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Second Revision No. 27-NFPA 11-2020 [Global Comment]

Add new Annex H and renumber remaining annexes.

Supplemental Information

File Name	Description	Approved
Annex_H.docx	For staff use	
11_Global_SR-27_Annex_H_new.pdf	For ballot	

Submitter Information Verification

Committee:

Submittal Date: Wed Feb 05 13:42:27 EST 2020

Committee Statement

Committee Statement: Management of the whole life cycle of foam has always been critical to ensuring efficient and effective application when it is needed. It is even more critical now due to the ever increasing restrictions on usage and environmental concerns. It is suggested that at least the basis of whole life assurance process through 10 elements is described and explained in an Appendix as recommended good practice. See CI-26 for additional information.

Response Message: SR-27-NFPA 11-2020

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Annex H Synthetic Fluorine-Free Foam (SFFF) Research Testing Summary

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

H.1 Overview.

Extensive testing has been done and additional testing is expected as different manufacturers and research organizations develop the next generation of fluorine-free firefighting foam for hydrocarbon/polar solvent fires. Testing has been conducted by the following three types of organizations:

(1) Foam manufacturers and research organizations

(2) User organizations or research organizations for those users such as LASTFIRE

(3) Research or standard writing organizations such as the Fire Protection Research Foundation (FPRF), FM Approvals, and Underwriters Laboratories, Inc.

H.1.1

Annex H covers testing conducted by two independent research organizations — LASTFIRE and the FPRF — to better understand the use of fluorine-free foams (FFFs) in extinguishing Class B flammable liquid fires.

Many of the application characteristics of synthetic fluorine free foam (SFFF) are the same or similar to the application characteristics of protein foam, the major firefighting foam prior to the introduction of aqueous film forming foams (AFFF). Both work by applying bubbles of foam on the fire.

H.1.2

Following is a summary of researchers' findings so far and the key differences between AFFF and SFFF. More research is needed, not only about the properties of the existing FFFs, but also for the still-to-be-introduced alternative foam agents and their properties.

(1) Drop-in replacements for AFFF and the common properties of each type of foam:

AFFF: Generally, listed AFFFs today have common properties and can be used interchangeably in proportioning and application systems with only minor change-out requirements (most manufacturers do not recommend mixing different AFFF, but this is done during emergency situations). Because their foam quality properties are common, one listed AFFF is a drop-in replacement for another listed AFFF.

SFFF: Generally, listed SFFFs today do not have common properties and cannot be used interchangeably in proportioning and application systems without first ensuring they will operate in AFFF equipment. Presently, there is no drop-in replacement SFFF for AFFF. The equipment would require reassessment to ensure that the proportioning and application nozzles operate correctly with the new foam. As in the early days of AFFFs, each SFFF is unique and cannot be used interchangeably with other SFFFs — they might not have the same

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density or viscosity properties. Users must work with foam suppliers to ensure the SFFFs and proportioning and application equipment work together.

(2) Foam blanket versus foam blanket and foam film:

AFFF: As the name implies, AFFFs, when properly applied, provide both a blanket of foam solution and air bubbles that flows across the fuel and a film that flows from the bubbles to quickly cover the fuel surface. This characteristic makes AFFF especially useful in aircraft fire and rescue situations.

SFFF: SFFF, when properly applied, provides a blanket of foam solution and air bubbles that flows across the fuel. This foam does not produce a film agent.

(3) Foam drain time:

AFFF: Drain time is relatively short — 10 to 15 minutes. This allows the foam bubbles to refresh the film, but the foam blanket/bubbles must be reapplied often. If the AFFF is being used for vapor suppression over a long period of time, a significant amount of foam concentrate is needed for AFFF reapplication.

SFFF: When properly applied, SFFF produces a blanket of foam that is robust and stays in the mixture longer — 30 minutes to several hours depending on how it is applied. This allows for less frequent reapplication than AFFF and results in lower foam concentrate use when SFFF is employed for vapor suppression.

(4) Aspiration rate of the foam:

AFFF: Presently, most AFFFs are applied using non-air-aspirating nozzles, whether by fixed equipment, handline, or master stream application. This results in an air-aspiration ratio of between 3 to 5 times foam solution to air aspiration. For many reasons, this has worked successfully for AFFFs, but the addition of the film to assist the foam in extinguishing the fire is the most important one.

SFFF: SFFFs presently available appear to work much better on extinguishing Class B fires when applied using an air-aspirated nozzle, whether fixed equipment, handline, or master stream. This results in an air-aspiration ratio of at least 7 to 10 times foam solution to air aspiration. The SFFFs being tested at this time also appear to work much better when applied using compressed air foam technology with its more uniform bubble configuration.

Based on previous experience with protein foam, higher air-aspiration ratios in the 10 to 20 range could produce even more robust SFFFs.

(5) Foam application range:

AFFF: Most AFFFs are applied using a nozzle that is not specifically designed to air-aspirate the foam. These AFFFs have a more concentrated liquid finished foam and, when applied, tend to have an application footprint similar to a water-only application. Chapter 5 requires the application rate to be increased by 50 percent to compensate for the impact of wind

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and foam drop-out. Large master stream non-air-aspirated appliances are available that can deliver non-air-aspirated foam up to 400 ft to 500 ft (120 m to 150 m) effectively.

SFFF: When properly applied using handline and master stream nozzles, SFFFs should have a higher air-aspiration ratio and will not travel as far as a similar water stream application. Chapter 5 requires the application rate to be increased by 50 percent to compensate for the impact of wind and foam drop-out — a concept originally developed for protein-based foam. Large master stream air-aspirated appliances are available that can deliver air-aspirated foam up to 350 ft to 400 ft (105 m to 120 m) effectively.

H.2 Testing Conducted by the Fire Protection Research Foundation (FPRF).

H.2.1 General.

To provide data and guidance for foam system application standards, the FPRF contracted Jensen Hughes and the Naval Research Laboratory (NRL) to conduct an experimental program to assess the firefighting capabilities of fluorine-free, Class B firefighting foams on fires involving hydrocarbon and alcohol-based fuels. The objectives of this study were to determine the fire extinguishment and burnback times for five FFFs and one short-chain C6 AFFF formulation (for baseline) as a function of application rate (gpm/ft^2) and foam discharge density (gal/ft^2) for a range of test parameters, including foam quality and aspiration, fuel type, water type, and fuel temperature. The complete report is available at the FPRF website.

H.2.2 Report Summary.

The assessment was conducted as a blind study. The foams were given generic names, and the manufacturers were not identified. The experimental approach consisted of conducting a parametric assessment of the critical variables that could affect the fire protection performance of new foam formulations using UL 162, *Foam Equipment and Liquid Concentrates*, as the basis for the investigation. Under UL 162, FFFs fall under the broad category of "synthetic (S)" foams and are defined as foams that have a chemical base other than a fluorinated surfactant or hydrolyzed protein. Because UL 162 was used as the basis of this assessment, the test parameters for synthetic foams were used.

The variables assessed during this program included the following:

(1) Two discharge types: UL Type II with polar solvents and UL Type III with other fuels

(2) Six foam types (all UL Listed): one alcohol-resistant C6 AFFF (AR-AFFF); three alcohol resistant FFFs (AR-FFF1, AR-FFF2, and AR-FFF3); and two hydrocarbon listed FFFs (H-FFF1 and H-FFF2)

(3) Four fuel types: heptane, gasoline (MIL SPEC and E10), and isopropyl alcohol (IPA)

(4) Fuel temperature: ambient temperature: 60°F (15°C); and high temperature: 85°F (30°C)

(5) Discharge densities: up to three discharge densities

(6) Two water types: freshwater and saltwater

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(7) Two foam qualities: lower aspiration (3 to 4 expansion) and higher aspiration (7 to 8 expansion)

The tests were conducted in two series. Series I focused on assessing the capabilities of these foams at a lower foam quality and aspiration, representative of a nonaspirating discharge device. Series II reassessed the foams at a higher foam quality and aspiration, representative of an aspirating discharge device.

The assessment was conducted on approval scale size fires. A 50 ft^2 (4.65 m^2) square stainless-steel pan with sides 12 in. (30 cm) high was constructed. The pan was placed on concrete cinder blocks and skirted on three sides during each test. The pan was filled with the appropriate amount of fuel, typically 8 in. to 10 in. (20 cm to 25 cm) below the top of the pan.

During Type II tests, the nozzle was fixed, positioned, and aimed so that the spray impacted a backboard located on the opposite side of the pan. The nozzle remained fixed for the duration of the test. Most of the Type II tests were conducted using IPA as the test fuel with no water substrate.

During Type III tests, the foam nozzle was initially fixed and held still so that the spray impacted the fuel near the center of the fire pan until the intensity of the fire was reduced by approximately 90 percent (defined as control). Once the fire had been knocked down and controlled, the firefighter then manually directed the spray at the remaining fire in the pan while simultaneously cooling the sides. The firefighter was limited to two sides of the pan, and the nozzle was never allowed to extend over the edge of the pan as required by UL 162. The two types of tests are illustrated in Figure H.2.2(a).

Figure H.2.2(a) Test Configurations.



Type II Configuration



Type III Configuration

During this assessment, 165 tests were conducted. To summarize the results, the baseline C6 AR-AFFF demonstrated consistent, superior firefighting capabilities through the entire test program under all test conditions. For the FFFs in general, the firefighting capabilities of the foams varied from manufacturer to manufacturer making it difficult to develop generic design requirements. This might also be the case with AFFFs, but only one was tested during this program, yielding no data to assess variability.

During the series II tests, all three AR-FFFs successfully extinguished the fires at rates 10 percent to -20 percent below the UL-listed parameters. The successful tests are summarized in Table H.2.2(a) and shown graphically in Figure H.2.2(b). All the Type II tests were conducted with the higher foam quality and aspiration rate.

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Table H.2.2(a) Successful Type II Test Results (IPA)

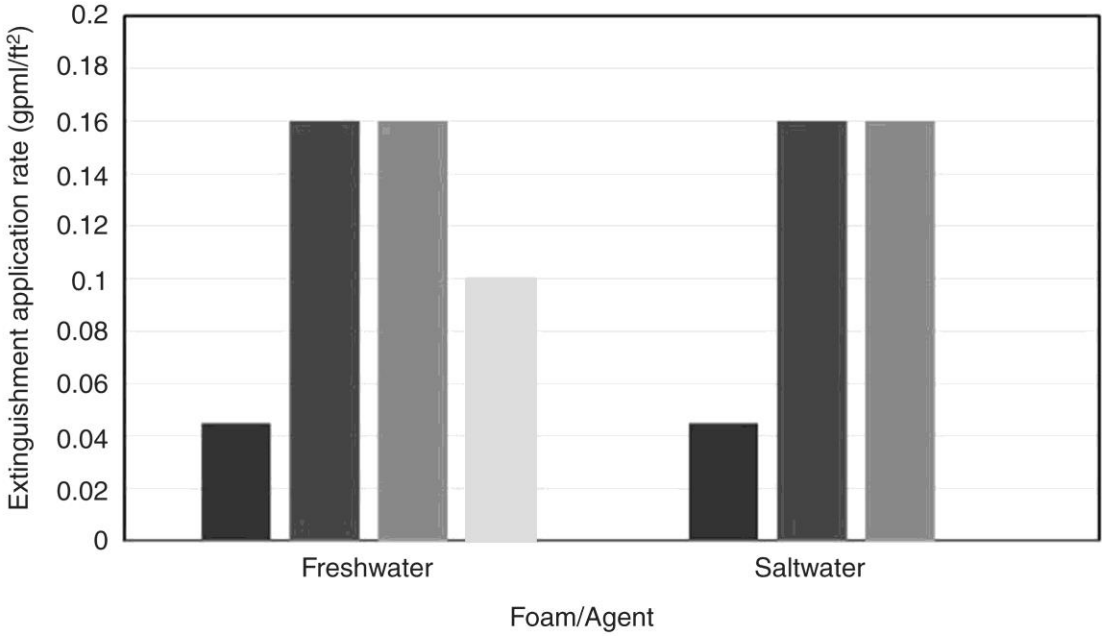
Foam	Type of Discharge	Fuel Type	Water Type	Flow Rate	Exp. Ratio	Cont. sec	Cont. gal/ft^2	Ext. sec	Ext. gal/ft^2
AR-AFFF	Type II	IPA	Fresh	2.25 gpm	7-8	160	0.12	270	0.203
AR-AFFF	Type II	IPA	Salt	2.25 gpm	7-8	140	0.105	270	0.203
AR-FFF1	Type II	IPA	Fresh	8.0 gpm	7-8	135	0.36	275	0.733
AR-FFF1	Type II	IPA	Salt	8.0 gpm	7-8	96	0.256	215	0.573
AR-FFF2	Type II	IPA	Fresh	8.0 gpm	7-8	120	0.32	295	0.787
AR-FFF2	Type II	IPA	Salt	8.0 gpm	7-8	115	0.307	255	0.68
AR-FFF3	Type II	IPA	Fresh	5.0 gpm	7-8	100	0.167	270	0.45

For SI units, 1 gpm = 3.8 L/min; 1 gal/ft^2 = 40 L/m^2.

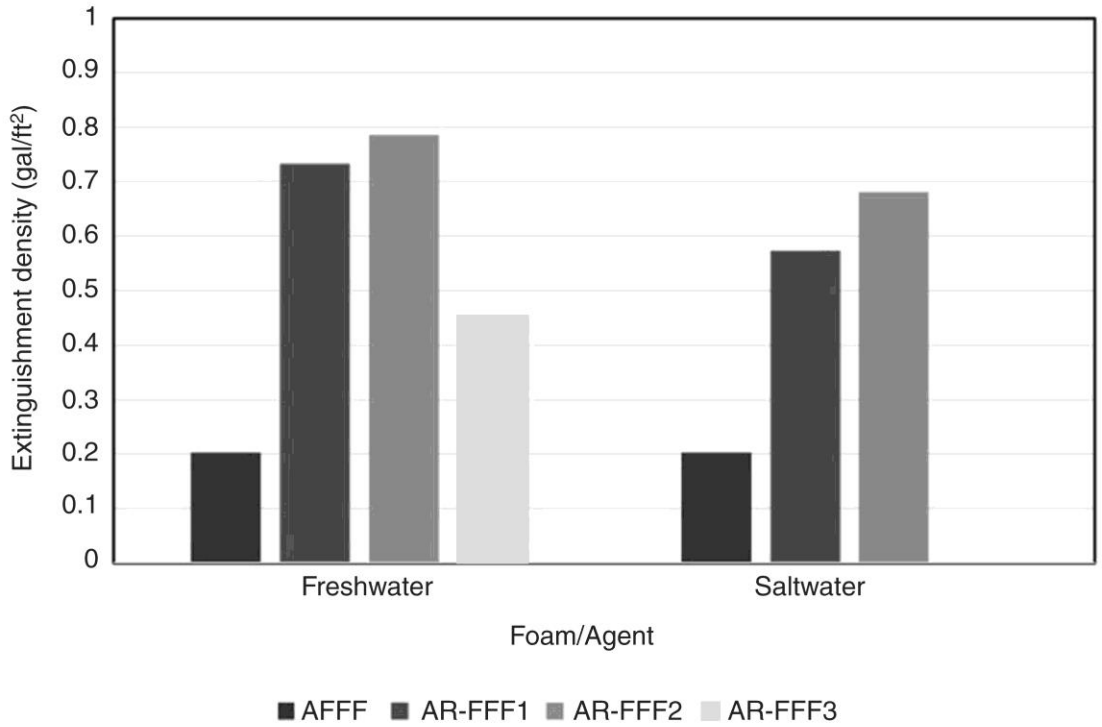
Figure H.2.2(b) Type II IPA Foam Comparison.

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Application Rate



Extinguishment Density



For SI conversions: 1 gpm = 3.8 L/min; 1 gal/ft² = 40 L/min/m².

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The Type III tests were conducted with both higher and lower foam qualities and aspiration rates, using heptane, MILSPEC gasoline, and E10 gasoline.

Throughout this test program, heptane was shown to be the easiest of the test fuels to control and extinguish. The original five foams all met the UL 162 requirements at the design and recommended flow rates with the higher aspirated foam (higher foam quality) using heptane as the fuel. Gasoline was shown to be more difficult to control and extinguish than heptane, with some FFFs requiring as much as a 50 percent increase in flow rate to extinguish the fire. The E10 gasoline was even harder to extinguish that the MILSPEC gasoline. The three AR-FFFs required a 50 percent increase in flow and application rate to extinguish the E10 fires. The two H-FFFs required a 25 percent increase in flow and application rate to extinguish the E10 fires. Surprisingly, the H-FFFs were able to extinguish the E10 fires at a lower rate than the AR-FFFs. Independent of the flow and application rate, the FFFs typically required about twice as much agent to extinguish the E10 fires as compared to the MILSPEC fires. In general terms and based on the extinguishment densities, it appears that MILSPEC gasoline is twice as hard to extinguish as heptane, and E10 gasoline is twice as hard as MILSPEC gasoline (four times as hard as heptane) for the FFFs. The results are summarized in Table H.2.2(b) and plotted in Figure H.2.2(c).

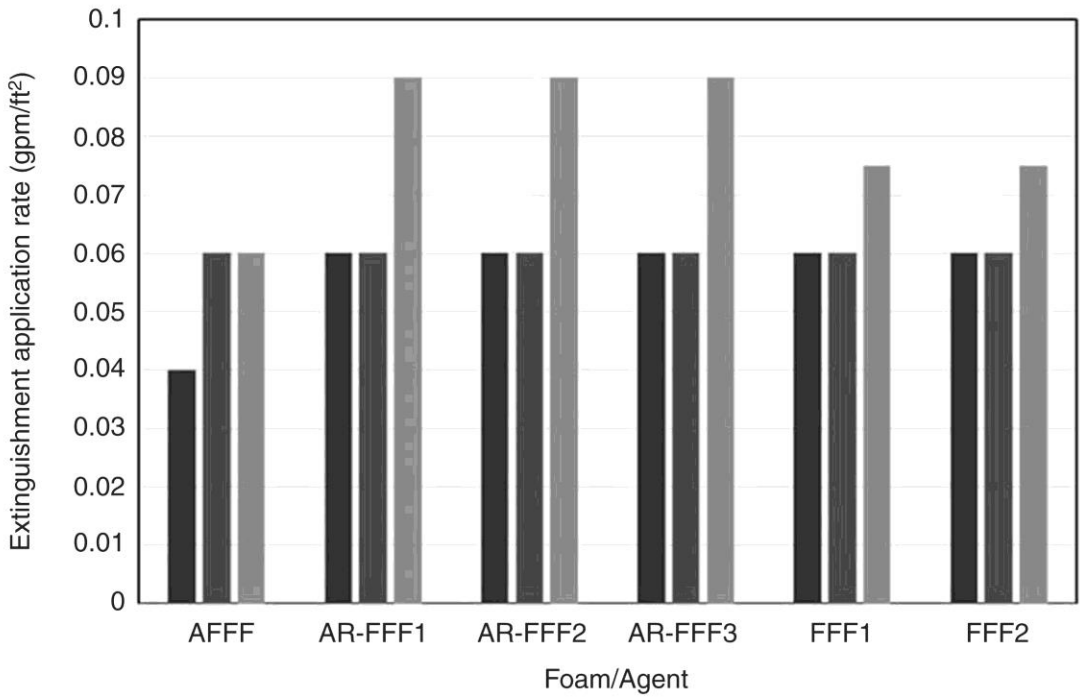
Table H.2.2(b) Summary of Findings: Fuel Type and Agent Comparison — Higher Aspirated Foam with Freshwater

				Heptane		MILSPEC		E(10)	
Foam	Type of Discharge	Water Type	Exp. Ratio	Flow Rate	Ext. gal/ft²	Flow Rate	Ext. gal/ft²	Flow Rate	Ext. gal/ft²
AR-AFFF	Type III	Fresh	7-8	3.0 gpm	0.051	3.0 gpm	0.065	3.0 gpm	0.06
AR-FFF1	Type III	Fresh	7-8	3.0 gpm	0.105	3.0 gpm	0.22	4.5 gpm	0.413
AR-FFF2	Type III	Fresh	7-8	3.0 gpm	0.107	3.0 gpm	0.21	4.5 gpm	0.383
AR-FFF3	Type III	Fresh	7-8	3.0 gpm		3.0 gpm	0.23	4.5 gpm	0.353
FFF1	Type III	Fresh	7-8	3.0 gpm	0.092	3.0 gpm	0.185	3.75 gpm	0.356
FFF2	Type III	Fresh	7-8	3.0 gpm	0.055	3.0 gpm	0.17	3.75 gpm	0.363

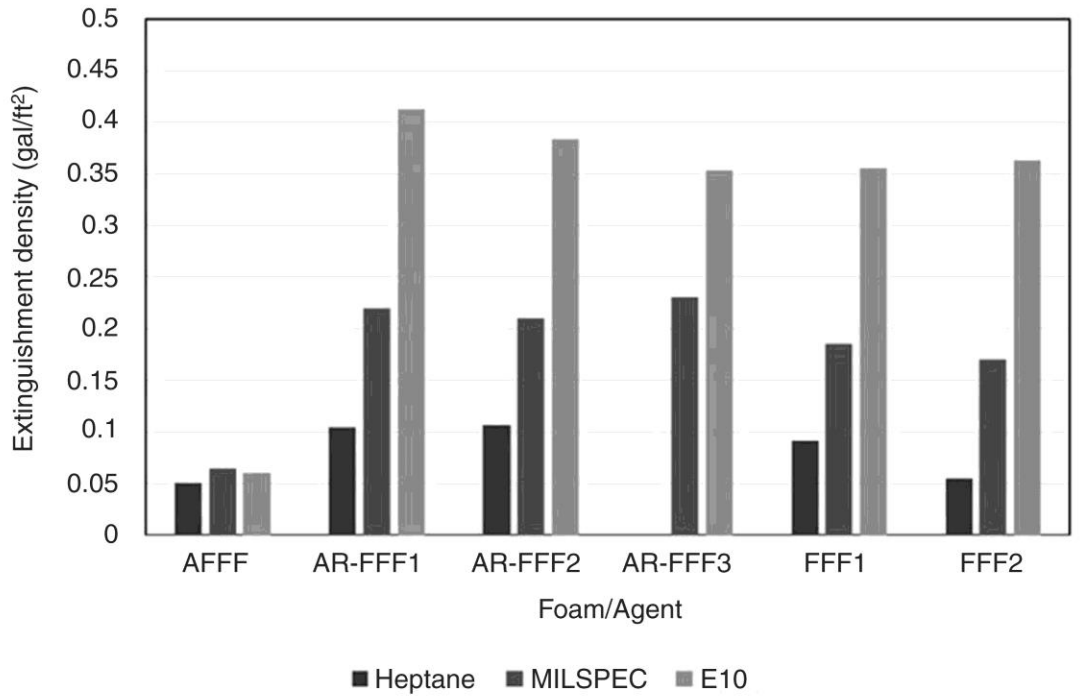
Figure H.2.2(c) Fuel Type and Agent Comparison — Higher Aspirated Foam with Freshwater.

