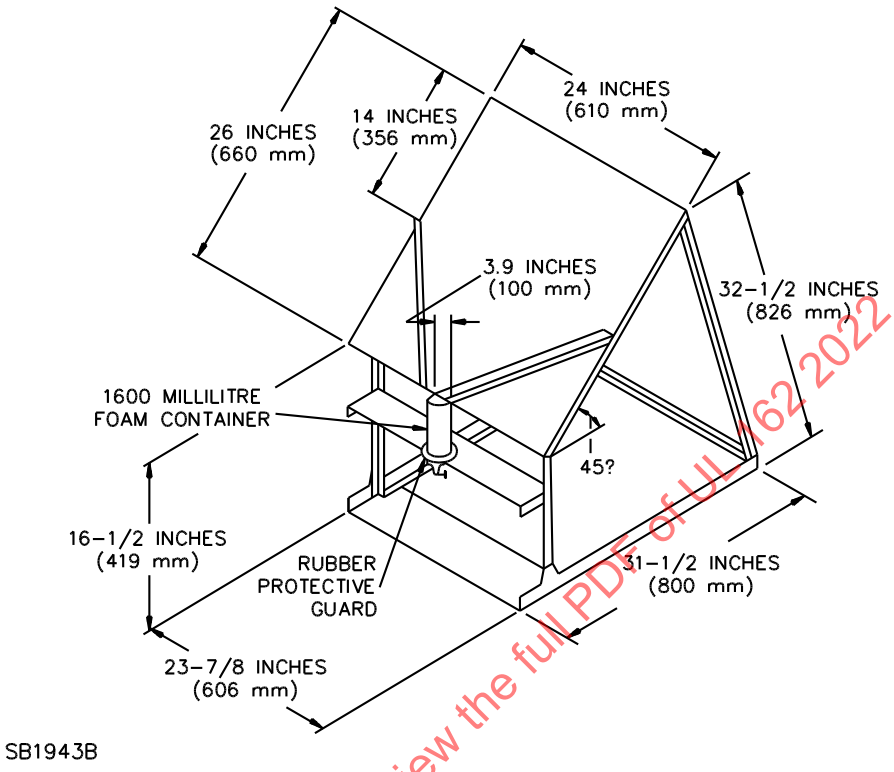
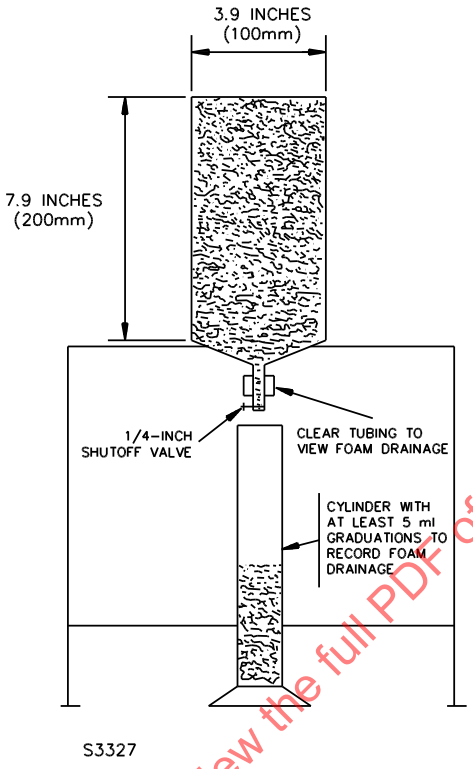


Figure 10.2

1600 mL Foam container



10.2.5 The volume of liquid collected is to be recorded at regular intervals, and the data is to be used as described in 10.2.6.

10.2.6 The time required to drain 25 percent of the volume of the liquid foam solution from the foam sample in the container is to be determined by interpolation of liquid volume against the time needed to collect that volume. Zero time is to be that time when a sufficient volume of foam has accumulated to fill the sample container.

10.2.7 As an alternative to the method described in 10.2.6, the 25 percent drain time may be determined by recording the time required to drain the volume of liquid having a weight equal to 25 percent of the weight of the foam sample, as determined in 10.3.2.

10.3 Expansion Test

10.3.1 Following completion of the twenty-five percent drain time test described in 10.2.1 – 10.2.7, all of the liquid drained from the foam sample is to be returned to the foam container. The weight of the container is to be determined to the nearest gram. The weight of the foam sample is to be determined by subtracting the weight of the container from the total weight.