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Application Rate



Extinguishment Density



For SI conversions: 1 gpm = 3.8 L/min; 1 gal/ft^2 = 40 L/min/m^2.

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One of the major findings of the study was the effect that foam quality and aspiration had on the capabilities of the FFFs. In general, lower foam quality and aspiration rates caused a 20 percent to 50 percent increase in extinguishment densities as compared to higher foam quality and aspiration rates and had a greater impact on the alcohol-resistant foams than the FFFs approved only for hydrocarbon fuels. In some instances, the reduced aspiration and foam quality required higher application rates to extinguish the fires. These findings are summarized in Table H.2.2(c) and illustrated in Figure H.2.2(d). Figure H.2.2(d) only illustrates data for the tests conducted using freshwater for the foam solution.

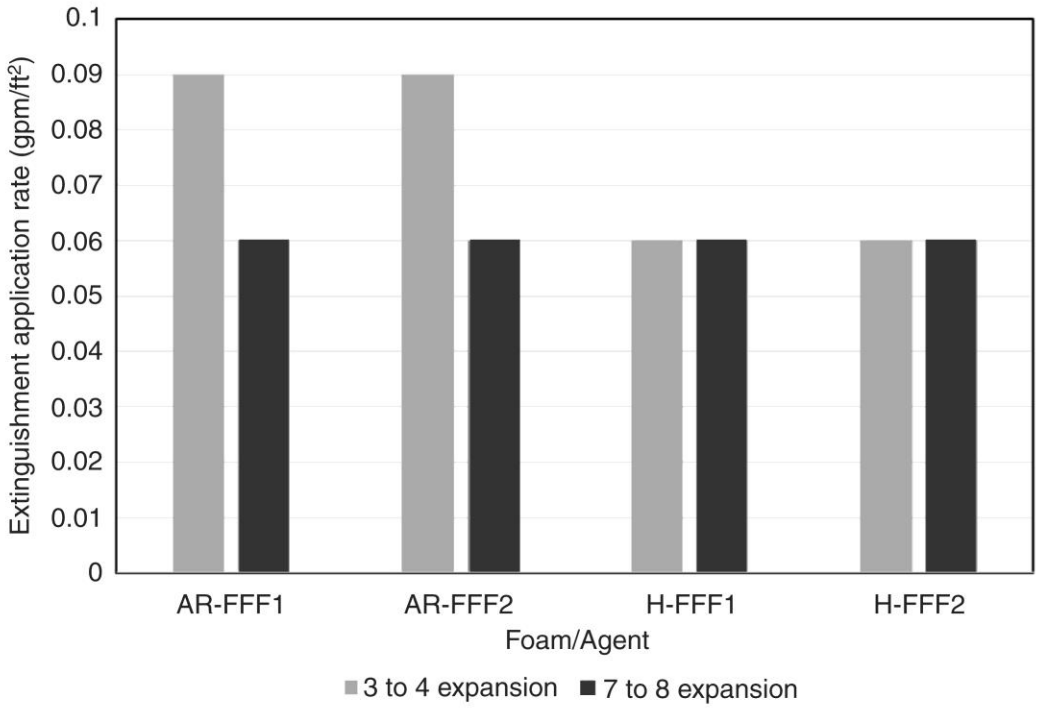
Table H.2.2(c) Foam Quality and Aspiration Comparison (MILSPEC Gasoline — Densities)

Foam	Type of Discharge	Fuel Type	Water Type	3 to 4 Expansion Ratio		7 to 8 Expansion Ratio	
				Flow Rate	Ext gal/ft^2	Flow Rate	Ext gal/ft^2
AR-FFF1	Type III	MILSPEC	Fresh	4.5 gpm	0.45	3.0 gpm	0.25
AR-FFF1	Type III	MILSPEC	Salt	4.5 gpm	0.375	3.0 gpm	0.26
AR-FFF2	Type III	MILSPEC	Fresh	4.5 gpm	0.39	3.0 gpm	0.255
AR-FFF2	Type III	MILSPEC	Salt	4.5 gpm	0.375	3.0 gpm	0.27
FFF1	Type III	MILSPEC	Fresh	3.0 gpm	0.165	3.0 gpm	0.15
FFF1	Type III	MILSPEC	Salt	3.0 gpm	0.29	3.0 gpm	0.21
FFF2	Type III	MILSPEC	Fresh	3.0 gpm	0.187	3.0 gpm	0.16

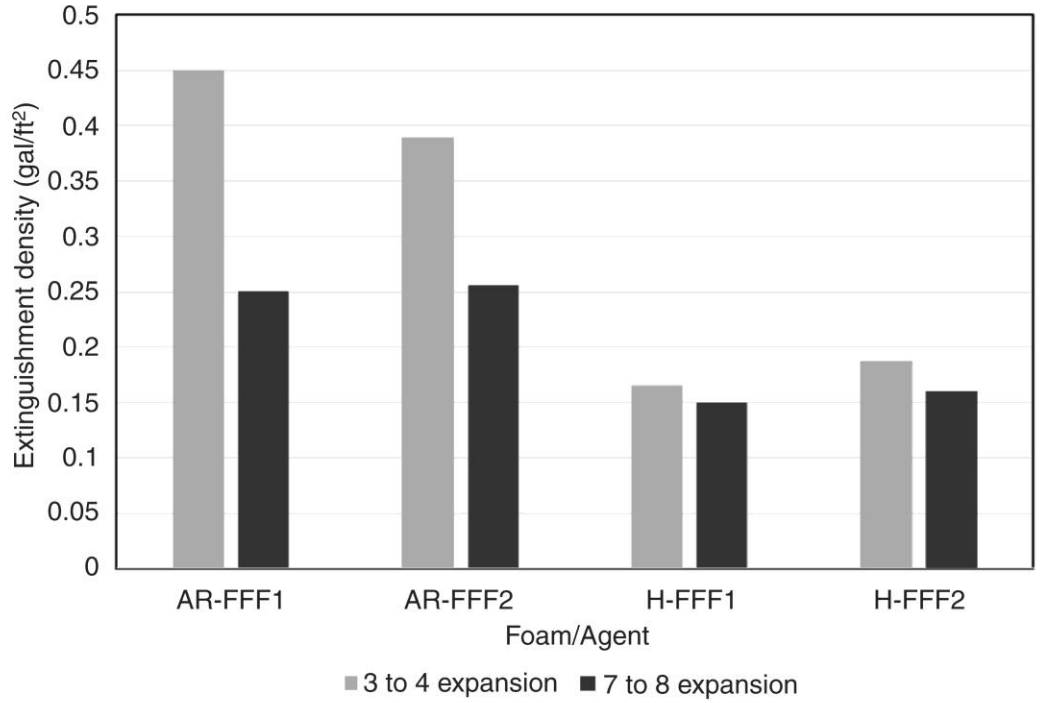
Figure H.2.2(d) Foam Quality and Aspiration Comparison — MILSPEC Gasoline and Freshwater.

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Application Rate



Extinguishment Density

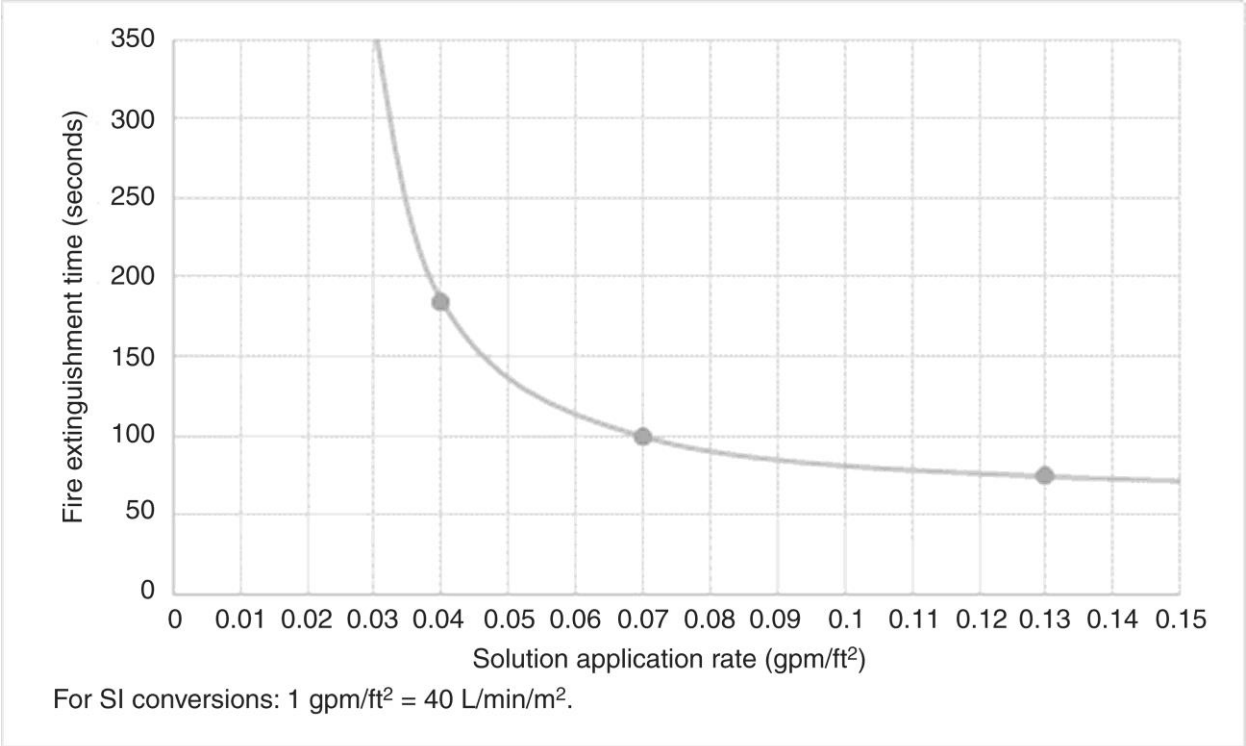


For SI conversions: 1 gpm = 3.8 L/min; 1 gpm/ft^2 = 40 L/min/m^2.

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During a study conducted for the FAA in the mid-90s, the firefighting capabilities (control and extinguishment times) of foam extinguishing agents were typically shown to follow an "L curve." An example L curve is shown in Figure H.2.2(e).

Figure H.2.2(e) Firefighting Control and Extinguishment Times — L Curve.

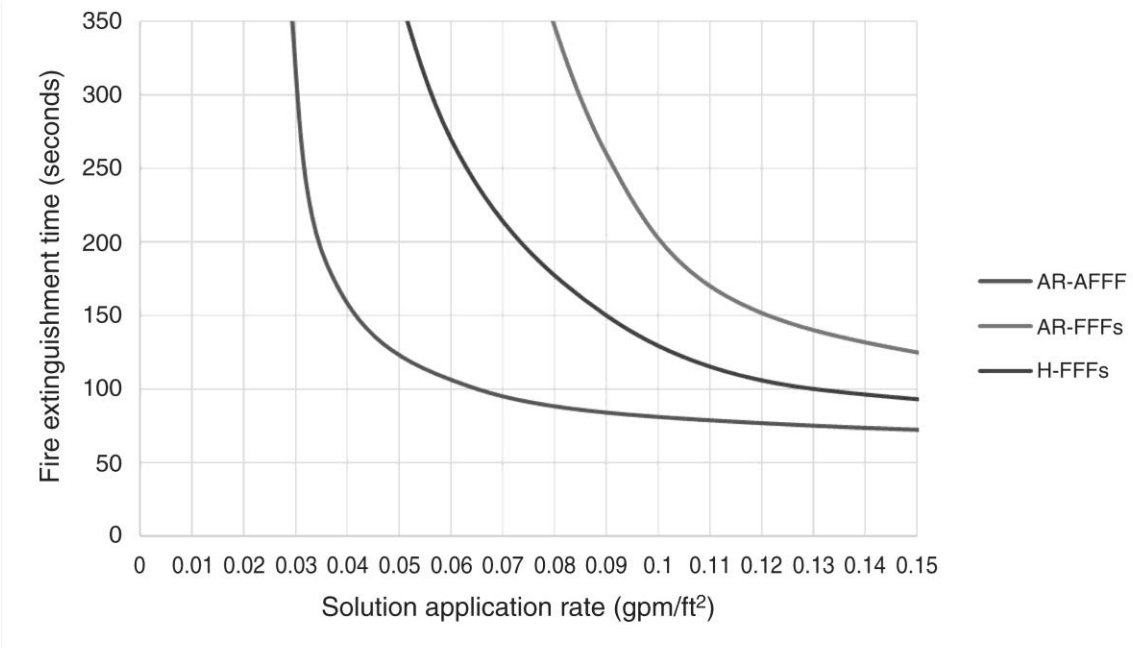


From a performance standpoint, this curve makes perfect sense. When the foam is applied at a high rate, the fire is quickly controlled and extinguished, as illustrated by the right side of the plot where the performance levels off even though the foam is being applied at higher rates. As the application rate is reduced, the times tend to increase as the rate approaches a critical value. Specifically, the times asymptotically approach the rate where the foam is being consumed by the fire as fast as it is being applied. In Figure H.2.2(e), this asymptotic value is just below 0.03 gpm/ft^2 (1.2 L/min/m^2). These tendencies are used to describe the capabilities of the FFFs in the following paragraphs. The L curves for the foams included in this assessment — AR-AFFF, AR-FFFs, and H-FFFs — are shown in Figure H.2.2(f) for the hydrocarbon-based fuels — heptane, E10 gasoline, and MILSPEC gasoline.

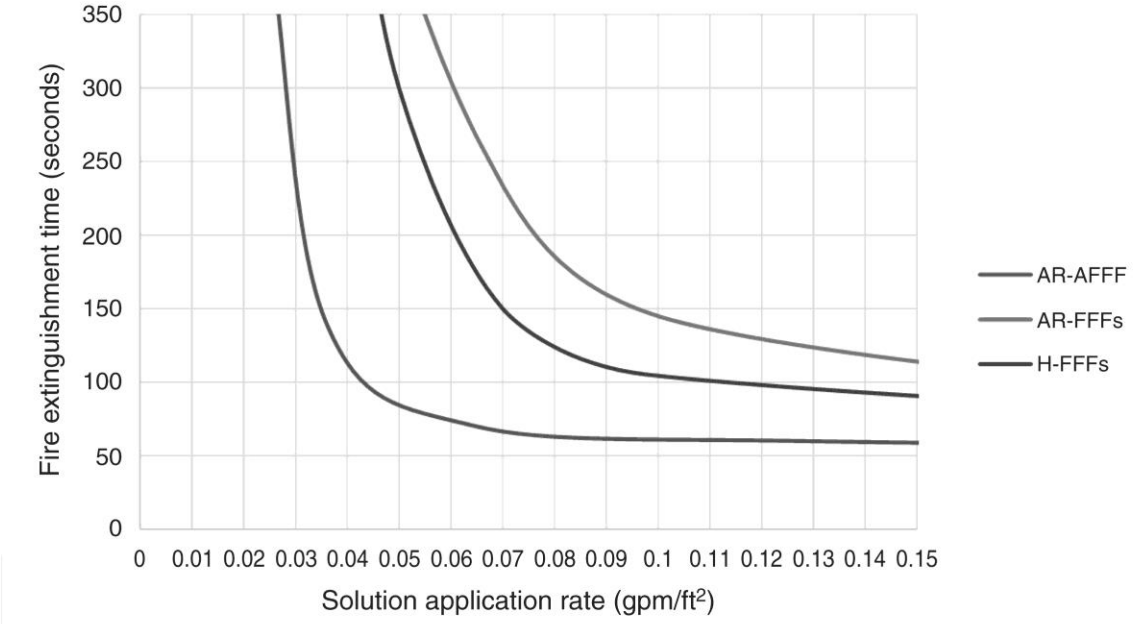
Figure H.2.2(f) L Curves Illustrating Extinguishment Capabilities (Agent-Type Comparison).

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(3 to 4 expansion)



(7 to 8 expansion)



For SI conversions: 1 gpm/ft^2 = 40 L/min/m^2.

When comparing the capabilities of the FFFs to the baseline AFFF at the same foam quality and aspiration, the FFFs typically required between 1.5 to 3 times the application rates to produce comparable performance for the fuels included in this assessment [heptane, gasoline (E10 and MILSPEC) and IPA]. When comparing the

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capabilities of the AR-FFFs to the H-FFFs, the H-FFFs were similar to the AR-FFFs at a 40-percent reduced flow rate for the lower expanded foam and a 30-percent reduced rate for the higher expanded foam. Consequently, the use of higher aspirated foam reduced the differences in capabilities between the two FFF types (i.e., alcohol-resistant and hydrocarbon FFFs). These capabilities are plotted in Figure H.2.2(f) as a function of foam type.

With respect to elevated fuel temperatures, the results were consistent over the range in ambient and fuel temperatures included in this assessment. With that said, it is understood that fires involving boiling flammable liquids are much harder to extinguish than fires that are combatted prior to the transition into boiling. The type of water (i.e., freshwater versus saltwater) was also shown to have a minimal effect on the firefighting capabilities of the FFFs and varied between foams.

H.2.3 Key Points and Conclusions.

In summary, the results demonstrated that, while FFFs have come a long way, there is more to learn about their capabilities and limitations. As of today, FFFs are not a drop-in replacement for AFFFs. However, some can be made to perform effectively as an AFFF alternative with proper testing and design (i.e., with higher application rates and densities).

The baseline C6 AR-AFFF performed well against all test fuels included in this assessment — IPA, heptane, and gasoline (MILSPEC and E10). The FFFs did well against heptane but struggled against some of the scenarios conducted with IPA and gasoline (both MILSPEC and E10), especially when the foam was discharged with a lower foam quality and aspiration. The FFFs typically required between 1.5 to 3 times the application rates to produce comparable performance as the baseline AR-AFFF for the range of parameters included in this assessment. The extinguishment densities for the FFFs were typically 2 to 4 times greater than the baseline AR-AFFF for the IPA fires conducted with the Type II test configuration, 3 to 4 times greater than the baseline AR-AFFF for the tests conducted with MILSPEC gasoline, and between 6 to 7 times greater than the baseline AR-AFFF for the tests conducted with E10 gasoline.

With respect to the types of FFFs (i.e., alcohol-resistant versus hydrocarbon), the H-FFFs typically demonstrated better capabilities than the AR-FFFs. In general, for the tests conducted with the lower aspiration, the extinguishment densities for the AR-FFFs were about twice that of the H-FFFs. This difference was reduced with the use of the higher aspirated foams. For the tests conducted with the higher aspirated foams, the extinguishment densities for the AR-FFFs were, on average, about 1.5 times that of the H-FFFs. However, the AR-FFFs required a higher flow and application rate of 1.5 times that of the H-FFFs against the E10 fires to achieve those results.

The results also showed that the legacy fuel — heptane — used to list and approve foams might not be a good surrogate for all hydrocarbon-based fuels. Some foams struggled against other fuels, like gasoline, compared to heptane. Going forward, it was recommended that FFFs be tested and listed for a variety of hydrocarbon fuels, the approach currently used for polar solvent listings and approvals.

Due to its oleophobic properties, AFFF has two separate mechanisms that combine to aid in the extinguishment of a flammable liquid fire: a water and surfactant film that forms on the fuel surface and a foam blanket of bubbles, both of which serve to seal in the flammable vapors resulting in extinguishment (i.e., shutting off the fuel vapors that are burning above the fuel surface). FFFs have only the foam blanket to

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seal in the vapors. As a result, the capabilities of FFFs will be highly dependent on the characteristics of the foam blanket, which depend on the associated discharge devices as well as the foam type itself. The film produced by AFFF has provided an additional level of protection for systems and discharge devices that do not produce aspirated foam. Additional attention will need to be given to the discharge devices identified as part of the UL listing when using these foams.

Ultimately, end users will need to design and install within the listed parameters to ensure a high probability of success during an actual event. This applies not only to the discharge devices but also to the proportioning systems, due to the highly viscous nature of some of the FFF concentrates.

H.3 Testing Conducted by LASTFIRE.

H.3.1 General.

Increasing environmental concerns related to fluorosurfactant-containing foams (PFAs) and the potential for regulatory controls have prompted a number of organizations to carry out extensive testing of new generation fluorine-free foams. In particular, the FPRF and LASTFIRE (the international Joint Industry Project developing best practice guidance for storage tank fire hazard management) conducted extensive complementary, independently managed testing. Key conclusions from LASTFIRE are summarized in this section but full reports are available from the respective organizations.

Because there are ongoing developments in this field, it is worthwhile to check for any updates in knowledge that might be relevant and assist in optimizing effectiveness prior to finalizing any foam application system design.

It should be noted that, while emphasis was placed on fluorine-free foams, testing was also carried out on new generation post-EPA stewardship program C6-based fluorosurfactant-containing foams. Such foams were developed to reduce the use of C8-based materials and minimize contamination levels of C8 fluorosurfactants in C6-based formulations. While such foams are film forming and generally work on the same principles as older formulations, they have not been subjected to the same levels of large-scale testing or actual incident application.

H.3.2 Report Summary.

LASTFIRE carried out a range of testing, normally totally funded by the organization, but also as independent witnesses of work carried out by others, including foam and equipment suppliers. The objective was to provide a firm basis for future cost-effective, long-term, sustainable policies regarding the selection and use of firefighting foam based on rational, relevant, and independent end-user-driven test programs.

Following are the series of tests conducted, including logical progression from small-scale in accordance with recognized test standards through to large-scale, real-life scenarios using this standard’s design guidelines for test protocol development. Full reports for most of the tests are available from LASTFIRE.