10.3.2 The foam expansion unit value may be approximated for test purposes as the reciprocal of the specific gravity of the foam generated. It is to be calculated using the following equation:

$$Foam\ Expansion\ Unit = \frac{Volume\ of\ container\ (mL\ of\ water)}{[Weight_{full}(g)\ minus\ Weight_{empty}(g)]^{a}}$$

[a] Since 1 gram of foam solution occupies a volume of essentially 1 milliliter, the volume of foam solution equals the number of grams.

10.4 Verification of liquid-concentrate concentration

10.4.1 A refractometer, conductivity meter, or other equivalent instrument is to be used to verify the percentage of foam liquid concentrate dissolved in the foam samples used in the expansion test in 10.3.1 and 10.3.2 and in the 25 percent drain time test in 10.2.1 – 10.2.7. Concentration determinations are not necessary when premixed foam solutions are used.

10.4.2 The instrument reading obtained is to be corrected, as necessary, for temperature. The foam solution concentration may then be determined using a calibration chart. To prepare a calibration chart, instrument readings are to be made for solutions of known percentage liquid concentrates and the results plotted as a graph of known percentage versus instrument reading.

11 Class B Fire Tests – Sprinklers and Spray Nozzles

11.1 General

11.1.1 A specified liquid concentrate in combination with foam-water sprinklers, standard sprinklers, or spray nozzles shall comply with the requirements specified in 11.1.2 – 11.5.6.

11.1.2 Foam produced by discharging foam solutions onto flammable liquid test fires shall comply with each of the requirements specified in 11.1.2 (a) – (d) when tested as described in 11.2.1 – 11.5.6.

a) The foam blanket shall spread over and completely cover the test fuel surface.

b) Fire shall be completely extinguished during or at the end of the foam discharge.

c) The test fuel blanketed with foam shall not reignite, candle, flame, or flashover when a lighted torch is moved over all areas of the surface.

Exception: Candling, flaming, or flashover that self-extinguishes is acceptable provided that the phenomenon does not remain in one area for more than 30 seconds.

d) When a stovepipe planted vertically in the foam (see 11.5.5) is removed, the foam blanket shall either:

1) Restrict, for 5 minutes, the spread of fire to an area not larger than 10 square feet (0.9 m^2), or

2) Flow over and reclose the burning area.

11.1.3 Each liquid concentrate to be tested is to be taken from its container as received from the manufacturer.

11.2 Fuel

11.2.1 The test fuel is to be commercial grade heptane.

11.2.2 If a foam liquid concentrate is intended to be tested with hydrocarbon fuel(s) other than heptane, or polar solvent fuel(s), these other fuels shall have impurities not exceeding 1 percent.

11.3 Test method

11.3.1 The test fuel is to be placed in the fire test pan, see 4.6. The pan is to be located on the ground.

Exception: The fire test pan may be located not more than 12 inches (305 mm) above the ground when continuous skirting is provided from the pan to the ground on at least three sides of the pan.

11.3.2 Fire tests conducted outdoors shall be conducted under conditions of no precipitation.

11.3.3 If heptane, or another test fuel that does not mix with water is used, a fuel layer 2 inches (50.8 mm) deep is to be floated on a layer of water not less than 1 inch (25.4 mm) deep. The water depth is to be adjusted to provide a distance from the top of the pan to the surface of the liquid of not less than 8 inches (203 mm).

11.3.4 If test fuels used are miscible with water, the fuel is to be placed directly in the test pan to a depth that provides a distance from the top of the pan to the surface of the liquid of not less than 8 inches (203 mm). The fuel depth is to be not less than 1-1/2 inches (39 mm).

11.3.5 The amount of fuel in U.S. gallons (liters x 0.26) to be used for each test may be calculated using the following formula:

$$U.S.\ Gallons = 0.625 \times A \times d$$

where:

A = Area in square feet (m^2 x 10.76) of fuel surface.

d = Depth in inches (mm x 0.04) of fuel.

11.3.6 The temperature of the test fuels shall not be less than 50°F (10°C) prior to the conduct of each fire test.

Note: Certain polar fuels may experience a decrease in temperature after being placed in the fire test pan. This temperature decrease is to be disregarded provided the fuel temperature, prior to being placed in the pan, is not less than 50°F (10°C).

11.4 Application density and sprinkler or spray nozzle arrangement

11.4.1 For testing foam-water sprinklers, standard orifice or large orifice sprinklers, a test piping grid representing the area to be protected is to be located not more than 15 feet (4.6 m) nor less than 14 feet (4.3 m) above the floor. The four test devices are to be installed as specified in Table 11.2 at the corners of the grid, the fire test pan is to be centered below the grid.

11.4.2 Foam water spray nozzles are to be arranged in a configuration recommended in the manufacturer's instructions.

11.4.3 The application density of a foam solution used in testing foam water sprinklers or standard sprinklers is to be as specified in Table 11.2.

Table 11.1
Fire test parameters for sprinklers
Table deleted

Table 11.2
Foam application and duration to burnback ignition for sprinklers

Application [a]	Foam liquid concentrate	Fuel group	Minimum test application density, gpm/ ft^2 (L/min/m^2) [b]	Minimum nominal test pressure, psi (kPa)	Time of foam application, minutes	Duration until burnback ignition, minutes	Minimum design application density, gpm/ft^2 (L/min/m^2)
Foam Water Sprinklers	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.16 (6.5)	30 (207)	5	15	0.16 (6.5) [c]
Sprinkler, Nominal 2.8 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.10 (4.1)	29 (200)	5	15	0.16 (6.5) [d]
Sprinkler, Nominal 4.2 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.10 (4.1)	13 (90)	5	15	0.16 (6.5) [d]
Sprinkler, Nominal 5.6 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.10 (4.1)	7 (48)	5	15	0.16 (6.5) [d]
Sprinkler, Nominal 8.0 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.14 (5.7)	7 (48)	5	15	0.22 (9.0) [d]
Sprinkler, Nominal 11.2 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.20 (8.2)	7 (48)	5	15	0.32 (13.1) [d]
Sprinkler, Nominal 14.0 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.25 (10.2)	7 (48)	5	15	0.40 (16.3) [d]
Sprinkler, Nominal 16.8 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.30 (12.3)	7 (48)	5	15	0.48 (19.6) [d]
Sprinkler, Nominal 19.6 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.35 (14.3)	7 (48)	5	15	0.56 (22.9) [d]
Sprinkler, Nominal 25.2 K-factor	P, FP, FFFP, AFFF, SFFF	Hydrocarbon Polar	0.44 (18.0)	7 (48)	5	15	0.70 (28.6) [d]

P – Protein
FP – Fluoroprotein
FFFP – Film Forming Fluoroprotein
AFFF – Aqueous Film Forming Foam
SFFF – Synthetic Fluorine Free Foam

[a] The sprinkler spacing for foam water sprinklers is 10 ft by 10 ft (3.04 m by 3.04 m). The sprinkler spacing for sprinklers other than foam water sprinklers is 12-1/14 ft by 12-1/4 ft (3.73 m by 3.73 m).

[b] The test application density for hydrocarbons shall be the minimum as specified in the table and for polar solvents may vary as specified by the manufacturer; but, not less than the minimum. For sprinklers, the test application density is determined by taking the flow per sprinkler given by the K-factor formula with known nominal K-factor and nominal inlet pressure; and dividing the flow by the area defined by the sprinkler spacing.

[c] For foam water sprinklers, the design application density is 0.16 (6.5) or 1.0 times the test application density, whichever is greater.

[d] For sprinklers other than foam water sprinklers, the design application density is 0.16 (6.5) or 1.6 times the test application density, whichever is greater.

11.5 Fuel ignition and foam discharge

11.5.1 After the fuel has been added to the test pan, the sprinklers or spray nozzles arranged, and the liquid concentrate density determined, the fuel is to be ignited and the resulting fire allowed to burn freely for a 15 second preburn.

11.5.2 At the end of the 15 second preburn, the foam is to be discharged. If heptane fuel is used, foam discharge is to continue for 5 minutes, followed by a water discharge for 5 minutes. If a polar solvent fuel is used, foam discharge is to continue for 5 minutes, and no water discharge is to follow. The foam blanket resulting from the foam discharge shall spread over and completely cover the fuel surface and the fire shall be completely extinguished during or at the end of the foam discharge.

11.5.3 After all discharge is completed, the foam blanket formed on top of the fuel is to be left undisturbed for 10 minutes if heptane fuel is used and for 15 minutes if polar solvent fuel is used.

11.5.4 During the time the foam blanket is left undisturbed, a lighted torch is to be passed approximately 1 inch (25.4 mm) above the entire foam blanket, including corners, in an attempt to reignite the fuel. The fuel shall not reignite, candle, flame, or flashover while the torch is being passed over the fuel. The torch test is to be conducted twice during this period; immediately after the end of foam discharge (polar fuels) or water discharge (hydrocarbon fuels) and prior to the ignition of the 12 inch diameter stovepipe. Each torch test shall be conducted for a period of not less than 1 minute.