(1) A series of small-scale tests of five different FFFs and both C6 and C8 (as a proven reference) fluorosurfactant-containing foams. This included testing to EN1568 (European norm) and LASTFIRE (a specific protocol designed by LASTFIRE to simulate storage tank fires) test protocols. Such tests were carried out at approximately 50 percent of the

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application rate used in practice based on recognized standards such as this standard.

(2) Small-scale [50 ft^2 (5 m^2) and 200 ft^2 (20 m^2)] spill fires using the same foam concentrates with a number of application techniques, including plunging (Type 3) semi-aspirating "monitor," aspirating "monitor," medium expansion and compressed air foam nozzles, and system pourer nozzles (Type 2). These tests included obstructions in the pan to simulate pipework, and so forth, that might disrupt foam movement and cause additional hot surfaces to seal against.

(3) Proportioning tests for the same foam concentrates using both venturi-based standard in-line proportioners and positive displacement pumped proportioning systems.

(4) Large-scale tank [1080 ft^2 (100 m^2) surface area, 36 ft (11 m) diameter, 30 ft (9m) high] application using the same foams but at this standard's system design rates using aspirating monitors, nonaspirating monitors, system pourer, and CAF monitor application. Note: The CAF application rate was approximately 75 percent of the conventional foam application rate. These tests were intended to validate the smaller scale testing and demonstrate the effectiveness of new generation foams when used at typical application rates using proprietary equipment. FFFs successfully extinguished fires in these tests. *[See Figure H.3.2(a).]*

(5) Long-flow [100 ft (30 m) and 130 ft (40 m)] application on Jet A fuel using conventional pourer and CAF pourer applications at typical design application rates. Only one FFF was taken through to this test. The application rate for CAF pourer was 0.7 gpm/ft^2 (2 L/min/m^2), for conventional pourer 1.4 gpm/ft^2 (4 L/min/m^2). These tests successfully extinguished fires. *[See Figure H.3.2(b).]* Some of the results are as follows:

(a) Conventional foam pourer application at 1.4 gpm/ft^2 (4 L/min/m^2), extinguishment at 100 ft (30 m) flow – 2'32"

(b) CAF based foam pourer application at 0.7 gpm/ft^2 (2 L/min/m^2), extinguishment at 100 ft (30 m) flow – 2'23"

(6) Subsurface application of one FFF on Jet A fuel using a test procedure based on UL 162. Successful extinguishment was accomplished with both conventional and CAF-based applications. *[See Figure H.3.2(c).]*

(7) Vapor suppression tests with both FFF and C6 fluorosurfactant-containing foams in fire and nonfire situations, using an array of vapor detectors over the LASTFIRE test.

(8) Hybrid monitor application using low expansion FFF to carry medium expansion foam further (claiming to lead to less forceful plunging into the fuel) than one FFF on 5650 ft^2 (525 m^2) diesel fire at typical application rates used in practice.

(9) Bund length 65 ft (20 m) flow testing of one FFF in system pourer application using approximately 75 percent of typical application rates

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— with extensive obstructions in the path of foam. Fire was successfully extinguished.

(10) Testing of one additional FFF in a 36 ft diameter (11 m diameter), 6.6 ft (2 m) high tank at approximately 75 percent of normal design application rates. Fire was successfully extinguished.

(11) Small-scale testing of a self-expanding foam (SEF) application system using FFF and the LASTFIRE test protocol adapted for SEF application. (SEF uses a premix foam solution held under CO_2 pressure. On actuation, the CO_2 comes out of solution and forms foam bubbles.)

Figure H.3.2(a) From LASTFIRE: FFF — 36 ft (11 m) Tank Fire Testing.

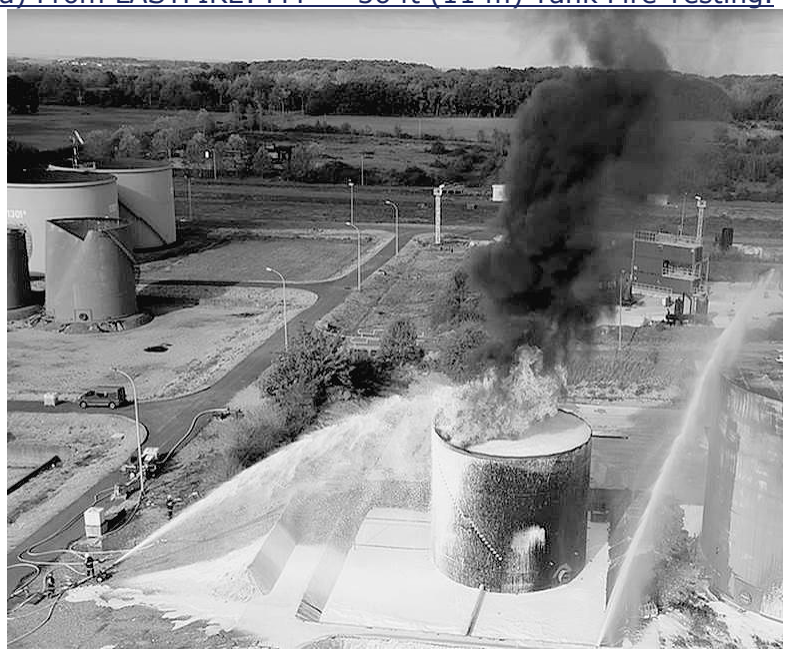


Figure H.3.2(b) A 98 ft (30 m) Flow Test Approaching Full Extinguishment.



Figure H.3.2(c) Extinguishing Sequence, FFF, Subsurface Injection.

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Throughout the tests a variety of fuels were used, including heptane, gasoline, diesel, crude, Jet A-1, and ethanol. In addition, some tests included both saltwater and freshwater applications. At times compatibility with dry chemical was also assessed.

H.3.3 Key Points and Conclusions.

LASTFIRE concluded that some FFFs are suitable for some applications, including hydrocarbon spill fires and smaller storage tanks subject to validated testing of the specific foam and application device. The LASTFIRE Group is confident that other applications can be proven with additional test work.

Further phases of testing are planned, including small-scale testing to optimize foam properties through equipment design, thereby maximizing extinguishing performance. In addition, further large-scale testing [165 ft (50 m) flow length] trials are to be carried out with a range of FFFs using both monitor and pourer applications.

These extensive testing programs have resulted in the following critical findings relevant to application of new generation foams. Although the focus is on FFFs, some apply to both "post-EPA stewardship" C6-based formulations.

(1) With the current stage of development of FFFs and the wide range of products being developed, it is not possible to be generic in terms of the performance of this type of foam concentrate on any specific fuel. Thus, it is important to base any system design on recognized and scenario-relevant approval tests, including the appropriate fuel, ideally also validated by larger scale testing.

(2) Foam performance is dependent on application equipment as well as foam concentrate and application rate. This is true with all foam types but appears to be particularly the case with FFF types. Undoubtedly, they all work more effectively with aspirating equipment, although LASTFIRE testing showed that some can work also with typical nonaspirating equipment.

(3) Physical properties as well as firefighting performance are critical to ensuring appropriate performance. Some FFFs, particularly those having high viscosity, might require modifications to the proportioning system to ensure a pick-up rate within acceptable tolerances. No foam of any type should be regarded as a drop-in replacement without fully evaluating extinguishing performance and system and equipment suitability and compatibility.

(4) Compressed air foam can provide effective extinguishing performance with FFF at lower application rates than conventionally generated foam

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— again, subject to validation through testing for a specific set of circumstances.

(5) It is recognized that further work should be carried out on other fuel types, especially water soluble polar solvent fuels, including alcohols such as IPA. Note: The ETANKFIRE Project of the SP Technical Research Institute of Sweden carried out some small-scale testing of FFFs on ethanol, but larger scale work is required to develop and validate application design rules.

(6) It is important that a validated test method specifically relevant to the application is used to determine system design characteristics wherever possible. Ideally a performance-based method should be used so that the end user can adjust parameters such as application rate, run time, or proportioning rate to suit the performance of the foam if necessary.

(7) It is recognized that a major gap in knowledge still exists in the application of any new generation foam, but particularly FFF types to large diameter tank fires using large throughput monitors, especially nonaspirating types. While the comparative tests on smaller tank fires [36 ft (11 m) diameter] have shown effective performance can be achieved with some foam and equipment combinations, this has not been validated in larger scale testing.

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Second Revision No. 47-NFPA 11-2020 [Global Comment]

Add new Annex I and renumber remaining annexes.

Supplemental Information

File Name	Description	Approved
Annex_I.docx	For staff use	
11_Global_SR-47_Annex_I_new.pdf	For ballot	

Submitter Information Verification

Committee:

Submittal Date: Wed Mar 18 10:15:32 EDT 2020

Committee Statement

Committee Statement: The following protocol has been developed as a methodology to demonstrate that a non-metallic floating roof structure has sufficient fire resistance to withstand the effects of a foreseeable rimseal and/or spill on roof fire to such an extent to maintain its integrity for sufficient time to allow extinguishment of a rimseal fire. It was developed by an industry group developing best practice guidance for storage tank fire hazard management.

Response Message: SR-47-NFPA 11-2020

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Annex I Rim Seal Fire Test Protocol

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only. Information in this annex is intended to be adopted by the jurisdiction at the discretion of the adopting jurisdiction. Additionally, information in this annex is intended to be incorporated on a voluntary basis by building owners and developers who might have a desire to include supplemental evacuation equipment in their projects.

Although this annex is written in mandatory language, it is not intended to be enforced or applied unless specifically adopted by the jurisdiction or, if it is being applied on a voluntary basis, by the building owner or developer.

The following protocol was developed as a methodology to demonstrate that a nonmetallic floating roof structure has sufficient fire resistance to withstand the effects of a foreseeable rim seal and/or spill on roof fire to such an extent to maintain its integrity for sufficient time to allow extinguishment of a rim seal fire. It was developed by an industry group developing best practice guidance for storage tank fire hazard management.

The test protocols in this annex were developed using SI units. Inch-pound conversion units provided were not part of the original testing protocols.

I.1 Test Rigs.

I.1.1

The following two tests shall be carried out:

(1) Roof test

(2) Roof, seal assembly, and foam dam test

I.1.2 Roof Test.

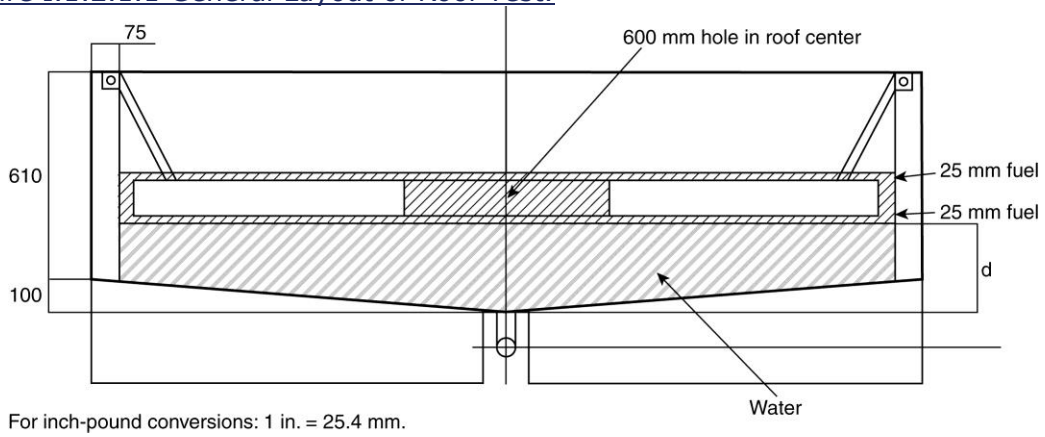
I.1.2.1

The roof test shall be conducted in accordance with I.1.2.1.1 through I.1.2.1.4.

I.1.2.1.1

The roof test shall be carried out in an 8 ft (2.44 m) diameter test pan, as illustrated in Figure I.1.2.1.1.

Figure I.1.2.1.1 General Layout of Roof Test.



For inch-pound conversions: 1 in. = 25.4 mm.

I.1.2.1.2

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The roof in this test shall be subjected to a spill on roof fire, covering the full surface but limited in duration by the fuel burn and regression rate, followed by a fire in the center of the roof within a hole 600 mm (24 in.) in diameter.

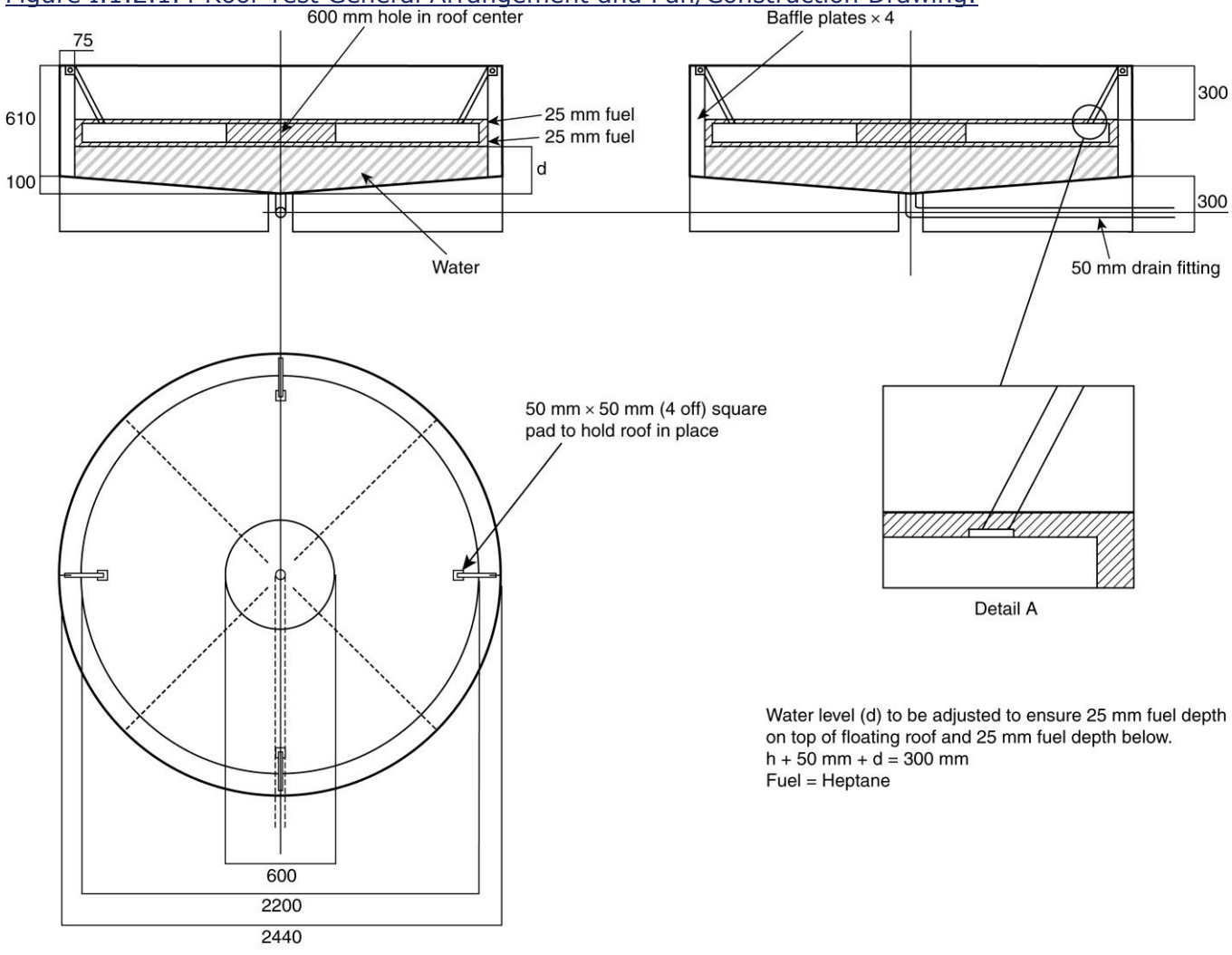
I.1.2.1.3

The rim area around the roof shall also be subject to burning.

I.1.2.1.4

The general arrangement shall be as shown in Figure I.1.2.1.1 and the construction drawing in Figure I.1.2.1.4.

Figure I.1.2.1.4 Roof Test General Arrangement and Pan/Construction Drawing.



For inch-pound conversions: 1 in. = 25.4 mm.

I.1.2.2

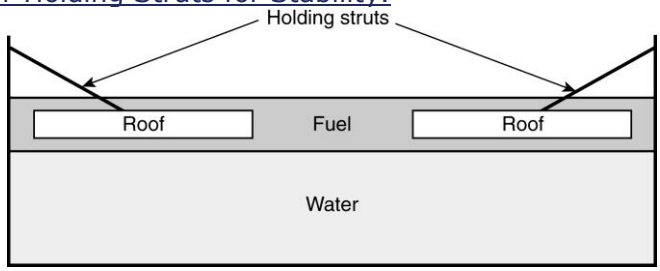
The roof sample shall be provided with an edge rim 150 mm (5.9 in.) in height if a rim is provided in actual installations.

I.1.2.3

Roof-holding struts shall be provided to stabilize the glass reinforced epoxy (GRE) roof (which has inherent buoyancy) and maintain a 25 mm (1 in.) fuel layer on top of the roof, as illustrated in Figure I.1.2.3.

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Figure I.1.2.3 Roof-Holding Struts for Stability.



I.1.2.4

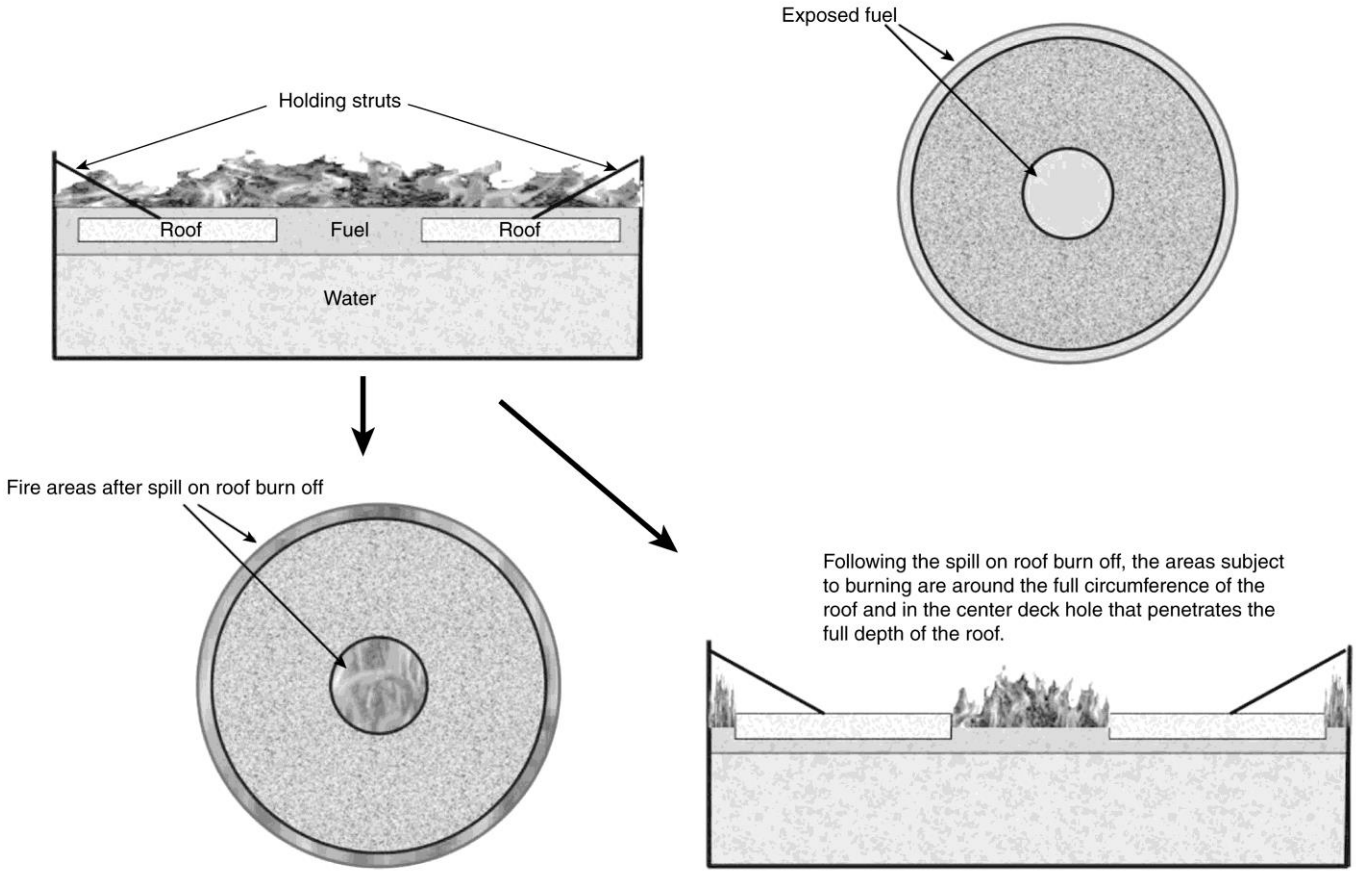
Exposed fuel areas, and therefore, areas subject to burning *(see Figure I.1.2.4)*, shall be as follows:

(1) Over the entire roof for the duration of the full-surface burn, simulating a spill on roof and relatively short-lived fire

(2) In the center of the roof in the area bounded by the 600 mm (24 in.) diameter hole cut through the roof sample from the top deck to the underside

(3) Around the full circumference of the roof

Figure I.1.2.4 Fire Areas During Roof Test.



I.1.3 Roof, Seal, and Foam Dam Assembly Test (Rim Seal Fire Test).

I.1.3.1

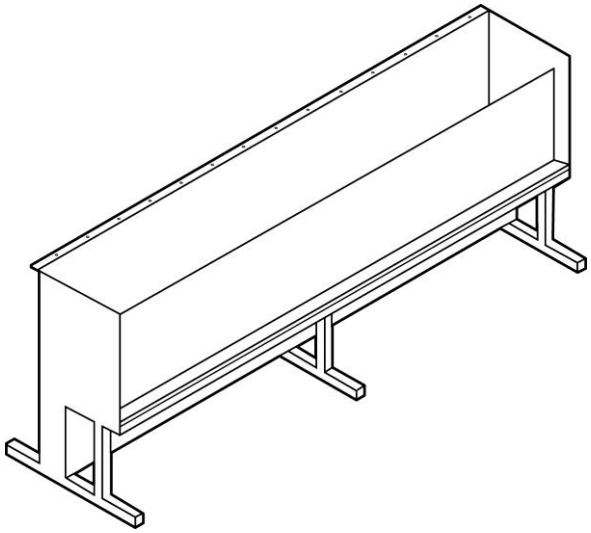
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The roof, seal, and foam dam assembly test shall be conducted in accordance with I.1.3.1.1 through I.1.3.1.4.