Exception: Candling, flaming, or flashover that self-extinguishes is acceptable provided that the phenomenon does not remain in one area for more than 30 seconds.

11.5.5 After completion of attempts to reignite the fuel with the lighted torch, a stovepipe is to be lowered into the foam blanket. The stovepipe is to be placed approximately 2-1/2 feet (0.76 m) from each of two adjacent sides of the test pan, in the corner considered to cause the most severe burnback condition, and lowered in such a manner that the foam blanket is not disturbed. The portion of the foam blanket that is enclosed by the stovepipe is to be removed with as little disturbance as possible of the blanket outside the stovepipe. The fuel cleared inside the stovepipe is to be ignited and allowed to burn for 1 minute. The stovepipe then is to be slowly removed from the pan while the fuel continues to burn.

11.5.6 After the stovepipe has been removed, the foam blanket shall either:

a) Restrict the spread of fire at any time during a 5 minute duration to a total area of not more than 10 square feet (0.9 m^2).The spread of fire caused by candling, ghosting or flashover, in which the flame height exceeds 2 feet, but then self extinguishes, shall be considered unacceptable if the total area involved in flames exceeds 10 square feet at any time during the 5 minute duration, or

b) Flow over and extinguish the burning area.

12 Class B Fire Tests – Topside Discharge Devices

12.1 General

12.1.1 A specified liquid concentrate in combination with topside discharge devices shall be tested in accordance with 12.4.1 or 12.4.2, or both, and comply with the requirements specified in 12.1.2 – 12.3.5, and 12.4.3 – 12.5.6.

12.1.2 Foam produced by discharging fresh or salt water or both fresh and salt water foam solutions onto flammable liquid test fires shall comply with each of the requirements specified in 12.1.2 (a) – (d) when tested as described in 12.2.1 – 12.5.6.

a) The foam blanket shall spread over and completely cover the test fuel surface.

b) Fire shall be completely extinguished during or at the end of the foam discharge.

c) The test fuel blanketed with foam shall not reignite, candle, flame, or flash over when a lighted torch is moved over all areas of the surface.

Exception: Candling, flaming, or flashover that self-extinguishes is acceptable provided that the phenomenon does not remain in one area for more than 30 seconds.

d) When a stovepipe planted vertically in the foam (see 12.5.5) is removed, the foam blanket shall either:

1) Restrict the spread of fire for 5 minutes to an area not larger than 10 square feet (0.9 m^2), or

2) Flow over and reclose the burning area.

12.1.3 Each liquid concentrate to be tested is to be taken from its container as received from the manufacturer, following storage at room temperature for at least 24 hours.

12.2 Fuel

12.2.1 The test fuel is to be commercial grade heptane.

12.2.2 If a foam liquid concentrate is intended to be tested with hydrocarbon fuel(s) other than heptane, or polar solvent fuel(s), these other fuels shall have impurities not exceeding 1.0 percent.

12.2.3 The test fuel's temperature shall comply with 11.3.5.

12.3 Test method

12.3.1 The test fuel is to be placed in the fire test pan. The pan is to be located on the ground.

Exception: The fire test pan may be located not more than 12 inches (305 mm) above the ground when continuous skirting is provided from the pan to the ground on at least three sides of the pan.

12.3.2 For fire tests conducted outdoors, they shall be conducted under conditions of no precipitation.

12.3.3 If heptane, or another test fuel that does not mix with water is used, a fuel layer 2 inches (50.8 mm) deep is to be floated on a layer of water not less than 1 inch (25.4 mm) deep. The water depth is to be adjusted to provide a distance from the top of the pan to the surface of the liquid of not less than 8 inches (203 mm).

12.3.4 If test fuels used are miscible with water, the fuel is to be placed directly in the test pan to a depth that provides a distance from the top of the pan to the surface of the liquid of not less than 8 inches (203 mm). The fuel depth is to be not less than 1-1/2 inches (39 mm).

12.3.5 The amount of fuel in U.S. gallons (liters x 0.26) to be used for each test may be calculated using the formula specified in 11.3.5.