I.1.3.1.1

The test shall be carried out on a rig with the general arrangement depicted in Figure I.1.3.1.1.

Figure I.1.3.1.1 General Arrangement of Test Rig for Roof Assembly — a Typical Sample.



I.1.3.1.2

The rig shall be designed to accommodate a rectangular roof slab, with corresponding rim seal and foam dam.

I.1.3.1.3

Fixing points shall be provided on the rig for the rim seal and the dam.

I.1.3.1.4

The roof, seal, and foam dam shall be exposed to a rim seal fire occurring in the rim gap between the rear of the rig (tank wall) and the roof.

I.1.3.2 The Rig.

I.1.3.2.1

The rig shall be designed to accommodate a roof slab with a nominal length of 3 m (9.8 ft), width of 400 mm (15.75 in.), and thickness of 68 mm (2.68 in.).

I.1.3.2.2

The roof slab, rim seal, and foam dam together shall be termed the *roof assembly [see Figure I.1.3.2.2(a) through Figure I.1.3.2.2(h)].*

Figure I.1.3.2.2(a) Rim Seal Test Rig Construction Drawing (1).

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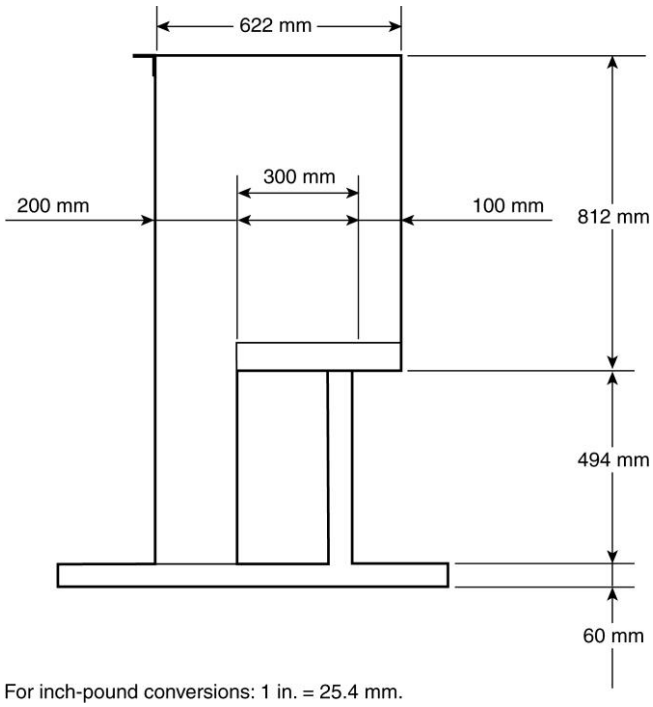


Figure I.1.3.2.2(b) Rim Seal Test Rig Construction Drawing (2).

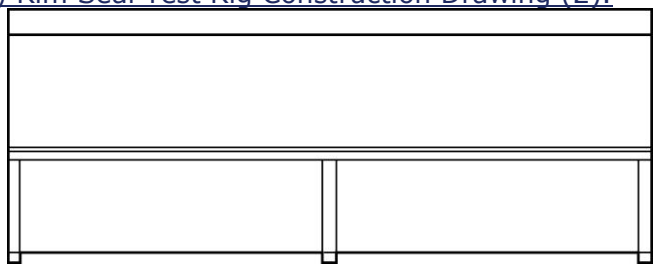


Figure I.1.3.2.2(c) Rim Seal Test Rig Construction Drawing (3).

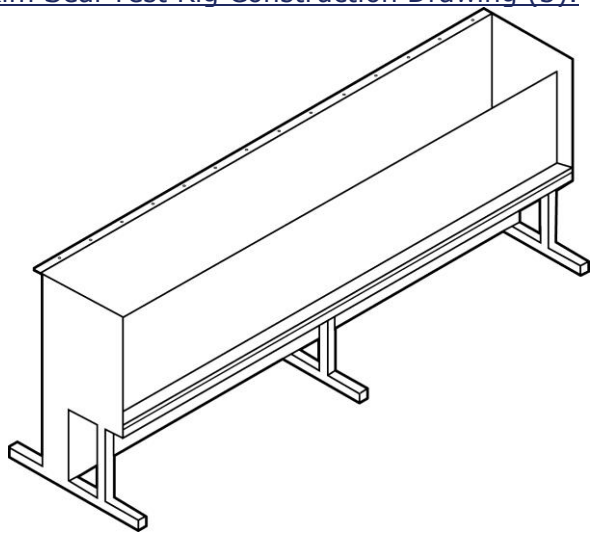


Figure I.1.3.2.2(d) Rim Seal Test Rig Construction Drawing (4).

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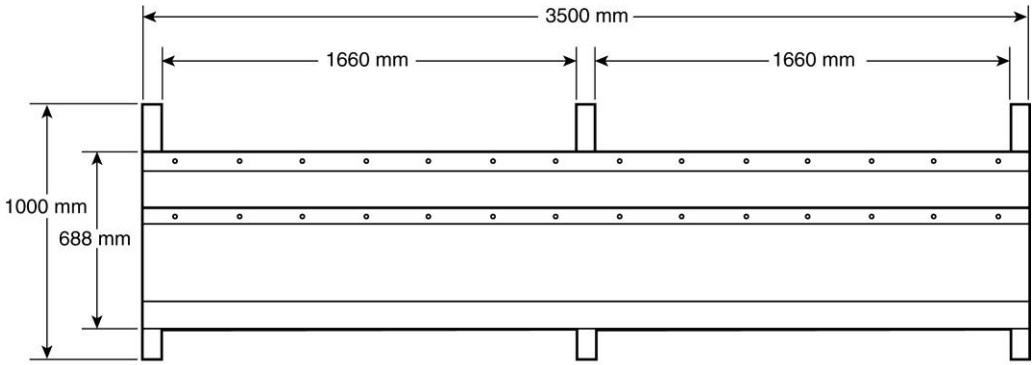


Figure I.1.3.2.2(e) Typical Roof Assembly Sample Dimensions for Rim Seal Test (1).

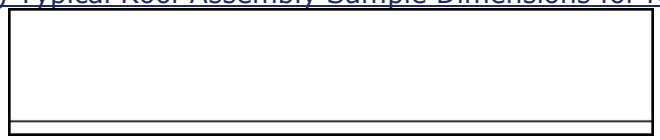


Figure I.1.3.2.2(f) Typical Roof Assembly Sample Dimensions for Rim Seal Test (2).

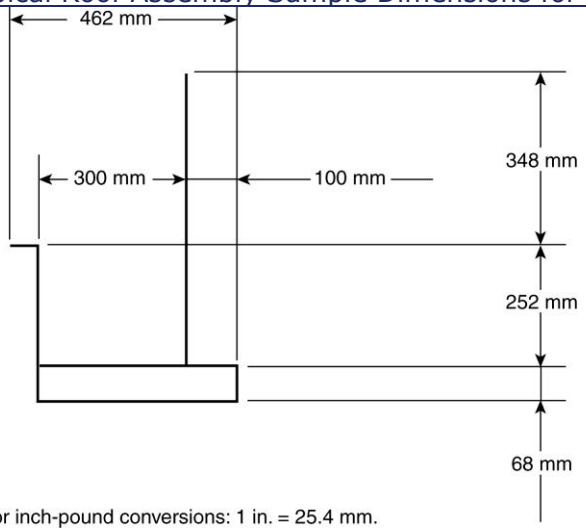


Figure I.1.3.2.2(g) Typical Roof Assembly Sample Dimensions for Rim Seal Test (3).

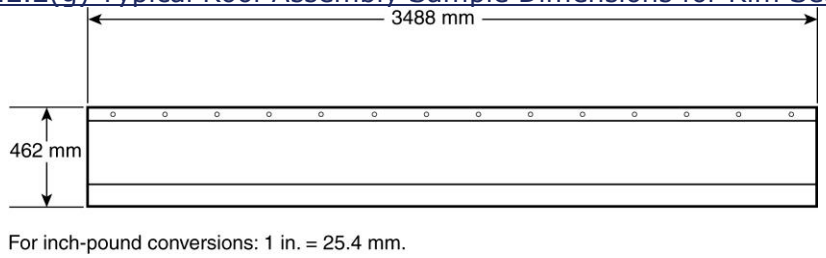
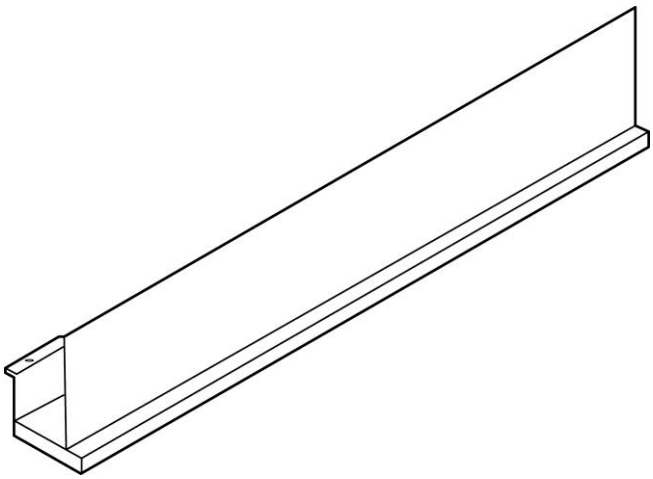


Figure I.1.3.2.2(h) Typical Roof Assembly Sample Dimensions for Rim Seal Test (4).

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I.1.3.3 Foam Dam.

The foam dam shall be a height of 600 mm (23.6 in., approx. 2 ft) assembled to the roof slab at a distance of 100 mm (approx. 3.94 in.) from the leading edge of the roof, that is, the part of the roof that would normally be furthest from the tank shell.

I.1.3.4 Rim Seal.
I.1.3.4.1

The rim seal assembly, either as a primary seal or a secondary seal, shall be as provided by the manufacturer or supplier.

I.1.3.4.1.1

It shall be assembled to the roof slab sample and test rig such that the seal covers the rim gap fully without distortion and with uniform pressure as far as is practicable.

I.1.3.4.1.2

The test rig rim gap shall be, ideally, 200 mm (approx. 7.9 in.), but no less than 150 mm (5.9 in.).

I.1.3.4.2

The rig shall have suitable fixing points for a range of seal types.

I.1.3.4.3

Nominally, there shall be fixing points every 260 mm (approx. 10 in.), as indicated in Figure I.1.3.2.2(d).

I.1.3.4.4

Seals shall be supplied with or without wax scrapers and other appurtenances according to the design.

I.2 Test Procedures.
I.2.1 Roof Test.
I.2.1.1

The roof shall be subjected to a limited duration spill on roof fire, covering the full surface.

I.2.1.2

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Once this fire has diminished, the roof shall be subjected to a fire in the center deck 600 mm (24 in.) diameter hole and a rim seal fire.

I.2.1.3

The test sequence shall be as outlined in Table I.2.1.3.

Table I.2.1.3 Roof Test Sequence

Sequence	Activity	Comments/Observations
1	Ensure the test tank is clean and in good order for the test.	
2	Fill the pan with water to approximately 150 mm (water to act as substrate for fuel).	
3	Place the roof module in the test pan, ensuring the roof is positioned correctly and is central within the pan.	
4	Add fuel (heptane) to the test pan. (NOTE: 2 × 200 L/2 × 55 USG drums should be sufficient.) The fuel should be added until the roof floats on 25 mm of fuel.	Test pan area = 4.67 m^2 600 mm dia. penetration area = 0.283 m^2 Fuel depths/amounts = (2 × 0.025 m) × 4.67 m^2 = 0.234 m^3 0.068 m (penetration) × 0.283 m^2 = 0.0192 m^3 Rim areas = (0.15 m × 0.118) × 2 = 0.0354 m^3 Total fuel quantity = 0.289 m^3 or 289 L
5	Position the holding struts on the roof.	
6	Add the remaining 25 mm of fuel.	There should be 25 mm of heptane on top of the roof deck, and fuel should be exposed around the entire rim circumference. Fuel should also be present in the penetration at the center deck position, throughout the full depth.
7	Ignite the fuel 120 sec ± 5 sec after fuel delivery.	Start test documentation/video and measurements. Video Thermal imaging Spot thermocouples on roof/shell (if used) Radiometers (if used) NOTE: If radiometers are used, the reduction in radiant heat from the fire and hence fire intensity can

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Sequence	Activity	Comments/Observations
		be gauged from comparison with baseline results during the spill on roof fire portion of the test.
8	Allow spill on roof fire to burn completely.	Record time at which fuel on top of the roof is consumed by fire.
9	Continue fire test — allow fuel in center penetration and at rim to burn freely.	Record time of transition to center penetration burning and observe behavior.
10	Allow the fire to burn for a minimum of 120 minutes or until cessation of fire test (whichever is reached first).	Cessation of the fire test can be brought about if, in the opinion of the test directors, the roof has failed to survive prolonged burning and it would not be in the general interest to prolong the test. (However, useful observations can be made regarding the fire behavior and survivability of the roof even if fire performance is reduced.) The final decision to cease testing rests with the test directors.
11	Discharge foam onto the roof using a small-scale semi-aspirating foam nozzle* for a period of at least 5 minutes.	The purpose of this is to assess the roof's ongoing stability during fire conditions when a dynamic load (semi-aspirated foam solution with typical expansion ratio of 4:1) is applied to the deck. The foam solution should be applied at a rate of at least 3.5 L/min/m^2 for a minimum of 5 minutes. It is recognized that normally foam would be applied in this way to a full surface fire and not necessarily a rim seal fire, but the purpose is to assess roof stability only. The test directors should determine a suitable protocol step for assessing this along with suitable criteria for stability.

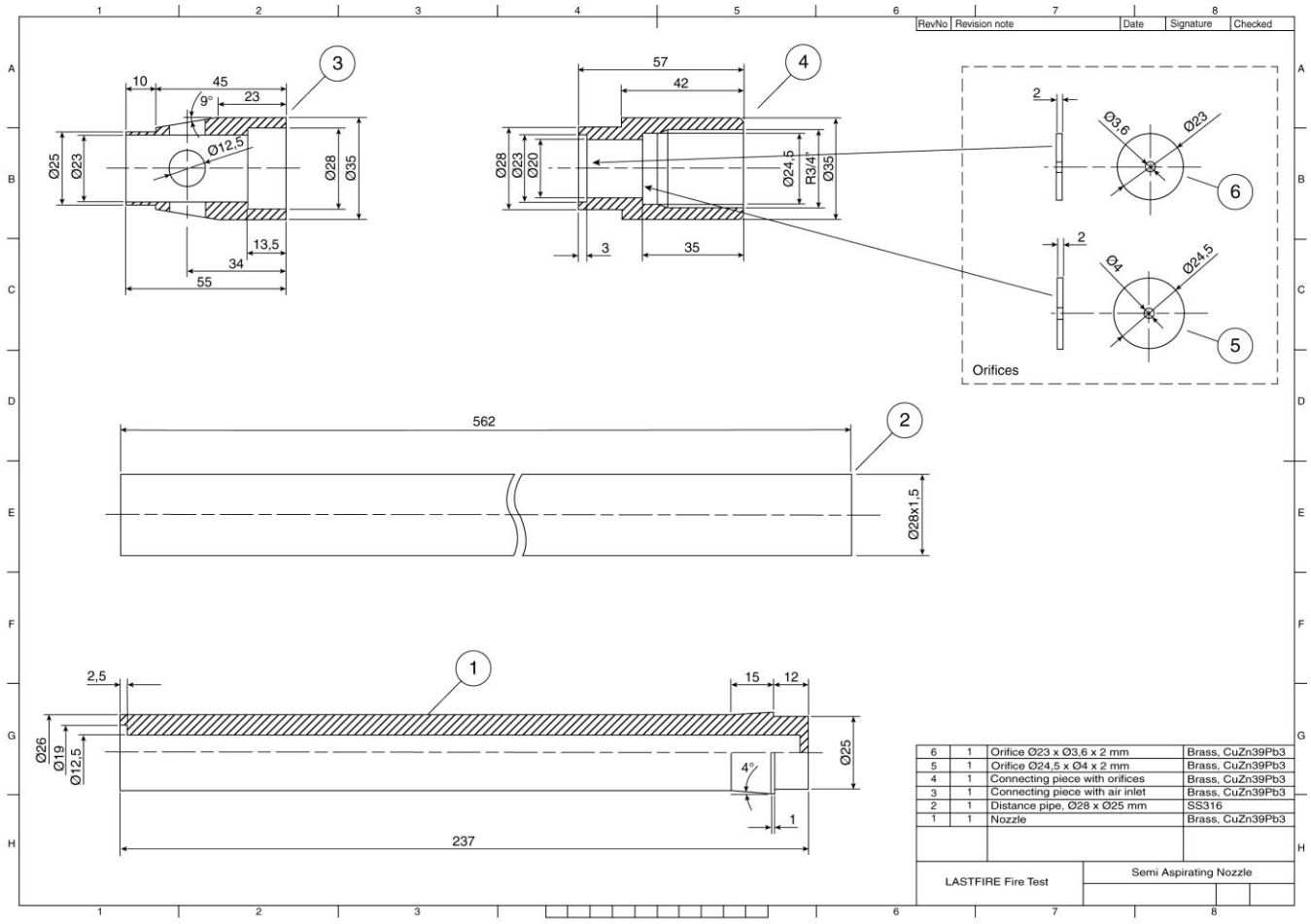
For inch-pound conversions: 1 m = 3.28 ft, 1 L = 0.26 gal, 1 L/min/m^2 = 0.025 gpm/ft^2.

*Other available nozzles include an aspirating nozzle (typically 3.5 L/min/m2 foam solution application rate) and a system nozzle (2.5 L/min/m^2). These rates are just over one-half this standard's recommended rates. The test directors should establish a suitable rate and nozzle combination for application to ensure that the roof stability test is a credible one.

See Figure I.2.1.3(a) for a drawing of a typical semi-aspirating nozzle set-up and Figure 1.2.1.3(b) for schematic of foam delivery system.

Figure I.2.1.3(a) Semi-aspirating Foam Nozzle for Foam Application/Roof Load Test.

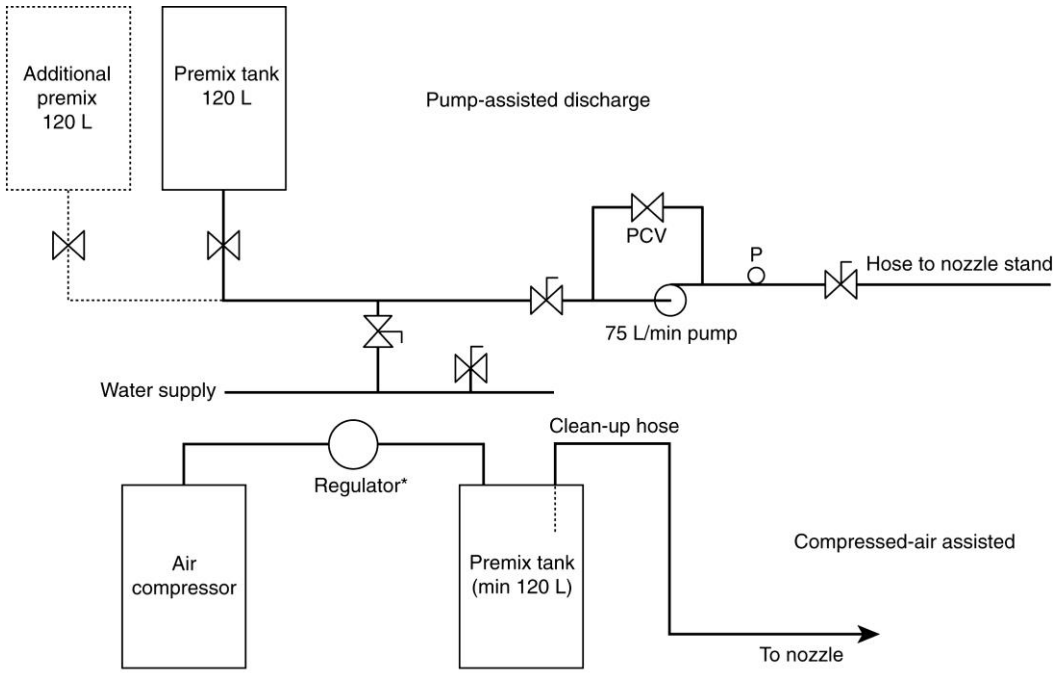
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For inch-pound conversions: 1 in. = 25.4 mm.

Figure I.2.1.3(b) Foam Delivery Schematic.

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*e.g., Nullmatic pressure regulator 3-200 psig range. Approximately 110 psig for aspirating (4 USG) nozzle/85 psig for system nozzle.

I.2.2 Rim Seal Assembly Fire Test.

I.2.2.1

A sample representative of the entire roof assembly shall be subjected to a prolonged duration rim seal fire of not less than 60 minutes to ascertain the resilience/fire resistance of the assembly.

I.2.2.2

The test sequence shall be as outlined in Table I.2.2.2.

Table I.2.2.2 Rim Seal Assembly Fire Test Sequence

Sequence	Activity	Comments/Observations
1	Ensure the test rig is clean and in good order for the test.	
2	Place the roof assembly in the test rig.	Roof assembly comprises the following: Roof deck: 3 m (9.8 ft) (L) 400 mm (15.75 in.) (W) 68 mm (2.68 in.) (D) Seal: Affixed to roof slab and designed to cover (ideally) the 200 mm rim gap but should be no less than 150 mm.

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Sequence	Activity	Comments/Observations
		Foam dam: 600 mm (2 ft) (H) 100 mm (4 in.) from roof edge NOTE: A 25 mm gap is provided on each side of the roof to allow for a ventilation-controlled rim seal fire.
3	Float 30 L of water into the fuel well/rig leg (seal area) to act as substrate.	To provide a depth of 150 mm of water.
4	Place 75 L of fuel into the fuel well/rig leg (seal area).	Depth of fuel should be in the order of 360 mm (approximately 14 in.) NOTE: This fuel amount is anticipated to be enough for at least a 60-minute burn. Fuel quantity/burn time can be adjusted at the discretion of the test directors during this development series.
5	Adjust water level to ensure fuel reaches topside of rim/underside of roof sample on the test rig.	The fuel level should reach the roof slab bounded by the 20 mm rim at the underside of the sample.
6	Ignite the fuel 120 sec ± 5 sec after fuel delivery.	Start test documentation/video and measurements. Video Thermal imaging Spot thermocouples on roof/shell (if used) Radiometers (if used) NOTE: If radiometers are used, the reduction in radiant heat from the fire and hence fire intensity can be gauged from comparison with baseline results during the spill on roof fire portion of the test.
7	Allow the rim seal fire to burn freely.	Monitor the fire burning characteristics.
8	Continue fire test — allow fuel in fuel well/rim seal area to burn freely.	Observe behavior of the roof, rim, and foam dam assembly under rim seal fire conditions and record state at 5, 10, 20, 30, 45, and 60 minutes.
9	Allow fire to burn until all the fuel is burned off.	Cessation of the fire test can be brought about if, in the opinion of the test directors, the assembly has failed to survive prolonged burning and it would not be in the general interest to prolong the test. (However, useful observations can be made regarding the fire behavior and survivability of the assembly even if fire

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Sequence	Activity	Comments/Observations
		performance is reduced.) The final decision to cease testing rests with the test directors.

For inch-pound conversions: 1 in. = 25.4 mm; 1 L = 0.26 gal.

I.3 Measurements/Observations.

I.3.1

The following tests and measurements shall be recorded:

(1) Complete dimensions of roof and roof assembly samples

(2) Complete description of roof construction and roof assembly construction, including seal type and whether primary, secondary, or both

(3) A video and photographic record

(4) Water layer depths and temperatures

(5) Fuel layer depths and temperatures

(6) Ambient temperature

(7) Wind speed

(8) Other weather data such as humidity and wind direction

(9) Foam solution application rate for foam application during roof test

(10) Foam quality — expansion and 25 percent drainage time

(11) Foam layer depth

(12) Foam type used and degree of aspiration

I.3.2

Recording the following measurements shall be optional:

(1) Spot temperatures of the following suggested roof samples or roof assembly using thermocouples:

(a) Roof deck

(b) Roof slab

(c) Seal

(d) Foam dam

(e) Tank shell

(2) Radiant heat measurement using radiometers

(3) Thermal observations using a thermal imaging camera

I.4 Performance Criteria.

I.4.1

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This section shall establish suitable performance criteria for the roofs or roof assemblies under test.

I.4.2

The test shall be terminated when the fire stops.

I.4.3 Roof Test.
I.4.3.1

The roof test determines the fire resistance of only the roof, not the roof and seal assembly.

I.4.3.2

Pass criteria shall be as follows:

(1) There is no damage to the roof sample and roof integrity is maintained when the fuel is completely burned off.

(2) Roof sample remains buoyant and in full contact with the liquid surface once the fuel is completely burned off.

(3) Where the roof sample is joined or covered by metal plates, no distortion is observed that could trap flammable vapors.

(4) No sustained flaming or glowing over the roof sample is observed once the fuel is completely burned off.

(5) No adhesion between the steel pad on the strut holding the roof in position and the roof is found.

(6) Central hole does not to exceed 625 mm (25 in.) diameter at the top surface of the roof once the fuel is completely burned off.

(7) Foam travels smoothly around the circumference and on the top of the roof and the minimum depth of the foam blanket is 150 mm (6 in.). Roof sample remains buoyant after foam is applied.

I.4.4 The Assembly Test.
I.4.4.1

The assembly test shall determine the integrity of the assembly sample.

I.4.4.2

Pass criteria shall be as follows:

(1) No damage to the primary seal that allow vapors to escape freely is observed.

(2) No damage to the roof part of the assembly is observed.

(3) Foam dam maintains its integrity.

(4) No sustained flaming or glowing over the assembly sample is observed once the fuel is completely burned off.

I.5 Test Report.
I.5.1

The test report shall contain the following information:

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(1) Number and/or title of test

(2) Name of the manufacturer and the test sample's place and year of manufacture

(3) A copy of the technical documentation of the test sample

(4) Name of the test place and the date of the test

(5) A unique test report number

(6) Weather conditions measurement made during the test

(7) A description of the damage or deformation arising in the test sample after the test is conducted in accordance with the performance criteria and whether the integrity of the sample was maintained

(8) Any pertinent observations made before, during, or after the test

(9) Photographs taken before, during, and after the test

I.5.2

The test report shall contain a statement that the results obtained relate only to the sample tested.

I.5.3

The test report shall not be considered a certificate of conformity.

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Second Revision No. 49-NFPA 11-2020 [Global Comment]

See word document for new chapter 13

Supplemental Information

File Name	Description	Approved
Chapter_13_Inspection_drh.1580947456796.docx	For staff use	
11_Global_SR-49_Chapter_13_For_ballot.pdf		

Submitter Information Verification

Committee:

Submittal Date: Wed Mar 25 13:33:09 EDT 2020

Committee Statement

Committee Statement: Changes made to correlate with NFPA 25 per the ITM Task Group see CI 56.

Section 13.2.2.2.1 Clarifies that all open discharge outlets be included. Water flow is the preferred method but alternate methods are still allowed.

Response Message: SR-49-NFPA 11-2020

Public Comment No. 17-NFPA 11-2019 [Sections 13.2.2.1, 13.2.2.2]

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Chapter 13 Inspection, Testing, and Maintenance

13.1 General.

13.1.1 Minimum Requirements.

13.1.1.1*

This chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of low-, medium-, and high-expansion foam, as well as foam-water sprinkler systems.

A.13.1.1.1

An inspection contract for the equipment service tests and operation at regular intervals is recommended.

13.1.1.2

Table 13.1.1.2 shall be used to determine the minimum required frequencies for inspection, testing, and maintenance. [**25:**11.1.1.2]

Table 13.1.1.2 Summary of Foam-Water Sprinkler System Inspection, Testing, and Maintenance

System/Component	Frequency	Reference [NFPA 25]
Inspection		
Control valve(s)		Chapter 13
Deluge/preaction valve(s)		Chapter 13
Discharge device location (spray nozzle)	Monthly	11.2.4
Discharge device location (sprinkler)	Annually	11.2.4
Discharge device position (spray nozzle)	Monthly	11.2.4
Discharge device position (sprinkler)	Annually	11.2.4
Drainage in system area	Quarterly	11.2.7
Fire pump system		Chapter 8

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System/Component	Frequency	Reference [NFPA 25]
Fittings corrosion	Annually	11.2.2
Fittings damage	Annually	11.2.2
Foam concentrate strainer(s)	Quarterly	11.2.6.4
Gauges		Chapter 13
Hangers/braces/supports	Annually	11.2.3
Pipe corrosion	Annually	11.2.2
Pipe damage	Annually	11.2.2
Proportioning system(s) — all	Monthly	11.2.8
Strainer(s) — Mainline	5 years	11.2.6.1
Water supply piping		11.2.5.1
Water supply tank(s)		Chapter 9
Waterflow alarm devices		Chapter 13
Test		
Backflow preventer(s)		Chapter 13
Complete foam-water sprinkler system(s) (operational test)	Annually	11.3.2, 11.3.3
Control valve(s)		Chapter 13
Deluge/preaction valve(s)		Chapter 13
Discharge device location	Annually	11.3.2.6
Discharge device obstruction	Annually	11.3.2.6
Discharge device position	Annually	11.3.2.6

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System/Component	Frequency	Reference [NFPA 25]
Fire pump system		Chapter 8
Foam-water solution	Annually	11.3.5
Manual actuation device(s)	Annually	11.3.4
Valve status test		Chapter 13
Water supply flow test		Chapter 7
Water supply tank(s)		Chapter 9
Waterflow alarm devices		Chapter 13
Maintenance		
Backflow preventer(s)		Chapter 13
Bladder tank type		
Foam concentrate tank — hydrostatic test	10 years	11.4.5.2
Sight glass	10 years	11.4.5.1
Check valve(s)		Chapter 13
Control valve(s)		Chapter 13
Deluge/preaction valves		Chapter 13
Detector check valve(s)		Chapter 13
Fire pump system		Chapter 8
Foam concentrate pump operation	Monthly	11.4.7.1
Foam concentrate samples	Per manufacturer's recommendation	11.4.2

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System/Component	Frequency	Reference [NFPA 25]
Foam concentrate strainer(s)	Quarterly	Section 11.4
In-line balanced pressure type		
Balancing valve diaphragm	5 years	11.4.8.3
Foam concentrate pump(s)	5 years*	11.4.8.2
Foam concentrate tank	10 years	11.4.8.4
Line type		
Foam concentrate tank — corrosion and pickup pipes	10 years	11.4.6.1
Foam concentrate tank — drain and flush	10 years	11.4.6.2
Pressure vacuum vents	5 years	11.4.9
Proportioning system(s) standard pressure type		
Ball drip (automatic type) drain valves	5 years	11.4.4.1
Corrosion and hydrostatic test	10 years	11.4.4.4
Foam concentrate tank — drain and flush	10 years	11.4.4.2
Standard balanced pressure type		
Balancing valve diaphragm	5 years	11.4.7.3
Foam concentrate pump(s)	5 years*	11.4.7.2
Foam concentrate tank	10 years	11.4.7.4
Strainer(s) — mainline	5 years	11.2.6.1
Water supply	Annually	11.2.5.2
Water supply tank(s)		Chapter 9

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*Also refer to manufacturer's instructions and frequency. Maintenance intervals other than preventive maintenance are not provided, as they depend on the results of the visual inspections and operational tests. For foam-water sprinkler systems in aircraft hangars, refer to the inspection, test, and maintenance requirements of Table 11.1.1 in NFPA 409.

[**25:**Table 11.1.1.2]

13.1.2 Other System Components.

Fire pumps, water storage tanks, common components, and valves common to other types of water-based fire protection systems shall be inspected, tested, and maintained in accordance with Chapters 8, 9, and 13, respectively [of NFPA 25], and as specified in Table 13.1.1.2. [**25:**11.1.2]

12.10.2 ~~**Testing and Inspection of Alarm and Detection Devices.**~~ **[Move to 13.1.3]**

Commented [BS1]: Delete remaining sections of 12.10 per Global SR-49.

Alarm and detection devices shall be tested and inspected in accordance with *NFPA 72*.

12.10.1.1 [Move to 13.1.4]

Systems shall be so arranged that tests and inspections can be made without discharging foam solution to the system piping in order to check operation of all mechanical and electrical components of the system.

12.10.1.2* [Move to 13.1.5]

The system shall be arranged so that tests are performed with as little loss of foam concentrate as possible.

A.12.10.3 [Reassociate annex to 13.1.5]

~~An inspection contract for the equipment service tests and operation at regular intervals is recommended.~~ Samples of foam liquid concentrate should be referred to the manufacturer to check its condition annually. Samples should be submitted in accordance with the manufacturer's recommended sampling procedure.

13.1.6

If during routine inspection and testing the system is determined to have been altered or replaced, it shall be determined whether the system operates properly.

A.13.1.6

Examples of system alterations include replaced or relocated equipment and replacement foam concentrate.

13.8.2 [13.1.7]

All persons who are expected to inspect, test, maintain, or operate apparatus shall be thoroughly trained, and training shall be kept current.

13.2 Low-, Medium-, and High-Expansion Foam Systems.

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13.1* ~~**Inspection, Testing, and Maintenance**~~**General. [Move to 13.2.1]**

13.1.1 [13.2.1.1]

At least annually, all foam systems shall be thoroughly inspected and ~~checked~~ tested for correct operation.

13.1.2 [13.2.1.2]

The goal of this inspection and testing shall be to ensure that the system is in full operating condition and that it remains in that condition until the next inspection.

13.1.3 [13.2.1.3]

The inspection report, with recommendations, shall be filed with the owner.

13.1.4 [13.2.1.4]

Between the regular service contract inspections or tests, the system shall be inspected by competent personnel following an approved schedule.

13.2* Foam-Producing Equipment. [Move to 13.2.2]

13.2.1 [13.2.2.1]

Proportioning devices, their accessory equipment, and foam makers shall be inspected.

13.2.2 [13.2.2.2]

Fixed discharge outlets equipped with frangible seals shall be provided with inspection means to permit maintenance and for inspection and replacement of vapor seals.

13.2.2.1* [13.2.2.2.1]

At least annually, water shall be discharged through each foam maker discharge outlet to confirm that foam makers and foam solution feed lines are not obstructed by debris.

13.2.2.2* [13.2.2.2.2]

Alternative methods where approved by the AHJ shall be permitted.

13.2.3* [13.2.2.3]

Proportioning equipment shall be tested annually in accordance with 13.2.6~~Section 12.6~~.

13.2.4 Compressed Air Foam-Producing Equipment. [13.2.2.4]

13.2.4.1 [13.2.2.4.1]

Compressed air foam-generating equipment and accessories shall be inspected annually.

13.2.4.2 [13.2.2.4.2]

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Discharge devices shall be visually inspected annually for evidence of mechanical damage.

13.3 Piping. [Move to 13.2.3]

13.3.1 [13.2.3.1]

Aboveground piping shall be examined to determine its condition and to verify that proper drainage pitch is maintained.

13.3.2 [13.2.3.2]

Pressure tests of normally dry piping shall be made when visual inspection indicates questionable strength due to corrosion or mechanical damage.

13.3.3 [13.2.3.3]

Underground piping shall be spot-checked for deterioration at least every 5 years.

13.4 Strainers. [Move to 13.2.4]

Strainers shall be inspected in accordance with manufacturer's instructions and shall be cleaned after each use and flow test.

13.5 Detection and Actuation Equipment. [Move to 13.2.5]

Control valves, including all automatic and manual-actuating devices, shall be tested at regular intervals.

13.6 Foam Concentrate Inspection. [Move to 13.2.6]

13.6.1 [13.2.6.1]

At least annually, an inspection shall be made of foam concentrates and their tanks or storage containers for evidence of excessive sludging or deterioration.

13.6.2 [13.2.6.2]

Samples of concentrates shall be sent to the manufacturer or qualified laboratory for quality condition testing.

13.6.3 [13.2.6.3]

When the foam type and brand of foam are known, the quality testing shall confirm the product meets the manufacturer’s specifications.

13.6.4 [13.2.6.4]

Quantity of concentrate in storage shall meet design requirements, and tanks or containers shall normally be kept full, with space allowed for expansion.

13.7 High-Pressure Cylinders. [Move to 13.2.7]

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High-pressure cylinders used in compressed air foam systems shall not be recharged without a hydrostatic test (and remarking) if more than 5 years have elapsed from the date of the last test. Cylinders that have been in continuous service without discharging shall be permitted to be retained in service for a maximum of 12 years, after which they shall be discharged and retested before being returned to service.

13.8 Operating Instructions and Training. [Move to 13.2.8]

~~**13.8.1**~~ **[Text moving to 13.2.8]**

Operation, system deactivation, and maintenance instructions and layouts shall be posted at control equipment with copies of each on file.

13.3 Foam-Water Sprinkler Systems.

13.3.1 General.

13.3.1.1*

If during routine inspection and testing the foam-water sprinkler system is determined to have been altered or replaced (e.g., equipment replaced, relocated, or foam concentrate replaced), it shall be determined whether the system operates properly. [**25:**11.1.4.1]

A.12.10.1 [Reassociate annex material to 13.3.1.1]

To provide a means of periodically checking the performance of the proportioners used in foam sprinkler systems, a test connection should be provided. Typical test connections are illustrated in Figure A.6.4.10. Two options are possible in locating the proportioning controller in the sprinkler riser: before the main sprinkler valve or after the main sprinkler valve. If the proportioning controller is located after the main sprinkler valve, an additional supervised OS valve is needed to isolate the sprinkler overhead during the proportioner test. This is done to eliminate the problems caused by air cushions in wet pipe sprinkler systems or the servicing delays caused during charging and draining of preaction or deluge sprinkler systems. The test connection should be routed to a drain area for easy disposal of the solution produced during the test. The manufacturer's test procedures should be followed closely.

13.3.1.2 Obstruction Investigations.

The procedures outlined in Chapter 14 [of NFPA 25] shall be followed where there is a need to conduct an obstruction investigation. [**25:**11.1.5]

13.3.1.3 Impairments.

The procedures outlined in Chapter 15 [of NFPA 25] shall be followed where an impairment to protection occurs. [**25:**11.1.6]

13.3.1.4 System Piping and Fittings.

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System piping and fittings shall be inspected for the following:
(1) Mechanical damage (e.g., broken piping or cracked fittings)
(2) External conditions (e.g., missing or damaged paint or coatings, rust, and corrosion)
(3) Misalignment or trapped sections
(4) Low-point drains (automatic or manual)
(5) Location and condition of rubber-gasketed fittings

[**25:**11.2.2]

13.3.1.5 Hangers, Braces, and Supports.

Hangers, braces, and supports shall be inspected for the following and repaired or replaced as necessary:
(1) Condition (e.g., missing or damaged paint or coating, rust, and corrosion)
(2) Secure attachment to structural supports and piping
(3) Damaged or missing hangers, braces, and supports

[**25:**11.2.3]

13.3.2 Inspection.

13.3.2.1* Foam-Water Discharge Devices.

A.13.3.2.1

Directional-type foam-water discharge devices are quite often located in heavy traffic areas and are more apt to be dislocated compared to ordinary sprinkler locations. Of particular concern are low-level discharge devices in loading racks in and around low-level tankage and monitor-mounted devices that have been pushed out of the way for convenience. Inspection frequency might have to be increased accordingly. [**25:**A.11.2.4]

13.3.2.1.1

Foam-water discharge devices shall be inspected visually and maintained to ensure that they are in place, continue to be aimed or pointed in the direction intended in the system design, and are free from external loading and corrosion. [**25:**11.2.4.1]

13.3.2.1.2

Where caps or plugs are required, the inspection shall confirm they are in place and free to operate as intended. [**25:**11.2.4.2]

13.3.2.1.3

Misaligned discharge devices shall be adjusted (aimed) by visual means, and the discharge patterns shall be inspected at the next scheduled flow test. [**25:**11.2.4.3]

13.3.2.1.4*

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Inspection shall verify that unlisted combinations of discharge devices and foam concentrate have not been substituted. [**25:**11.2.4.4]

A.13.3.2.1.4

Discharge devices are listed or approved for particular foam concentrates. [**25:**A.11.2.4.4]

13.3.2.2 Water Supply.

13.3.2.2.1

The dependability of the water supply shall be ensured by regular inspection and maintenance, whether furnished by a municipal source, on-site storage tanks, a fire pump, or private underground piping systems. [**25:**11.2.5.1]

13.3.2.2.2*

Water supply piping shall be maintained free of internal obstructions. [**25:**11.2.5.2]

A.13.3.2.2.2

Water supply piping should be free of internal obstructions that can be caused by debris (e.g., rocks, mud, tubercles) or by closed or partially closed control valves. See Chapter 5 [of NFPA 25] for inspection and maintenance requirements. [**25:**A.11.2.5.2]

13.3.2.3 Strainers.

13.3.2.3.1

Mainline and individual discharge device strainers (basket or screen) shall be inspected every 5 years for damaged and corroded parts. [**25:**11.2.6.1]

13.3.2.3.2

Other maintenance intervals shall be permitted, depending on the results of the visual inspection and operating tests. [**25:**11.2.6.2]

13.3.2.3.3

Discharge device strainers shall be removed, inspected, and cleaned during the flushing procedure for the mainline strainer. [**25:**11.2.6.3]

13.3.2.3.4

Foam concentrate strainers shall be inspected visually to ensure the blowdown valve is closed and plugged. [**25:**11.2.6.4]

13.3.2.3.5

Baskets or screens shall be removed and inspected after each operation or flow test. [**25:**11.2.6.5]

13.3.2.4 Drainage.

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The area beneath and surrounding a foam-water spray system shall be inspected to ensure that drainage facilities, such as trap sumps and drainage trenches, are not blocked, and retention embankments or dikes are in good repair. [**25:**11.2.7]

13.3.2.5* Proportioning Systems.

A.13.3.2.5

Proportioning systems might or might not include foam concentrate pumps. If pumps are part of the proportioning system, the driver, pump, and gear reducer should be inspected in accordance with the manufacturer's recommendations, and the inspection can include items such as lubrication, fuel, filters, oil levels, and clutches. [**25:**A.11.2.8]

13.3.2.5.1

The components of the various proportioning systems described in 12.3.2.5 shall be inspected in accordance with the frequency specified in Table 13.1.1.2. [**25:**11.2.8.1]

13.3.2.5.2

Valves specified to be inspected shall be permitted to be open or closed, depending on specific functions within each foam-water sprinkler system. [**25:**11.2.8.2]

13.3.2.5.3

The position (open or closed) of valves shall be verified in accordance with specified operating conditions. [**25:**11.2.8.3]

13.3.2.5.4*

Inspection of the concentrate tank shall include verification that the quantity of foam concentrate satisfies the requirements of the original design. [**25:**11.2.8.4]

A.13.3.2.5.4

In some cases, an adequate supply of foam liquid is available without a full tank. This is particularly true of foam liquid stored in nonmetallic tanks. If liquid is stored in metallic tanks, the proper liquid level should be one-half the distance into the expansion dome. [**25:**A.11.2.8.4]

13.3.2.5.5

Additional inspection requirements shall be performed as detailed for the proportioning systems specified in 13.3.2.5. [**25:**11.2.8.5]

13.3.2.5.5.1 Standard Pressure Proportioner.

13.3.2.5.5.1(A)*

The pressure shall be removed before the inspection to prevent injury. [**25:**11.2.8.5.1.1]

A.13.3.2.5.5.1(A)

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The standard pressure proportioner is a pressure vessel. Although under normal standby conditions this type of proportioning system should not be pressurized, some installations allow for inadvertent pressurization. Pressure should be removed before inspection. [**25:**A.11.2.8.5.1.1]

13.3.2.5.5.1(B)

The inspection shall verify the following:
(1) Ball drip valves (automatic drains) are free and opened.
(2) External corrosion on foam concentrate storage tanks is not present.