12.4 Application density and nozzle positioning

12.4.1 For Type II application, the nozzle is to be positioned in front of and above the test pan, fixed in position by mechanical means and centered with respect to the pan as measured from side-to-side. The nozzle is to be positioned so that foam is directed across the pan and strike a flat steel backboard on the opposite side of the pan throughout the duration of the foam application. In no case is the nozzle to extend over any part of the test pan.

12.4.2 For Type III application, the nozzle is to be positioned in front of and above the test pan. The nozzle may be moved throughout the duration of foam application or fixed in position for part or all of the application. Until control is attained, all foam application is to be from behind one side of the test pan and discharged directly onto the fuel surface. After control, foam application may be from the front and one adjacent side and may be directed onto the inside of the test pan. The nozzle may be moved beyond the adjacent side extensions. In no case is the nozzle to extend over any part of the test pan.

12.4.3 The application density for various concentrates is to be as specified in Table 12.1. Film forming fluoroprotein concentrates are required to comply with both hydrocarbon minimum application densities.

Exception: A alcohol resistant type liquid concentrate is to be applied at the minimum recommended density specified by the manufacturer when testing polar solvent fuels, but not less than 0.06 gallons per minute per square foot (2.4 L/min/m^2).

Table 12.1
Foam application and duration to burnback ignition for topside outlets

Application	Foam liquid concentrate	Fuel group	Minimum test application density, gpm/ft^2 (L/min/m^2) [a]	Time of foam application, minutes	Duration until burnback ignition, minutes	Minimum design application density, gpm/ft^2 (L/min/m^2)
Type III, portable discharge outlets	P, FP, FFFP, SFFF	Hydrocarbon	0.06 (2.5)	5	15	0.16 (6.5) [b]
Type III, portable discharge outlets	FFFP, AFFF	Hydrocarbon	0.04 (1.6)	3	9	0.10 (4.1) [c]
Type II fixed discharge outlets	P, FP, FFFP, SFFF	Hydrocarbon	0.06 (2.5)	5	15	0.10 (4.1) [d]
Type II, fixed discharge outlets	FFFP, AFFF	Hydrocarbon	0.04 (1.6)	3	9	0.10 (4.1) [c]
Type II, fixed discharge outlets	P, FP, FFFP, AFFF, SFFF	Polar	0.06 (2.5)	5	15	0.10 (4.1) [d]

P – Protein FFFP – Film Forming Fluoroprotein

FP – Fluoroprotein AFFF – Aqueous Film Forming Foam SFFF – Synthetic Fluorine Free Foam

[a] The test application density for hydrocarbons shall be the minimum as specified in the table and for polar solvents may vary as specified by the manufacturer; but, not less than the minimum. For discharge outlets, the test application density is determined by dividing the flow by the area of the test pan.

[b] The design application density is 0.16 (6.5) or 2-2/3 times the test application density, whichever is greater.

[c] The design application density is 0.10 (4.1) or 2-1/2 times the test application density, whichever is greater.

[d] The design application density is 0.10 (4.1) or 1-2/3 times the test application density, whichever is greater.

12.5 Fuel ignition and foam discharge

12.5.1 After the fuel has been added to the test pan, the nozzle has been arranged, and the liquid concentrate rate has been determined, the fuel is to be ignited and the resulting fire allowed to burn freely for a 60 second preburn.

12.5.2 At the end of the 60 second preburn, the foam is to be discharged for the duration specified in Table 12.1. The foam blanket resulting from the foam discharge shall spread over and completely cover the fuel surface, and the fire shall be completely extinguished before the end of the foam discharge.

12.5.3 After all discharge is completed, the foam blanket formed on top of the fuel is to be left undisturbed for the period specified in Table 12.1.

12.5.4 During the time the foam blanket is left undisturbed, a lighted torch is to be passed approximately 1 inch (25.4 mm) above the entire foam blanket, including corners, in an attempt to reignite the fuel. The fuel shall not reignite, candle, flame, or flash over while the torch is being passed over the fuel. The torch test is to be conducted twice during this period; immediately after the end of foam discharge and prior to the ignition of the 12 inch diameter stovepipe. Each torch test shall be conducted for a period of not less than 1 minute.

Exception: Candling, flaming, or flashover that self-extinguishes is acceptable provided that the phenomenon does not remain in one area for more than 30 seconds.