[**25:**11.2.8.5.1.2]

13.3.2.5.5.2 Bladder Tank Proportioner.

13.3.2.5.5.2(A)*

The pressure shall be removed before the inspection to prevent injury. [**25:**11.2.8.5.2.1]

A.13.3.2.5.5.2(A)

The bladder tank proportioner is a pressure vessel. Where inspecting for a full liquid tank, the manufacturer's instructions should be followed. If inspected incorrectly, the tank sight gauges could indicate a full tank when the tank actually is empty of foam liquid. Some foam liquids, due to their viscosity, might not indicate true levels of foam liquid in the tank where inspected via the sight glass.

CAUTION: Depending on system configuration, this type of proportioner system might be pressurized or nonpressurized under normal conditions. Pressure should be removed before inspection.

[**25:**A.11.2.8.5.2.1]

13.3.2.5.5.2(B)

The inspection shall include the following:
(1) Water control valves to foam concentrate tank
(2) An inspection for external corrosion on foam concentrate storage tanks
(3) An inspection for the presence of foam in the water surrounding the bladder (annual)

[**25:**11.2.8.5.2.2]

13.3.2.5.5.3 Line Proportioner.

The inspection shall include
the following:
(1)* Strainers
(2)* Verification that pressure vacuum vent is operating freely
(3) An inspection for external corrosion on foam concentrate storage tanks

[**25:**11.2.8.5.3]

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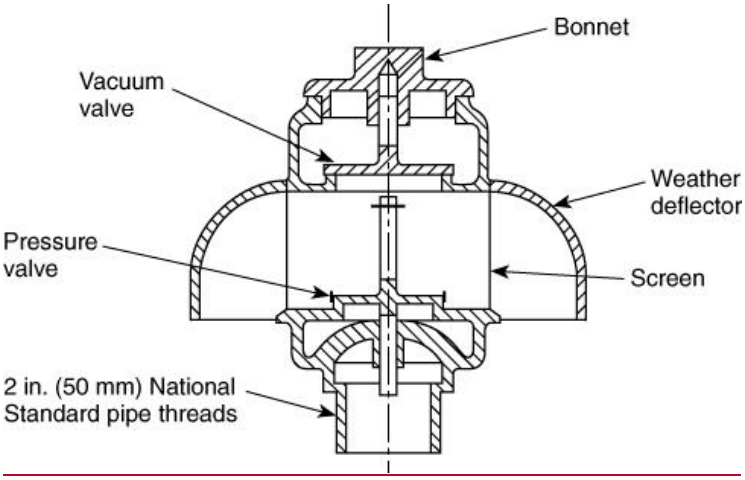
A.13.3.2.5.5.3(1)

See 13.3.2.3.1.

A.13.3.2.5.5.3(2)

See Figure A.13.3.2.5.5.3(2).

Figure A.13.3.2.5.5.3(2) Pressure Vacuum Vent. [25:Figure A.3.3.34]



13.3.2.5.5.4 Standard Balanced Pressure Proportioner.

The inspection shall include the following:
(1)* Strainers
(2)* Verification that pressure vacuum vent is operating freely
(3) Verification that gauges are in good operating condition
(4) Verification that sensing line valves are open
(5) Verification that power is available to foam liquid pump

[**25:**11.2.8.5.4]

A.13.3.2.5.5.4(1)

See 13.3.2.3.1.

A.13.3.2.5.5.4(2)

See Figure A.12.3.2.5.5.3(2).

13.3.2.5.5.5 In-Line Balanced Pressure Proportioner.

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The inspection shall include the following:
(1)* Strainers
(2)* Verification that pressure vacuum vent is operating freely
(3) Verification that gauges are in good working condition
(4) Verification that sensing line valves at pump unit and individual proportioner stations are open
(5) Verification that power is available to foam liquid pump

[**25:**11.2.8.5.5]

A.13.3.2.5.5.5(1)

See 13.3.2.3.1.

A.13.3.2.5.5.5(2)

See Figure A.12.3.2.5.5.3(2).

13.3.2.5.5.6 Orifice Plate Proportioner.

The inspection shall include the following:
(1)* Strainers
(2)* Verification that pressure vacuum vent is operating freely
(3) Verification that gauges are in good working condition
(4) Verification that power is available to foam liquid pump

[**25:**11.2.8.5.6]

A.13.3.2.5.5.6(1)

See 13.3.2.3.1.

A.13.3.2.5.5.6(2)

See Figure A.12.3.2.5.5.3(2).

13.3.3* Operational Tests.

Frequency of system tests shall be in accordance with Table 13.1.1.2. [**25:**11.3]

A.13.3.3

Operational tests generally should be comprised of the following:
(1) A detection/actuation test with no flow to verify that all components such as automated valves, foam and water pumps, and alarms operate properly
(2) A water-only flow test to inspect piping continuity, discharge patterns, pressures, and line flushing
(3) A foam flow test to verify solution concentration
(4) Resetting of system to its normal standby condition, including draining of lines and filling of foam liquid tank

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[**25:**A.11.3]

13.3.3.1* Test Preparation.
Precautions shall be taken to prevent damage to property during the test. [**25:**11.3.1]

A.13.3.3.1

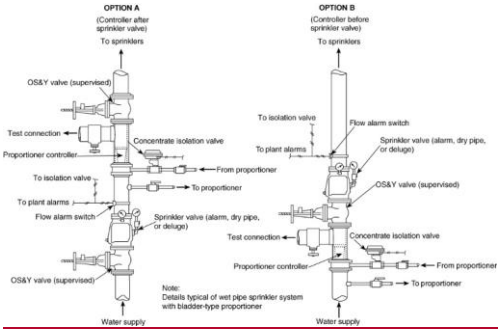
The property owner or designated representative should take care to prevent damage to equipment or the structure during the test. Damage could be caused by the system discharge or by runoff from the test site. It should be verified that there is adequate and unobstructed drainage. Equipment should be removed or covered as necessary to prevent damage. Means such as curbing or sandbagging should be used to prevent entry of the foam-water solution. [**25:**A.11.3.1]

13.3.3.2* Operational Test Performance.

A.13.3.3.2

An alternative method for achieving flow can be permitted to be an installation as shown in Figure A.13.3.3.2. This type of testing does not verify system pipe conditions or discharge device performance but only the water supply, foam concentrate supply, and proportioning accuracy. [**25:**A.11.3.2]

Figure A.13.3.3.2 Foam System/Test Header Combination [25:Figure A.11.3.2]



13.3.3.2.1

Operational tests shall be conducted to ensure that the foam-water sprinkler system(s) responds as designed, both automatically and manually. [**25:**11.3.2.1]

13.3.3.2.2

The test procedures shall simulate anticipated emergency events so the response of the foam-water sprinkler system(s) can be evaluated. [**25:**11.3.2.2]

13.3.3.2.3

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Where discharge from the system discharge devices would create a hazardous condition or conflict with local requirements, an approved alternate method to achieve full flow conditions shall be permitted. [**25:**11.3.2.3]

13.3.3.2.4 Response Time.

Under test conditions, the automatic fire detection systems, when exposed to a test source, shall operate within the requirements of *NFPA 72* for the type of detector provided, and the response time shall be recorded. [**25:**11.3.2.4]

13.3.3.2.5 Discharge Time.

The time lapse between operation of detection systems and water delivery time to the protected area shall be recorded for open discharge devices. [**25:**11.3.2.5]

13.3.3.2.6 Discharge Patterns.

13.3.3.2.6.1

The discharge patterns from all of the open spray devices shall be observed to ensure that patterns are not impeded by plugged discharge devices and to ensure that discharge devices are correctly positioned and that obstructions do not prevent discharge patterns from covering surfaces to be protected. [**25:**11.3.2.6.1]

13.3.3.2.6.2

Where obstructions occur, the piping and discharge devices shall be cleaned and the system retested. [**25:**11.3.2.6.2]

13.3.3.2.6.3

Discharge devices shall be permitted to be of different orifice sizes and types. [**25:**11.3.2.6.3]

13.3.3.2.7* Pressure Readings.

A.13.3.3.2.7

Specific foam concentrates typically are listed or approved with specific sprinklers. Part of the approval and listing is a minimum sprinkler operating pressure. Sprinkler operating pressure affects foam quality, discharge patterns, and fire extinguishment (control) capabilities. Discharge pressures less than this specified minimum pressure should be corrected immediately; therefore, it is necessary to test under full flow conditions. [**25:**A.11.3.2.7]

13.3.3.2.7.1

Pressure readings shall be recorded at the most hydraulically demanding discharge device.

13.3.3.2.7.2

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It shall be permissible to test the full flow discharge from foam-water deluge systems using water only in lieu of foam. [**25:**11.3.2.7.2]

13.3.3.2.7.3

A second pressure reading shall be recorded at the main control valve. [**25:**11.3.2.7.3]

13.3.3.2.7.4

Readings shall be compared to the hydraulic design pressures to ensure the original system design requirements are met. [**25:**11.3.2.7.4]

13.3.3.3 Multiple Systems.

The maximum number of systems expected to operate in case of fire shall be tested simultaneously to inspect the adequacy of the water supply and concentrate pump. [**25:**11.3.3]

13.3.3.4 Manual Actuation Devices.

Manual actuation devices shall be tested annually. [**25:**11.3.4]

13.3.3.5 Concentration Testing.

13.3.3.5.1

During the operational test, a foam sample shall be taken. [**25:**11.3.5.1]

13.3.3.5.2

Where approved by the authority having jurisdiction, simulated foam concentrates or alternative test systems shall be permitted to be substituted for actual foam concentrate, but system pressures and flows shall remain as described above and meet manufacturer's system requirements and recommendations. [**25:**11.3.5.2]

13.3.4* Maintenance.

A.13.3.4

The maintenance items specified in the body of this standard are in addition to the typical inspection and test procedures indicated. Foam-water sprinkler systems are, as are all fire protection systems, designed to be basically maintenance free. There are, however, some areas that need special attention. Foam concentrate shelf life varies between liquids and is affected by factors such as heat, cold, dilution, contamination, and many others. As with all systems, common sense dictates those maintenance-sensitive areas that should be given attention. Routine testing and inspection generally dictate the need for additional maintenance items. Those maintenance items specified are key procedures that should be performed routinely. [**25:**A.11.4]

13.3.4.1

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Maintenance of foam-water sprinkler systems shall be in accordance with the requirements of those chapters covering the specific component parts. [**25:**11.4.1]

13.3.4.2 Foam Concentrate Samples.

Samples of foam concentrates shall be sent to the manufacturer or qualified laboratory for quality condition testing at the frequency recommended by the manufacturer. [**25:**11.4.2]

13.3.4.3 Foam Components.

Maintenance of specific foam components shall be in accordance with 13.3.4.4 through 13.3.4.8. [**25:**11.4.3]

13.3.4.4 Standard Pressure Proportioner.

13.3.4.4.1

The ball drip (automatic-type) drain valves shall be disassembled, cleaned, and reassembled. [**25:**11.4.4.1]

13.3.4.4.2*

The foam liquid storage tank shall be drained of foam liquid and flushed. [**25:**11.4.4.2]

A.13.3.4.4.2

Foam concentrates tend to settle out over time. Depending on the specific characteristics of the foam concentrate, sedimentation accumulates in the bottom of the storage vessel. This sediment can affect proportioning and foam concentrate integrity. Some concentrates tend to settle out more rapidly than others. If the annual samples indicate excessive sediment, flushing the tank could be required more frequently. [25:A.11.4.4.2]

13.3.4.4.3

Foam liquid shall be permitted to be salvaged and reused. [25:11.4.4.3]

13.3.4.4.4

The foam liquid tank shall be inspected for internal and external corrosion and hydrostatically tested to the specified working pressure. [**25:**11.4.4.4]

13.3.4.5 Bladder Tank Proportioner.

13.3.4.5.1

Sight glass, where provided, shall be removed and cleaned. [**25:**11.4.5.1]

13.3.4.5.2*

The foam concentrate bladder tank shall be hydrostatically tested at system working pressure. [**25:**11.4.5.2]

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A.13.3.4.5.2

When hydrostatically testing bladder tanks, the generation of a pressure differential across the diaphragm could cause damage to the diaphragm. Tanks should be filled with agent to no less than the normal fill capacity and air should be vented from inside and outside the bladder before pressurizing. [**25:**A.11.4.5.2]

13.3.4.5.2.1

The hydrostatic test shall not create a pressure differential across the diaphragm. [**25:**11.4.5.2.1]

13.3.4.5.2.2

While under system working pressure, the exterior of the foam concentration bladder tank shall be inspected for leaks. [**25:**11.4.5.2.2]

13.3.4.6 Line Proportioner.

13.3.4.6.1

The foam concentrate tank shall be inspected for internal corrosion. [**25:**11.4.6.1]

13.3.4.6.2

Pickup pipes inside the tank shall be inspected for corrosion, separation, or plugging. [**25:**11.4.6.2]

13.3.4.6.3

The foam concentrate tank shall be drained and flushed. [**25:**11.4.6.3]

13.3.4.6.4

Foam concentrate shall be permitted to be salvaged and reused. [**25:**11.4.6.4]

13.3.4.7 Standard Balanced Pressure Proportioner.

13.3.4.7.1 Pump Operation.

13.3.4.7.1.2

Foam concentrate shall be circulated back to the tank. [**25:**11.4.7.1.2]

13.3.4.7.2 Servicing.

Foam pumps, drive train, and drivers shall be serviced in accordance with the manufacturer's instructions and frequency but not at intervals of more than 5 years. [**25:**11.4.7.2]

13.3.4.7.3 Flushing.

The diaphragm balancing valve shall be flushed through the diaphragm section with water or foam concentrate until fluid appears clear or new. [**25:**11.4.7.3]

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13.3.4.7.4 Corrosion and Sediment.

13.3.4.7.4.1

The foam concentrate tank shall be inspected internally for corrosion and sediment. [**25:**11.4.7.4.1]

13.3.4.7.4.2

Excessive sediment shall require draining and flushing of the tank. [**25:**11.4.7.4.2]

13.3.4.8 In-Line Balanced Pressure Proportioner.

13.3.4.8.1 Pump Operation.

13.3.4.8.1.1

The foam concentrate pump shall be operated. [**25:**11.4.8.1.1]

13.3.4.8.1.2

Foam concentrate shall be circulated back to the tank. [**25:**11.4.8.1.2]

13.3.4.8.2 Servicing.

Foam pumps, drive train, and drivers shall be serviced in accordance with the manufacturer's instructions and frequency but not at intervals of more than 5 years. [**25:**11.4.8.2]

13.3.4.8.3 Flushing.

The diaphragm balancing valve shall be flushed through the diaphragm section with water or foam concentrate until fluid appears clear or new. [**25:**11.4.8.3]

13.3.4.8.4 Corrosion and Sediment.

13.3.4.8.4.1

The foam concentrate tank shall be inspected internally for corrosion and sediment. [**25:**11.4.8.4.1]

13.3.4.8.4.2

Excessive sediment shall require draining and flushing of the tank. [**25:**11.4.8.4.2]

13.3.4.9 Pressure Vacuum Vents.

The procedures specified in 13.3.4.9.1 through 13.3.4.9.13 shall be performed on pressure vacuum vents every 5 years. [**25:**11.4.9]

13.3.4.9.1

The vent shall be removed from the expansion dome. [**25:**11.4.9.1]

13.3.4.9.2

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The vent shall be inspected to ensure that the opening is not blocked and that dirt or other foreign objects do not enter the tank. [**25:**11.4.9.2]

13.3.4.9.3

The vent bonnet shall be removed. [**25:**11.4.9.3]

13.3.4.9.4

The vacuum valve and pressure valve shall be lifted out. [**25:**11.4.9.4]

13.3.4.9.5

The vent body shall be flushed internally, and the vacuum valve and the pressure valve shall be washed thoroughly. [**25:**11.4.9.5]

13.3.4.9.6

The vent shall be inspected to ensure that the screen is not clogged, and the use of any hard, pointed objects to clear the screen shall be avoided. [**25:**11.4.9.6]

13.3.4.9.7

If the liquid has become excessively gummy or solidified, the vent body and parts shall be soaked in hot soapy water. [**25:**11.4.9.7]

13.3.4.9.8

The vent body shall be turned upside down and drained thoroughly. [**25:**11.4.9.8]

13.3.4.9.9

Parts shall be dried by placing them in a warm and dry area or by using an air hose. [**25:**11.4.9.9]

13.3.4.9.10

Parts shall be sprayed with a light Teflon® coating, and the vent shall be reassembled. [**25:**11.4.9.10]

13.3.4.9.11

The use of any type of oil for lubrication purposes shall not be permitted. [**25:**11.4.9.11]

13.3.4.9.12

The vent bonnet shall be replaced, and the vent shall be turned upside down slowly a few times to ensure proper freedom of the movable parts. [**25:**11.4.9.12]

13.3.4.9.13

The vent shall be attached to the liquid storage tank expansion dome. [**25:**11.4.9.13]

13.3.3.5 Component Action Requirements.

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13.3.5.1

Whenever a component in a foam-water sprinkler system is adjusted, repaired, reconditioned, or replaced, the action required in Table 13.3.5.1 shall be performed. [**25:**11.5.1]

Table 13.3.5.1 Summary of Component Action Requirements

Component	Adjust	Repair/Recondition	Replace	Required Action
Water Delivery Components				
Discharge devices	X		X	(1) Inspect for leaks at system working pressure
				(2) Inspect for impairments at orifice
Fire department connections	X	X	X	See Chapter 13
Manual release	X	X	X	(1) Operational test
				(2) Inspect for leaks at system working pressure
				(3) Test all alarms
Pipe and fittings on closed-head system	X	X	X	Hydrostatic test in conformance with NFPA 16
Pipe and fittings on open-head system	X	X	X	Operational flow test
Foam Components				
Ball drip (automatic-type) drain valves				See Chapter 13
Bladder tank	X	X	X	Inspect water jacket for presence of foam concentrate

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Component	Adjust	Repair/Recondition	Replace	Required Action
Foam concentrate	X		X	Submit a sample for laboratory analysis for conformance with manufacturer's specifications
Foam concentrate pump				See Chapter 8
Foam concentrate strainer(s)				See Chapter 13
Foam concentrate tank	X	X	X	Inspect for condition; repair as appropriate
Proportioning system(s)	X	X	X	Conduct flow test and inspect proportioning by refractometer test or equivalent
Water supply tank(s)				See Chapter 9
Alarm and Supervisory Components				
Detection system	X	X	X	Operational test for conformance with NFPA 16 and/or *NFPA 72*
Pressure-switch-type waterflow	X	X	X	Operational test using inspector's test connection
Valve supervisory device			X	Test for conformance with NFPA 16 and/or *NFPA 72*
Vane-type waterflow	X	X	X	Operational test using inspector's test connection
Water motor gong			X	Operational test using inspector's test connection
Status-Indicating Components				

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Component	Adjust	Repair/Recondition	Replace	Required Action
Gauges	X		X	Verify at 0 psi (0 bar) and system working pressure; see Chapter 13 regarding calibration
Testing and Maintenance Components				
Auxiliary drains	X	X	X	Inspect for leaks at system working pressure
Inspector's test connection	X	X	X	Inspect for leaks at system working pressure
Main drain	X	X	X	Full-flow main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Inspect for conformance with NFPA 16 and/or NFPA 13
Pipe stands	X	X	X	Inspect for conformance with NFPA 16 and/or NFPA 13
Informational Components				
General information sign	X	X	X	Inspect for conformance with NFPA 16 and/or NFPA 13
Hydraulic information sign	X	X	X	Inspect for conformance with NFPA 16 and/or NFPA 13
Valve signs	X	X	X	Inspect for conformance with NFPA 16 and/or NFPA 13

[**25:**Table 11.5.1]

13.3.5.2

Where the original installation standard is different from the cited standard, the use of the appropriate installing standard shall be permitted. [**25:**11.5.2]

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Second Revision No. 52-NFPA 11-2020 [Detail]

Add Annex material to 5.2 Outdoor Fixed Roof (Cone) Tanks.

A.5.2

Historical records of fixed foam systems, where the tank roof is partially damaged and open or completely blown off, would suggest that the fixed foam pourer system could have been compromised, and portable monitor nozzles might have been needed to supplement or replace the system and extinguish the fire.

Submitter Information Verification

Committee:

Submittal Date: Wed Mar 25 16:36:48 EDT 2020

Committee Statement

Committee Statement: Fire test both small and large scale conducted by LASTFIRE supports including Compressed air foam delivery systems as one of the options for tank and other hydrocarbon extinguishment systems. Present data does not support establishing a standard application requirement for all

Compressed air foam delivery systems or type of foam using that system at this time. Not all foams and CAFs will meet the same level of performance so for this reason fire testing will be required to set application rates.

Response Message: SR-52-NFPA 11-2020

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Second Revision No. 2-NFPA 11-2020 [Section No. 2.3.3]

2.3.3 ASTM Publications.

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

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

~~ASTM A105/A105M, *Standard Specification for Carbon Steel Forgings for Piping Applications* , 2014.~~

~~ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service* , 2018.~~

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

~~ASTM A182/A182M, *Standard Specification for Forged or Rolled Alloy- and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service* , 2018.~~

~~ASTM A216/A216M, *Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service* , 2018.~~

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

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

~~ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures* , 1999, reapproved 2014.~~

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

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

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

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

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

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

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2018a~~ 2019b .

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

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 09:09:00 EST 2020

Committee Statement

Committee Statement: Referenced standards update.

Response Message: SR-2-NFPA 11-2020

Public Comment No. 3-NFPA 11-2019 [Section No. 2.3.3]

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Second Revision No. 50-NFPA 11-2020 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

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

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* ~~2017~~ 2020 edition.

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

NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* 2016 edition.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 25 13:57:20 EDT 2020

Committee Statement

Committee Statement: Update to latest edition of NFPA 25.

Response Message: SR-50-NFPA 11-2020

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Second Revision No. 37-NFPA 11-2020 [Section No. 3.3.12.8]

3.3.12.8* Synthetic Fluorine-Free Foam (SFFF).

Foam concentrate ~~that is~~ based on a mixture of hydrocarbon surface active agents that ~~do~~ is not formulated to contain ~~fluorine~~ per- or polyfluoroalkyl substances (PFAS) .

A.3.3.12.8 Synthetic Fluorine-Free Foam (SFFF).