12.5.5 After completion of attempts to reignite the fuel with the lighted torch, a stovepipe is to be lowered into the foam blanket. The stovepipe is to be placed approximately 2-1/2 feet (0.76 m) from each of two adjacent sides of the test pan in the corner considered to cause the most severe burnback condition, and lowered in such a manner that the foam blanket is not disturbed. The portion of the foam blanket that is enclosed by the stovepipe is to be removed with as little disturbance as possible of the blanket outside the stovepipe. The fuel cleared inside the stovepipe is to be ignited and allowed to burn for 1 minute. The stovepipe then is to be slowly removed from the pan while the fuel continues to burn.

12.5.6 When the stovepipe is removed, the foam blanket shall either:

a) Restrict the spread of fire at any time during a 5 minute duration to a total area of not more than 10 square feet (0.9 m^2).The spread of fire caused by candling, ghosting or flashover, in which the flame height exceeds 2 feet (.6 m), but then self extinguishes, shall be considered unacceptable if the total area involved in flames exceeds 10 square feet at any time during the 5 minute duration, or

b) Flow over and extinguish the burning area.

13 Class B Fire Tests – Subsurface Injection

13.1 General

13.1.1 A specified liquid concentrate in combination with subsurface injection equipment shall comply with the requirement specified in 13.1.2 – 13.3.4.

13.1.2 When tested as specified in 13.2.1 – 13.3.4, a foam liquid concentrate intended for subsurface injection into fuel storage tanks shall produce foam that:

a) Flows across and completely covers the test fuel surface, and

b) Extinguishes the test fire within 15 minutes of the start of foam discharge.

13.2 Fuel

13.2.1 The test fuel is to be heptane (or, at the manufacturer's option, a more volatile fuel) of a commercial grade having the characteristics specified in 4.29(a).

13.2.2 If the container of a liquid concentrate is marked to indicate that the concentrate is intended to be used with hydrocarbon fuel(s) other than heptane, fire tests are also to be conducted using the other fuel(s) indicated.

13.3 Test Method

13.3.1 An upright, cylindrical, open top tank of steel plate construction is to be used for these tests and is to be at least 15 feet (4.6 m) in diameter, and at least 13 feet (4 M) deep.

13.3.2 Fuel is to be added to the tank to a depth of at least 10 feet (3.0 m). Water to a maximum depth of 1 foot (0.3 m) may be added to the bottom of the tank. The distance from the top of the tank to the surface of the liquid is to be not less than 3 feet (0.9 m) nor more than 4 feet (1.2 m). Foam is to be injected within the bottom 2 feet (0.6 m) of the fuel.

13.3.3 After the tank has been filled, the fuel is to be ignited and allowed to burn freely for a 10 minute preburn. Immediately following the 10 minute preburn, foam is to be continuously discharged into the bottom of the tank for not more than 10 minutes, at an application density of 0.10 gallons per minute per square foot (4.1 L/min/m^2) of test fuel surface area. The inlet velocity of the foam is to be not less than 10 feet per second (3.0 m/s). Foam discharge may be stopped prior to the 10 minute time if so desired by the manufacturer. Once discharge has been stopped, it is not to be restarted. The foam shall flow across the test fuel surface and extinguish the fire within 15 minutes after the start of foam discharge.

13.3.4 Foam inlet velocity is calculated using the formula:

$$V_I = \frac{(Q)\ (EXP)}{(2.448)\ (d^2)}$$

where:

V_I = Inlet velocity, fps

Q = Flow, gpm

EXP = Foam expansion ratio as determined using the fire test foam maker

d = Orifice diameter, in.

14 Induction Rate Tests

14.1 The liquid concentrate induction rate of a proportioner, expressed as a percentage of the flow rate of the mixed water plus concentrate solution, shall be minus zero (0) percent, plus thirty (30) percent of the manufacturer's specified induction rate or one percent point, whichever is less.

14.2 The sample proportioner is to be installed to simulate service conditions. Inductors are to be tested using the maximum recommended hose lay or at the minimum and maximum back pressures for the inductor inlet pressure. The foam maker or discharge device employed in the tests is to have a capacity equal to the rated capacity of the proportioner.

14.3 Liquid concentrate induction rate tests are to be conducted with the liquid concentrate metered through a fixed orifice or through a metering valve having selective orifices.

14.4 The temperature of the liquid concentrate is to be not less than 60°F (15°C).

14.5 Solutions with properties similar to the liquid concentrate may be substituted for liquid concentrate if tests are performed to establish correlation between the induction rates of the two liquids.

15 Minimum Storage Temperature Test

15.1 The quantity of liquid concentrate inducted or proportioned at the minimum storage temperature by means of the proportioning equipment intended for use with the concentrate shall be not less than 85 percent of that inducted or proportioned at a temperature of 60°F (15.6°C) or higher.