Contamination of per- and polyfluoroalkyl substances (PFAS) from equipment previously used with fluorinated foam concentrates or from environmental sources can potentially be found in synthetic fluorine-free foam concentrates that were not specifically manufactured using these substances.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Fri Feb 28 08:44:23 EST 2020

Committee Statement

Committee Statement: Ingredients, especially water, used during formulation of foam concentrates will contain fluorine from inorganic compounds such as fluoride which are currently not under scrutiny. Laboratories have the capability to differentiate the fluorine contained in inorganic compounds from the fluorine contained in organic molecules such as those that fall under the category of per- and polyfluoroalkyl substances (PFAS).

Response Message: SR-37-NFPA 11-2020. Setting a standard limit that might change will create future confusion.

Public Comment No. 2-NFPA 11-2019 [Section No. 3.3.12.8]

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Second Revision No. 26-NFPA 11-2020 [New Section after 3.3.31]

3.3.31 Storage Tank Roofs.

3.3.31.1* Cone Roof.

A fixed structural steel conical or dome roof permanently attached to the exterior tank shell.

A.3.3.31.1 Cone Roof.

There are several types of roof systems that can be considered cone roofs or domes *(see Figure A.3.3.31.1)* . The roof can be self-supporting or designed with support members such as structural chord or “radial” rafters. The roof can be supported with vertical columns as well.

A cone roof has the following characteristics:

(1) It is used predominately for combustible liquids.

(2) It has a fixed structural roof system that is permanent.

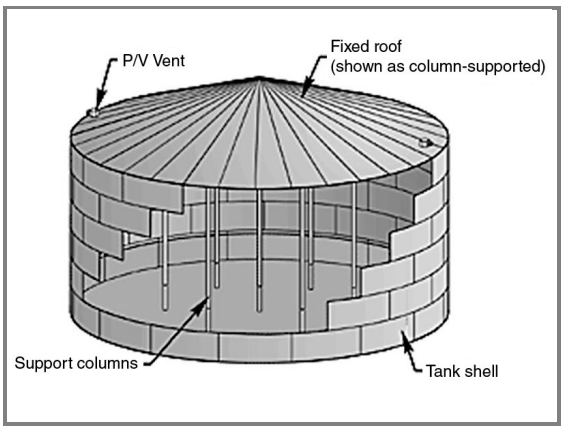
(3) It will not fail or "melt" away easily.

(4) It is vented.

(5) It includes no other roof system, internal or otherwise.

(6) It has no foam dam.

Figure A.3.3.31.1 Cone/Dome Roof System. ***(Source: Rob Ferry, P.E., Trinity Consultants, Inc.)***



3.3.31.2* External Floating Roof.

A roof system fitted to the inside diameter of a storage tank designed to automatically adjust to fluctuating liquid levels and is exposed to the atmosphere.

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A.3.3.31.2 External Floating Roof.

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For the purpose of this standard, an aluminum geodesic dome is not considered a cone or dome roof. Aluminum geodesic domes are often used to cover what would otherwise be an external floating roof system. These roof coverings cannot withstand the temperatures expected from a full surface or rim seal fire. The presence of such a covering over the top of a floating roof system will not be considered adequate to withstand a fire; therefore, the roof will still be considered an external floating roof. *[See Figure A.3.3.31.2(a) and Figure A.3.3.31.2(b) .]*

An external floating roof has the following characteristics:

(1) It is used predominately for both flammable and combustible liquids.

(2) It is a floating roof system with vapor seals.

(3) It might have a roof structure that is considered external because it is not substantial or will fail or "melt" away easily (e.g., the aluminum geodesic dome).

(4) It is vented.

(5) It might or might not have a foam dam.

Figure A.3.3.31.2(a) External Floating Roof System. ***(Source: Rob Ferry, P.E., Trinity Consultants, Inc.)***

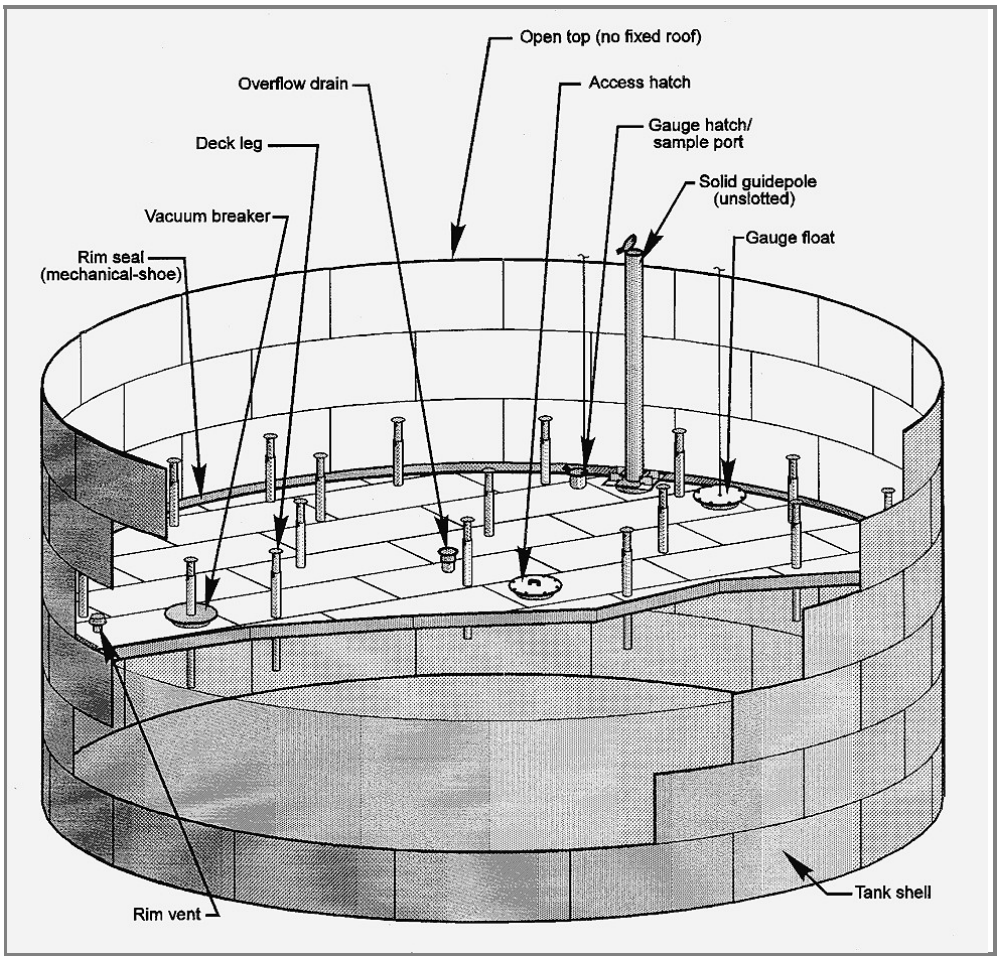
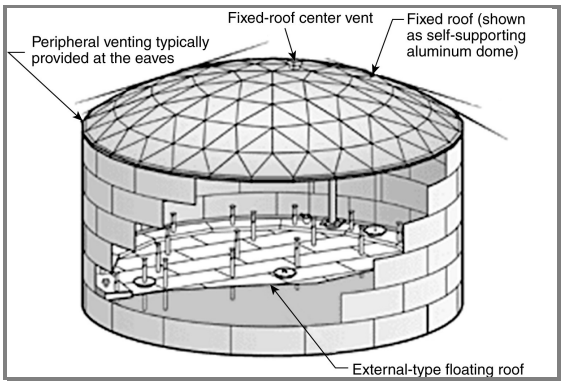


Figure A.3.3.31.2(b) External Floating Roof System with Geodesic Dome (Considered External Floating). ***(Source: Rob Ferry, P.E., Trinity Consultants, Inc.)***

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3.3.31.3* Internal Floating Roof.

A roof system fitted to the inside diameter of a storage tank designed to automatically adjust to fluctuating liquid levels; covered completely by a permanently fixed structural steel cone or dome roof system attached to the exterior tank shell.

A.3.3.31.3 Internal Floating Roof.

There are several different types of internal floating roofs (IFR), including single- and double-deck pontoon roof systems *(see Figure A.3.3.31.3)* . They are typically constructed of carbon steel, aluminum tubing, and plastic.

An internal floating roof has the following characteristics:

(1) It is used predominately for flammable liquids.

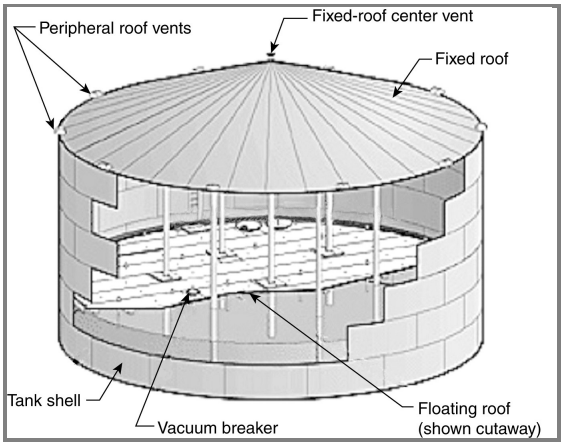
(2) It is a floating roof system with vapor seals.

(3) It is considered internal because it is covered with a fixed structural cone or dome roof system that is permanently attached to the exterior tank shell.

(4) It is vented or gas padded.

(5) It might or might not have a foam dam.

Figure A.3.3.31.3 Internal Floating Roof System With Fixed Cone or Dome Roof Covering.
(Source: Rob Ferry, P.E., Trinity Consultants, Inc.)



Supplemental Information

File Name	Description	Approved
NFPA_11_Roof_Definitions_1-20-_2020_v3..docx	For staff use	

Submitter Information Verification

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Committee: FOM-AAA

Submittal Date: Wed Feb 05 10:44:03 EST 2020

Committee Statement

Committee Statement: A description of storage tanks covered by this standard is needed. This is based on the report of the large tank Task Group and CI 52.

Response Message: SR-26-NFPA 11-2020

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Second Revision No. 51-NFPA 11-2020 [Section No. 4.3.1.1]

4.3.1.1*

Foam concentrate shall be listed for use with the foam concentrate proportioning equipment and with the discharge devices with which a given system is equipped.

A.4.3.1.1

The foam concentrate proportioning equipment and discharge devices produce finished foam with certain qualities, including expansion ratio and 25 percent drainage time. The testing conducted by the Fire Protection Research Foundation showed that expansion ratios of 7 to 10 were critical for SFFFs' ability to extinguish fires. Consultation with the foam concentrate and/or foam equipment manufacturer might be necessary to confirm acceptable operating parameters.

4.3.1.1.1

Replacement supplies of foam concentrates shall be listed for use with system components.

4.3.1.1.2*

Different types and/or brands of foam concentrates shall not be mixed for storage. Different brands of the same type of concentrate shall not be mixed unless data are provided by the manufacturer and accepted by the AHJ, to prove that the brands are compatible.

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Mar 25 13:58:42 EDT 2020

Committee Statement

Committee Statement: Communication of results of the NFPA 11 Task Groups findings on SFFF. See CI 36.
Response Message: SR-51-NFPA 11-2020

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Second Revision No. 4-NFPA 11-2020 [Section No. 4.6.8]

4.6.8

A foam concentrate pump shall have the capacity to meet the actual ~~the~~ maximum flow rate at the highest proportioning flow rate as permitted by 12.6.5 or the AHJ.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 09:25:23 EST 2020

Committee Statement

Committee Statement: Revision to provide clarity.

Response Message: SR-4-NFPA 11-2020

Public Comment No. 21-NFPA 11-2019 [Section No. 4.6.8]

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Second Revision No. 5-NFPA 11-2020 [Section No. 4.7.2.8]

4.7.2.8

Underground foam solution pipe shall be installed in accordance with NFPA 24.

4.7.2.8.1

Piping materials and specifications shall be in accordance with this standard.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 09:32:18 EST 2020

Committee Statement

Committee Statement: This provides clarity on the intent of this section requiring foam solution pipe selected in Section 4.7.2.1, be installed in accordance with NFPA 24. See CI 47 Piping Task Group Report. Providing further direction for underground pipe materials specific for foam solution service prevents confusion between NFPA 11 and NFPA 24.The installation must be in accordance with NFPA 24 however piping materials must be in accordance with NFPA 11.

Response Message: SR-5-NFPA 11-2020

Public Comment No. 19-NFPA 11-2019 [Section No. 4.7.2.8]

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Second Revision No. 38-NFPA 11-2020 [Section No. 5.1]

5.1* Types of Hazards.

This chapter shall cover design information for the use of low-expansion foam to protect outdoor storage tanks, interior flammable liquid hazards, loading racks, diked areas, and nondiked spill areas.

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A.5.1

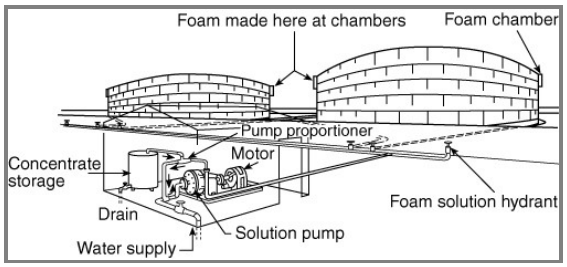
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There have been cases reported where the application of foam through solid streams that were plunged into the flammable liquid has been believed to be the source of ignition of the ensuing fire. The ignitions have been attributed to static discharges resulting from splashing and turbulence. Therefore, any application of foam to an unignited flammable liquid should be as gentle as possible. Correct application methods with portable equipment might include a spray pattern or banking the foam stream off a backboard so that the foam flows gently onto the liquid surface. Also, correctly designed fixed foam chambers on tanks could be expected to deliver the foam fairly gently and not cause a problem. Covered (internal) floating roof tanks can experience two distinct types of fires: a full surface area fire (as a result of the floating roof sinking) or a seal fire. There have been few fires in double-deck or pontoon-type floating roof tanks where fixed roofs and venting are designed in accordance with NFPA 30. Prior to selecting the method of protection, the type of fire that will serve as the basis for design should be defined.

Outdoor Fixed-Roof (Cone) Tanks. Within the scope of this standard, fixed-roof (cone) tanks are defined as vertical cylindrical tanks with a fixed roof designed as a conical section, and they comply with the requirements set forth in NFPA 30. Typically, these tanks have a weak seam at the junction of the vertical side and roof. In the event of an internal explosion, the seam usually parts and the roof blows off, leaving the shell intact to retain the tank contents. The resulting fire involves the entire exposed surface of the product.

These systems are used for the protection of outdoor process and storage tanks. They include the protection of such hazards in manufacturing plants as well as in large tank farms, oil refineries, and chemical plants. These systems usually are designed for manual operation but, in whole or in part, can be automatic in operation. Foam systems are the preferred protection for large outdoor tanks of flammable liquids, as shown in Figure A.5.1.

Figure A.5.1 Schematic Arrangement of Air Foam Protection for Storage Tanks.



The following decision process is to be used by the owner or AHJ to determine the appropriate fire protection method (fixed or portable) for outdoor storage tanks:

(1) Determine which of the following tank configurations apply (see definitions for further explanation of tank configurations):

  (a) Cone roof tanks

  (b) External floating roof tanks

  (c) Aluminum geodesic dome fixed roof tank

  (d) Internal floating roof tank

  (e) Others that are not covered by NFPA 11 (e.g., concrete tanks)

(2) Determine the roof construction [The tank construction and the roof construction assist the AHJ or owner/operator in determining what type of fire protection (fixed or portable) that will be needed to protect the tank]:

  (a) Cone roof tank *(see Section 5.2 for specific fire protection details)*

    i. Steel fixed roof

  (b) External floating roof tank *(see Section 5.3 for specific fire protection details)*

    i. Steel: All roofs in accordance with Annex C of API STD 650 designed for EFR applications are all steel construction, including buoyant compartmented sections. There are two types: annular pontoon floating roofs and double deck floating roofs.

    ii. Other steel or other construction: Cable supported, center annular pontoon (might not be in accordance with Annex C of API STD 650)

  (c) Internal floating roof tank *(see Section 5.4 for specific fire protection details).*

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(d) Steel double deck (in accordance with Annex C of API STD 650)

(e) Steel annular pontoon (in accordance with Annex C of API STD 650)

(f) Steel pans (in accordance with Annex C of API STD 650)

(g) Aluminum, plastic, composite, or other (in accordance with Annex H of API STD 650). Annex H roofs might be steel, aluminum, composite, stainless steel, or other materials. They have much less buoyancy than Annex C roofs and are normally suitable for operation only in IFR tanks that are not exposed to the weather.

(h) Other aluminum, plastic, composite, or other

(3) Step 3: What is the fire hazard(s) being protected against?

(a) Seal area fire

(b) Spill on roof fire

(c) Full tank surface area fire

(d) Combination of the above

(e) Dike fire area

(f) Other type of fire

(4) Step 4: What type of fire protection system is being selected to provide that protection? (This step should be in accordance with the section in Chapter 5 that applies to the construction as selected previously.)

(a) Portable handlines (dike area, seal area)

(b) Portable monitors (dike area, seal area, full surface)

(c) Fixed seal extinguishment system

(d) Fixed full surface extinguishment system

(5) Step 5: Go to the section in the following list for specific fire protection requirements:

(a) Cone roof tank *(see Section 5.2)*

(b) External floating roof tank *(see Section 5.3)*

(c) Internal floating roof tank *(see Section 5.4)*

Supplemental Information

File Name	Description	Approved
NFPA_11_Annex_A.5.1.docx	For staff use	

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 11 07:20:23 EDT 2020

Committee Statement

Committee Statement: Additional guidance on the type of protection for various tanks is needed. See CI 56 on design objectives and fire test protocol.

Response Message: SR-38-NFPA 11-2020

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Second Revision No. 53-NFPA 11-2020 [Section No. 5.2 [Excluding any Sub-Sections]]

The following methods for protecting exterior fixed-roof tanks shall be included within this section and shall not be considered to be in any order of preference:

(1) Foam monitors and handlines, including those supplied by compressed air foam generation technology

(2) Surface application with fixed foam discharge outlets, including those supplied by compressed air foam generation technology

(3) Subsurface application

(4) Semisubsurface injection methods

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 25 16:39:14 EDT 2020

Committee Statement

Committee Statement: Fire test both small and large scale conducted by LASTFIRE supports including Compressed air foam delivery systems as one of the options for tank and other hydrocarbon extinguishment systems. Present data does not support establishing a standard application requirement for all Compressed air foam delivery systems or type of foam using that system at this time. Not all foams and CAFs will meet the same level of performance so for this reason fire testing will be required to set application rates.

Response Message: SR-53-NFPA 11-2020

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Second Revision No. 23-NFPA 11-2020 [Section No. 5.2.4.1.1]

5.2.4.1.1*

Monitor nozzles shall ~~not~~ be permitted to be used as the primary means of protection for ~~fixed-~~ cone roof tanks ~~over 60 ft (18 m) in diameter.~~ when part of a portable, mobile, or semi-fixed system (adequate fire water delivery, foam concentrate supply, and portable or fixed foam monitors), which can be put in service within 4 hours to protect the cone roof tank when the following requirements are met:

(1) Risk assessment completed

(2) Pre-incident contingency plan completed

(3) Where approved by the AHJ

A.5.2.4.1.1

Since the most common cone roof tank fire involves an overfill of the cone roof tank or an internal explosion that results in total or partial roof separation, the AHJ should develop and approve appropriate response tactics to deal with each credible scenario when mobile foam monitors or handlines are selected as the method to be used. The pre-incident contingency plan should be in accordance with API RP 2021.

Testing by the Copenhagen Airport Fire Department and the LASTFIRE Consortium has demonstrated that some SFFF can be applied to both spill and fuel in-depth fires using monitor nozzles to successfully extinguish those types of fires.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 08:51:45 EST 2020

Committee Statement

Committee Statement: To reflect existing advancements in technology and the method to protect cone roof tanks. See Ci 52 Large Tank Task Group

Response Message: SR-23-NFPA 11-2020

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Second Revision No. 24-NFPA 11-2020 [Section No. 5.2.4.2.1]

5.2.4.2.1* Flow Considerations.

A.5.2.4.2.1

The specified minimum delivery rate for primary protection ~~is based on the assumption~~ assumes that ~~all~~ the additional foam ~~reaches~~ solution that is determined using the 1.5 factor will be enough to deliver the remaining needed specified foam to the area being protected. Testing by the FPRF would suggest that some SFFF needs to be air-aspirated. Nozzles with an air-aspiration factor of at least 8 to 10 should be used.

5.2.4.2.1.1

To determine actual solution flow requirements, consideration shall be given to potential foam losses from wind, and other factors shall be included in the calculations.

5.2.4.2.1.2

A factor of 1.5 additional foam application rate shall be used as a minimum to compensate for these factors.

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Feb 05 10:01:47 EST 2020

Committee Statement

Committee Statement: Clarifies confusion of what safety factor should be used.
Response Message: SR-24-NFPA 11-2020

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Second Revision No. 1-NFPA 11-2020 [Section No. 5.2.4.2.2]

5.2.4.2.2*

The design parameters for the use of monitors and handline nozzles to protect tanks containing hydrocarbons shall be in accordance with Table 5.2.4.2.2.

Table 5.2.4.2.2 Foam Handline and Monitor Protection for Fixed-Roof Storage Tanks Containing Hydrocarbons

Hydrocarbon Type	Minimum Application Rate		Minimum Discharge Time (minutes)
	gpm/ft^2	mm/min*	
Flash point between 100°F and 140°F (38°C and 60°C)	0.16	6.5	50
Flash point below 100°F (38°C) or liquids heated above their flash points	0.16	6.5	65
Crude petroleum	0.16	6.5	65

Notes:

(1) Included in this table are gasohols and unleaded gasolines containing no more than 10 percent oxygenated additives by volume. Where oxygenated additives content exceeds 10 percent by volume, protection is normally in accordance with 5.2.4.3. Certain nonalcohol-resistant foams might be suitable for use with fuels containing oxygenated additives of more than 10 percent by volume. The manufacturer should be consulted for specific listings or approvals.

(2) Flammable liquids having a boiling point of less than 100°F (38°C) might require higher rates of application. Suitable rates of application should be determined by test. Flammable liquids with a wide range of boiling points might develop a heat layer after prolonged burning and then can require application rates of 0.2 gpm/ft^2 (8.2 mm/min) or more.