15.2 For the purposes of test uniformity, a liquid concentrate is to be categorized according to the minimum storage temperature at which it may be inducted or proportioned in acceptable concentrations. Minimum storage temperatures are to be minus 20°F (minus 28.9°C), 0°F (minus 17.8°C), 20°F (minus 6.7°C), or 35°F (1.7°C).

Exception No. 1: A bladder tank type proportioner is to be tested at 35°F (1.7°C) only.

Exception No. 2: Bladder tank type proportioning, pump-and-motor induction and pressure induction type proportioning devices do not need to be tested with a foam concentrate at the minimum storage temperature, provided that the foam concentrate complies with 15.1 when tested by a vacuum induction device at the foam concentrate's minimum storage temperature.

16 Hydrostatic Pressure Test

16.1 Foam equipment shall withstand, for 1 minute without rupture, an internal hydrostatic pressure of four times its maximum operating pressure, or 700 psi (4.83 MPa), whichever is higher.

Exception: A discharge device that does not incorporate an integral shutoff device need not be subjected to the hydrostatic pressure test.

16.2 With reference to 16.1, weeping type leakage is acceptable.

16.3 During these tests, the test pressure is to be exerted on all parts of the assembly subject to intended operating pressure.

16.4 The hydrostatic pressure test for strength of body castings, flanges, covers, and the like, is not to be considered a test for bolts, gaskets, or seals. During this test, bolts and gaskets employed with castings or parts of a large area may be reinforced by using high strength bolts and clamps, and for regularly employed gaskets and seals, other materials capable of withstanding the test pressure may be substituted.

17 Equipment Pressurization Test

17.1 The load on any bolt shall not exceed the minimum tensile strength specified in Table II of the Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Fasteners, ASTM A307-91, when the equipment is pressurized, as specified in 16.1.

17.2 The area of the application of pressure is to be calculated using the following assumptions:

a) If a full face gasket is used, the area of force application extends out to the center line of the bolts.

b) If an "O" ring seal or ring gasket is used, the area of force application extends out to the center line of the "O" ring or gasket.

18 10-Day Moist Ammonia Air Stress Cracking Test

18.1 After being subjected to the conditions described in 18.2 – 18.4, a brass part containing more than 15 percent zinc when examined using 25X magnification shall:

a) Show no evidence of cracking; or

b) Show evidence of cracking when examined using 25X magnification; and

1) For parts that are pressure retaining, comply with the Hydrostatic Pressure Test, in Section 16 at two times the maximum operating pressure rather than four times the maximum operating pressure.

2) For parts that are not pressure retaining, function as intended when operated at its highest inlet pressure and highest flow for 2 minutes.

18.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and maintained during the test. Samples with threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened to the torque specified in Table 18.1. Teflon tape or pipe compound are not to be used on the threads.

Table 18.1
Torque requirements for threaded connections

Nominal thread size, inches	Torque	
	pound-inches	(N·m)
1	1200	(135.6)
1-1/4	1450	(168.8)
1-1/2	1550	(175.1)
2	1650	(186.4)
2-1/2	1750	(197.7)
3	1800	(203.4)

18.3 Three samples are to be degreased and then continuously exposed is a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

18.4 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inch (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and at a temperature of 93°F (34°C).

19 Salt Spray Corrosion Test

19.1 Equipment constructed from metallic parts using combinations of brass, bronze, or ferrous metals shall comply with the following, after being subjected to a 240 hour salt spray exposure as specified in 19.2 – 19.7:

a) Any corrosion resistant coating (such as paint) shall remain intact and shall adhere to the surface so as not to be removable (when removal exposes a material subject to corrosion) by such action as washing or rubbing with a fingernail.

b) Dissimilar metals in contact or close proximity with one another shall show no evidence of galvanic corrosion.

c) The sample shall show no destruction of metal surfaces having no protective coating or paint.

19.2 Equipment constructed from metallic materials other than brass, bronze, or ferrous metals shall comply with the requirements specified in 19.1, except that the salt spray exposure is to be for 720 hours.

19.3 The test samples are to be supported and exposed to salt spray (fog) as specified by the Standard Method of Salt Spray (Fog) Testing, ASTM B117-90. The fog chamber used for salt spray exposure is to have:

a) Inside dimensions of 48 by 30 by 36 inches (1.2 by 0.76 by 0.91 m),

b) A solution reservoir,

c) A supply of conditioned compressed air,

d) A dispersing tower for producing a salt fog,

e) Specimen supports, and

f) Provision for heating the chamber.

19.4 The dispersion tower is to be located in the center of the chamber and is to be supplied with salt solution and with warmed, humidified air at pressures at 17 and 19 psig (117 and 131 kPa), so as to disperse the salt solution in the form of a fine mist or fog throughout the interior of the chamber. The temperature within the chamber is to be maintained between 92 and 97°F (33.3 and 36.1°C).

19.5 Condensate accumulation on the cover of the chamber is not to be permitted to drop onto the test samples. Drops of the solution that fall from the samples are not to be recirculated but are to be removed through a drain located in the floor of the chamber.

19.6 The salt solution is to be 20 percent (by weight) common salt (sodium chloride) and 80 percent distilled water. The pH value of this solution as collected after spraying in the test apparatus is to be between 6.5 and 7.2, and the specific gravity between 1.126 and 1.157 at 95.5°F (35.3°C).

19.7 A metallic part is to be connected to a typical pipe fitting or hose coupling to simulate field installation, unless marked to specify fitting and coupling material(s).

20 Elastomeric Parts Tests Other Than Hose

20.1 General

20.1.1 This test applies to elastomeric parts other than hose.

20.2 Parts other than bladder parts

20.2.1 An elastomeric part used to provide a seal shall have the following properties when tested as specified in the Standard for Gaskets and Seals, UL 157:

a) For silicone rubber (having poly-organo-siloxane as its constituent characteristic), a minimum tensile strength of 500 psi (3.4 MPa) and a minimum ultimate elongation of 100 percent.

b) For fluoroelastomers, a minimum tensile strength of 1000 psi (6.9 MPa) and a minimum ultimate elongation of 150 percent.

c) For natural rubber and synthetic rubber other than silicone rubber or fluoroelastomers, a minimum tensile strength of 1200 psi (8.3 MPa) and minimum ultimate elongation of 150 percent.

d) Those properties relating to maximum tensile set; minimum tensile strength and elongation after oven aging; and hardness after oven aging, all as specified in UL 157. The maximum service temperature used to determine the oven time and temperature for oven aging is considered to be 140°F (60°C).

e) For a material in continuous contact with liquid concentrate or foam solution, a minimum tensile strength and a minimum ultimate elongation of 60 percent of the original after exposure to the concentrate or foam for 60 days at 158°F (70°C).

20.2.2 The Standard for Gaskets and Seals, UL 157, provides for the testing of either finished elastomeric parts or sheet or slab material. Sheet or slab material is to be tested when the elastomeric parts are O-rings having diameters of less than 1 inch (25.4 mm). The material tested is to be the same as that used in the product, regardless of whether finished elastomeric parts or sheet or slab material is tested.

20.3 Non-reinforced bladder parts

20.3.1 A non-reinforced bladder part shall have the following properties when tested as specified in the Standard for Gaskets and Seals, UL 157:

a) For silicone rubber (having poly-organo-siloxane as its constituent characteristic), a minimum tensile strength of 500 psi (3.4 MPa) and a minimum ultimate elongation of 100 percent.

b) For natural rubber and synthetic rubber other than silicone rubber, a minimum tensile strength of 1500 psi (10.3 MPa) and minimum ultimate elongation of 150 percent.

c) Those properties relating to maximum tensile set as specified in UL 157. Also, after oven aging as specified in UL 157, the minimum tensile strength and minimum elongation shall each be at least 85 percent of the original.

d) For a material in continuous contact with liquid concentrate or foam solution, a minimum tensile strength and a minimum ultimate elongation of 85 percent of the original after exposure to the liquid concentrate for 60 days at 158°F (70°C).

20.3.2 The Standard for Gaskets and Seals, UL 157, provides for the testing of either finished elastomeric parts or sheet or slab material. Sheet or slab material is to be tested when the elastomeric parts are O-rings having diameters of less than 1 inch (25.4 mm). The material tested is to be the same as that used in the product, regardless of whether finished elastomeric parts of sheet or slab material is tested.

20.4 Reinforced bladder parts

20.4.1 A reinforced elastomeric diaphragm or bladder material shall:

a) Be flexible.

b) Have a hydrostatic resistance not less than 85 percent of the original as received value, and

c) Show no signs of deterioration that could affect performance when subjected for 60 days to:

1) Air at 158°F (70°C), and