(3) Care should be taken in applying portable foam streams to high-viscosity materials heated above 200°F (93°C). Good judgment should be used in applying foam to tanks containing hot oils, burning asphalts, or burning liquids that have a boiling point above the boiling point of water. Although the comparatively low water content of foams can beneficially cool such fuels at a slow rate, it can also cause violent frothing and “slop-over” of the tank's contents.

(4) Testing by the LASTFIRE Group has confirmed that the use of compressed air foam delivery systems can extinguish tank fires using monitors, handlines, and fixed foam application appliances. The results of testing by listing agencies, other third-party research testing organizations, or manufacturer’s data should be used to determine application rates for this type of hydrocarbon fire control.

(5) When using SFFF, the user should refer to Annex H and the manufacturer’s recommendations to determine application rates.

* L/min·m^2 is equivalent to mm/min.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 09:02:25 EST 2020

Committee Statement

Committee Statement: Fire test both small and large scale conducted by LASTFIRE supports a lower rate of application and discharge time for CAFs. Proposed are lower ROAs and shorter discharge times that would establish the lowest level allowed by the standard subject to supporting fire testing witnessed by a third party. In this standard there is already established lower ROAs and durations for CAFs when applied with fixed pipe, spray nozzles systems. The recent study conducted by LASTFIRE provides test data that supports these statements. Not all foams and CAFs will meet this level of performance

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so for this reason fire testing witnessed by a third party shall be required of all manufactures

Response Message: SR-1-NFPA 11-2020

Public Comment No. 8-NFPA 11-2019 [Section No. 5.2.4.2.2]

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Second Revision No. 39-NFPA 11-2020 [Section No. 5.2.4.3.1]

5.2.4.3.1*

Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to regular (non- alcohol-resistant) foams shall use alcohol-resistant foams.

A.5.2.4.3.1

In general, alcohol-resistant foams can be effectively applied through foam monitor or foam hose streams to spill fires of these liquids where the liquid depth does not exceed 1 in. (25 mm). Recent FPRF testing on SFFF would suggest that any gasoline with a minimum of 10 percent ethanol must be treated as a polar solvent for foam selection purposes.

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Mar 11 07:52:06 EDT 2020

Committee Statement

Committee Statement: Additional information on florene free foam.
Response Message: SR-39-NFPA 11-2020

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Second Revision No. 40-NFPA 11-2020 [Section No. 5.2.4.3.2]

5.2.4.3.2*

For liquids ~~of a depth~~ in depths greater than 1 in. (25 mm), monitor and foam hose streams shall be limited for use with special alcohol-resistant foams listed and/or approved for the purpose.

A.5.2.4.3.2

If application results in foam submergence, the performance of alcohol-resistant foams usually deteriorates significantly, particularly where there is a substantial depth of fuel. The degree of performance deterioration depends on the degree of water solubility of the fuel (i.e., the more soluble, the greater the deterioration). Special alcohol-resistant foams are available for polar solvents in depths greater than 1 in. (25 mm) in both AFFF and SFFF.

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Mar 11 07:53:14 EDT 2020

Committee Statement

Committee Statement: Additional information on alcohol resistant foams.
Response Message: SR-40-NFPA 11-2020

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Second Revision No. 10-NFPA 11-2020 [Section No. 5.2.4.4]

5.2.4.4* Design Parameters.

Where monitors and handline nozzles are used to protect tanks containing flammable and combustible liquids requiring alcohol-resistant foams, the operation time shall be 65 minutes at listed application rates, unless the foam manufacturer has established, by fire test, that a shorter time shall be permitted.

A.5.2.4.4

Foam should not be used with monitors or handlines to plunge into polar solvents such as ethanol. Every effort should be made to apply the foam as gently as possible to the fuel surface. When using handlines, care should be exercised to gently apply the foam.

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Tue Feb 04 14:35:03 EST 2020

Committee Statement

Committee Statement: Already covered in A.5.1 but needs be repeated here.
Response Message: SR-10-NFPA 11-2020

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Second Revision No. 18-NFPA 11-2020 [Section No. 5.2.5.2.2]

5.2.5.2.2* Minimum Discharge Times and Application Rates.

Where fixed foam discharge outlets are used for fixed-roof (cone) tanks containing hydrocarbons, the minimum discharge times and application rates shall be in accordance with Table 5.2.5.2.2.

Table 5.2.5.2.2 Minimum Discharge Times and Application Rates for Type II Fixed Foam Discharge Outlets on Fixed-Roof (Cone) Storage Tanks Containing Hydrocarbons

Hydrocarbon Type	Minimum Application Rate		Minimum Discharge Time (minutes)
	gpm/ft^2	mm/min*	
Flash point between 100°F and 140°F (38°C and 60°C)	0.10	4.1	30
Flash point below 100°F (38°C) or liquids heated above their flash points	0.10	4.1	55
Crude petroleum	0.10	4.1	55

Notes:

(1) Included in this table are gasohols and unleaded gasolines containing no more than 10 percent oxygenated additives by volume. Where oxygenated additives content exceeds 10 percent by volume, protection is normally in accordance with 5.2.5.3. Certain nonalcohol-resistant foams might be suitable for use with fuels containing oxygenated additives of more than 10 percent by volume. Consult manufacturer for specific listings or approvals.

(2) Flammable liquids having a boiling point of less than 100°F (38°C) might require higher rates of application. Suitable rates of application should be determined by test.

(3) For high-viscosity liquids heated above 200°F (93°C), lower initial rates of application might be desirable to minimize frothing and expulsion of the stored liquid. Good judgment should be used in applying foams to tanks containing hot oils, burning asphalts, or burning liquids that have boiling points above the boiling point of water. Although the comparatively low water content of foams can beneficially cool such liquids at a slow rate, it can also cause violent frothing and “slop-over” of the tank's contents.

(4) Type I discharge outlets are considered obsolete, and those currently installed become Type II outlets if damaged. Refer to A.5.2.5.2.2 for additional information and minimum discharge times for existing Type I outlets.

(5) Testing by the LASTFIRE Group has confirmed that the use of compressed air foam delivery systems can extinguish tank fires using monitors, handlines, and fixed foam application appliances. The results of testing by listing agencies, other third-party research testing organizations, or manufacturer’s data should be used to determine application rates for this type of hydrocarbon fire control.

(6) When using SFFF, the user should refer to Annex H and the manufacturer’s recommendations to determine application rates.

*L/min·m^2 is equivalent to mm/min.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 08:25:27 EST 2020

Committee Statement

Committee Statement: Fire test both small and large scale conducted by LASTFIRE supports a lower rate of application and discharge time for CAFs. Proposed are lower ROAs and shorter discharge times that would establish the lowest level allowed by the standard subject to supporting fire testing witnessed by a third party. In this standard there is already established lower ROAs and durations for CAFs when applied with fixed pipe, spray nozzles systems. The recent study conducted by LASTFIRE provides

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test data that supports these statements. Not all foams and CAFs will meet this level of performance so for this reason fire testing witnessed by a third party shall be required of all manufactures

Response Message: SR-18-NFPA 11-2020 Fire test both small and large scale conducted by LASTFIRE supports including Compressed air foam delivery systems as one of the options for tank and other hydrocarbon extinguishment systems. Present data does not support establishing a standard application requirement for all Compressed air foam delivery systems or type of foam using that system at this time. Not all foams and CAFs will meet the same level of performance so for this reason fire testing will be required to set application rates.

Public Comment No. 20-NFPA 11-2019 [Section No. 5.2.5.2.2]

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Second Revision No. 41-NFPA 11-2020 [Section No. 5.2.6.1.2]

5.2.6.1.2*

Foam concentrates and equipment for subsurface injection shall be listed for this purpose.

A.5.2.6.1.2

The expansion ratios for subsurface injection are typically between 2:1 and 4:1. Limited testing with SFFFs applied with subsurface form injection systems suggests that, for some fuels, some SFFFs can be applied using subsurface foam injection systems. However, the user should check with the specific foam manufacturer to confirm that it has been tested for that use.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 11 08:23:22 EDT 2020

Committee Statement

Committee Statement: Additional information on synthetic flourine free foam testing.

Response Message: SR-41-NFPA 11-2020

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Second Revision No. 19-NFPA 11-2020 [Section No. 5.2.6.2.4]

5.2.6.2.4*

Where two or more outlets are required, they shall be located so that the foam travel on the surface cannot exceed 100 ft (30 m).

A.5.2.6.2.4

Fire tests have proven that most types of firefighting foam applied by monitors, fixed foam appliances, and compressed air foam appliances can and will travel over a burning fuel surface greater than 100 ft (30 m). Test results show that travel of 130 ft (40 m) to as much as 150 ft (46 m) is possible. See *LASTFIRE Ongoing Testing of New Generation Foams DFW Large Scale Extended Flow Test Report* for supporting test data.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 08:27:30 EST 2020

Committee Statement

Committee Statement: In recent fire test it has been proven that CAF can and will travel over a burning fuel surface greater than 100 ft (30) meters. Test results show that 131 ft. (40) meters travel is possible at the reduced ROA of 0.05 gpm / sq. ft. (2 lpm / sq. m)

See LASTFIRE report for supporting test data.

Response Message: SR-19-NFPA 11-2020

Public Comment No. 9-NFPA 11-2019 [Section No. 5.2.6.2.4]

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Second Revision No. 29-NFPA 11-2020 [Section No. 5.2.6.5.1]

5.2.6.5.1

The minimum discharge times and application rates for subsurface application on fixed-roof storage tanks shall be in accordance with Table 5.2.6.5.1.

Table 5.2.6.5.1 Minimum Discharge Times and Application Rates for Subsurface Application on Fixed-Roof Storage Tanks

Hydrocarbon Type	Minimum Application Rate		Minimum Discharge Time (minutes)
	gpm/ft^2	mm/min*	
Flash point between 100°F and 140°F (38°C and 60°C)	0.1	4.1	30
Flash point below 100°F (38°C) or liquids heated above their flash points	0.1	4.1	55
Crude petroleum	0.1	4.1	55

Notes:

(1) The maximum application rate shall be 0.20 gpm/ft^2 (8.1 mm/min).

(2) For high-viscosity liquids heated above 200°F (93°C), lower initial rates of application might be desirable to minimize frothing and expulsion of the stored liquid. Good judgment should be used in applying foams to tanks containing hot oils, burning asphalts, or burning liquids that are heated above the boiling point of water. Although the comparatively low water content of foams can beneficially cool such liquids at a slow rate, it can also cause violent frothing and “slop-over” of the tank's contents.

(3) When using SFFF, the user should refer to Annex H and the manufacturer’s recommendations to determine application rates.

*L/min·m^2 is equivalent to mm/min.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 14:54:01 EST 2020

Committee Statement

Committee Statement: Research test data indicates higher application rates might be needed for SFFF. See CI 36.

Response Message: SR-29-NFPA 11-2020

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Second Revision No. 42-NFPA 11-2020 [Section No. 5.3.1]

5.3.1 Tank Protection Options.

5.3.1.1

Tanks shall be protected by seal area protection only *(see 5.3.1.2)* or by seal protection and full surface protection *(see 5.3.1.3)* .

5.3.1.2

Seal area protection systems shall be permitted for the following types of roof construction:

(1) Steel double deck

(2) Steel pontoon

(3)* Other tank construction that has passed external tank construction testing

A.5.3.1.2(3) _

LASTFIRE has developed testing protocols. Examples of other tank construction include full liquid surface contact, metallic sandwich panels and full liquid surface contact, and composite sandwich roof/seal systems, designed in accordance with the performance criteria in Appendix H, “Internal Floating Roofs,” of API STD 650.

5.3.1.3

The following tank construction types shall be protected with both seal area and full surface protection due to the higher probability that the floating roof will be damaged and sink in a fire:

(1) Roofs made from floating diaphragms

(2) Roofs that rely on floatation device closures that are easily submerged if damaged

(3) Pan roofs

5.3.1.4

Tanks equipped with the following floating roof types shall not be covered in Section 5.3:

(1) Roofs made from floating diaphragms

~~Roofs made from plastic blankets~~

~~Roofs made from plastic or other flotation material, even if encapsulated in metal or fiberglass~~

(2) Roofs that rely on flotation device closures that are easily submerged if damaged

(3) Pan roofs

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Mar 11 08:45:57 EDT 2020

Committee Statement

Committee Statement: Changes based on Large Tank Task Group report.
Response Message: SR-42-NFPA 11-2020

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Second Revision No. 43-NFPA 11-2020 [Section No. 5.3.3.1]

5.3.3.1 Subsurface and Semisubsurface Injection.

Subsurface and semisubsurface injection shall not be used for protection of open-top or covered floating roof tanks because of the possibility of improper distribution of foam at the fuel surface caused by the floating roof, even if partially submerged .

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Mar 11 08:46:53 EDT 2020

Committee Statement

Committee Statement: Revisions based on Large Tank Task Group Report.
Response Message: SR-43-NFPA 11-2020

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Second Revision No. 44-NFPA 11-2020 [Section No. 5.3.4.1]

5.3.4.1

The following methods for fire protection of seals in open-top floating roof tanks shall be as required in 5.3.5 through 5.3.7:

(1) Fixed discharge outlets

(2) Foam handlines

(3)* ~~Foam monitors~~ Small portable monitors [500 gpm (1900 L/min) or less] from the top platform

A.5.3.4.1(3)

It should be recognized that overapplication of foam to a seal area can cause roof tilt and escalate the fire.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 11 08:47:43 EDT 2020

Committee Statement

Committee Statement: Additional annex material based on Large Tank Task Group Report.

Response Message: SR-44-NFPA 11-2020

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Second Revision No. 30-NFPA 11-2020 [Section No. 5.3.5.3.1]

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5.3.5.3.1

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The design parameters for the application of fixed foam discharge outlets on top of the seal to protect open-top floating roof tanks shall be in accordance with Table 5.3.5.3.1 and Figure 5.3.5.3.1.

Table 5.3.5.3.1 Top-of-Seal Fixed Foam Discharge Protection for Open-Top and Internal Floating Roof Tanks

					Maximum Spacing Between Discharge Outlets with			
	Applicable Illustration Detail	Minimum Application Rate		Minimum Discharge Time (minutes)	12 in. (305 mm) Foam Dam		(600 mm) Foam Dam	
		gpm/ft^2	mm/min*		ft	m	ft	m
Mechanical shoe seal	A	0.3	12.2	20	40	12	80	24
Tube seal with metal weather shield	B	0.3	12.2	20	40	12	80	24
Fully or partly combustible secondary seal	C	0.3	12.2	20	40	12	80	24
All metal secondary seal	D	0.3	12.2	20	40	12	80	24

~~Note~~ Notes :

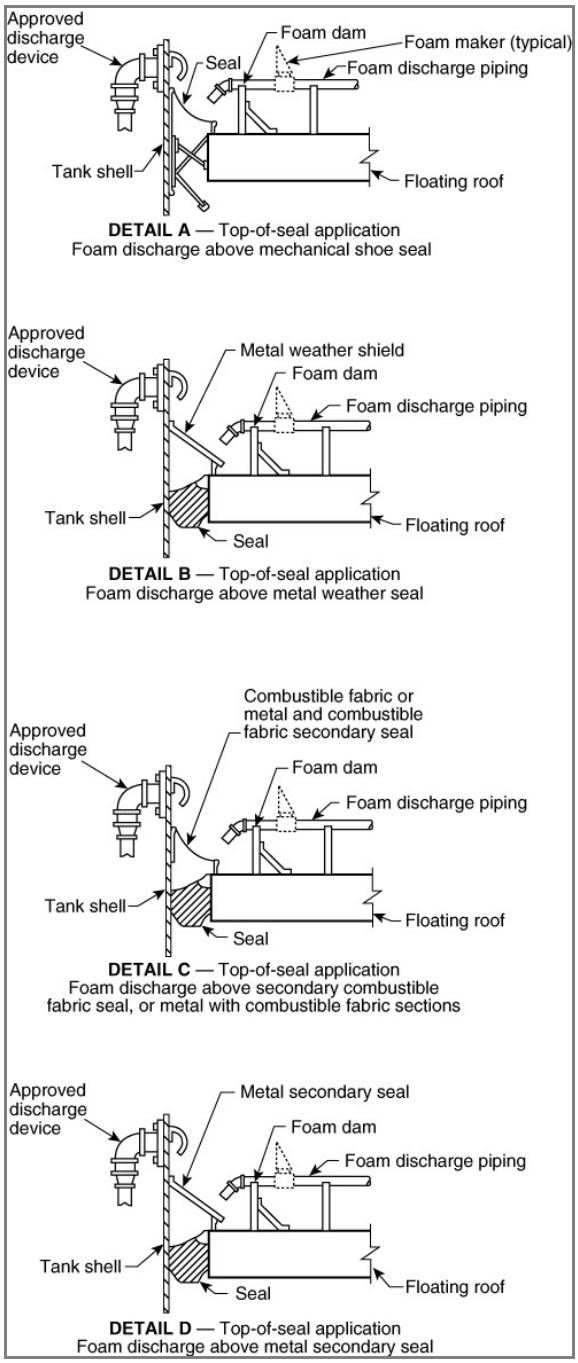
(1) Where the fixed foam discharge outlets are mounted above the top of the tank shell, a foam splashboard is necessary due to the effect of winds.

(2) When using SFFF, the user should refer to Annex H and the manufacturer's recommendations to determine application rates.

*L/min·m^2 is equivalent to mm/min.

Figure 5.3.5.3.1 Typical Foam System Illustrations for Top-of-Seal Fire Protection. Both fixed foam (wall-mounted) and roof-mounted discharge outlets are shown for illustrative purposes. Although both methods are shown, only one is needed.

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DETAIL A — Top-of-seal application
Foam discharge above mechanical shoe seal

DETAIL B — Top-of-seal application
Foam discharge above metal weather seal

DETAIL C — Top-of-seal application
Foam discharge above secondary combustible fabric seal, or metal with combustible fabric sections

DETAIL D — Top-of-seal application
Foam discharge above metal secondary seal

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 14:55:44 EST 2020

Committee Statement

Committee Statement: Research test data indicates higher application rates might be needed for SFFF. See CI 36.

Response Message: SR-30-NFPA 11-2020

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Second Revision No. 6-NFPA 11-2020 [Section No. 5.4.2 [Excluding any Sub-Sections]]

Seal area protection systems shall be permitted for the following types of roof construction:

(1) Steel double deck

(2) Steel pontoon

(3) Full liquid surface contact, metallic sandwich panel, conforming to Appendix H, “Internal Floating Roofs,” requirements of API STD 650

(4)* Full liquid surface contact, composite sandwich roof/seal system, designed in accordance with the performance criteria in Appendix H, “Internal Floating Roofs,” requirements of API STD 650 and the following:

(a) Fiberglass components shall be made from high-grade vinyl ester resin with a corrosion-resistant bottom surface and be compatible with the stored product.

(b) ~~Top~~ The top layer shall ~~provide~~ exhibit a flame spread ~~properties~~ index not exceeding 25 when tested in accordance with ASTM E84 ~~flame spread~~ (Class A) ~~rating~~ .

(c) The structural laminate of the composite sandwich structure shall be in accordance with ASTM C582.

(d) Core material shall be of a closed-cell structure for inherent redundant buoyancy and shall be chemically compatible with the stored product.

(e) The roof surfaces shall be a seamless, one-piece construction that utilizes chemical bonds to join all components.

(f) The perimeter seal system shall be gas-tight and utilize noncombustible material to cover the rim space.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 09:39:33 EST 2020

Committee Statement

Committee Statement: The only change proposed is editorial, to use the correct terminology, in item (b). All other changes were introduced by Terra. No requirements are being changed and no changes are being proposed for any other item.ASTM E84 provides flame spread index values and does not provide "flame spread". Class A flame spread index is a flame spread index not exceeding 25 and Class A ratings include smoke developed index requirements also and such requirements are not asked for in NFPA 11.

Proposed wording for item (b): (b) The top layer shall exhibit a flame spread index not exceeding 25 when tested in accordance with ASTM E84 (Class A).

Response Message: SR-6-NFPA 11-2020 Adds test protocol per CI 56 .

Public Comment No. 5-NFPA 11-2019 [Section No. 5.4.2 [Excluding any Sub-Sections]]

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Second Revision No. 20-NFPA 11-2020 [Section No. 5.6.3]

5.6.3 Methods of Protection.

The following methods shall be permitted for protecting loading racks:

(1) Foam-water sprinkler application utilizing air-aspirating foam-water sprinklers or nozzles or non-air-aspirating open standard sprinklers or foam nozzles using compressed air foam delivery systems

(2) Foam monitors or foam monitors using compressed air foam delivery systems

(3) Other devices approved by the AHJ

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 08:31:32 EST 2020

Committee Statement

Committee Statement: Adding compressed air delivery systems for foam monitors and foams nozzles for protecting hydrocarbon loading racks provides additional information on this technology and its use in applying foam for this type of hazard. Testing has demonstrated its successful use in extinguishing this type of fire.

Response Message: SR-20-NFPA 11-2020 Reject, but see modification: Adding compressed air delivery systems for foam monitors and foams nozzles for protecting hydrocarbon loading racks provides additional information on this technology and its use in applying foam for this type of hazard. Testing has demonstrated its successful use in extinguishing this type of fire.

Public Comment No. 16-NFPA 11-2019 [Section No. 5.6.3]

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Second Revision No. 46-NFPA 11-2020 [Section No. 5.7.3.2]

5.7.3.2* Minimum Application Rates and Discharge Times for Fixed Discharge Outlets on Diked Areas Involving Liquid Hydrocarbons.

The minimum application rates and discharge times for fixed foam application on diked areas shall be as specified in Table 5.7.3.2.

Table 5.7.3.2 Minimum Application Rates and Discharge Times for Fixed Foam Application on Diked Areas Involving Hydrocarbon Liquids

Type of Foam Discharge Outlets	Minimum Application Rate		Minimum Discharge Time (minutes)	
	gpm/ft^2	mm/min*	Class I Hydrocarbon	Class II Hydrocarbon
Low-level foam discharge outlets	0.10	4.1	30	20
Foam monitors	0.16	6.5	30	20
Foam using compressed air foam technology	Consult manufacturer for listed minimum application rate	Consult manufacturer for listed minimum application rate	30	20

*L/min·m^2 is equivalent to mm/min.

A.5.7.3.2

When using SFFF, the user should refer to Annex H and the manufacturer's recommendations to determine application rates.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Mon Mar 16 09:37:42 EDT 2020

Committee Statement

Committee Statement: Adding Foam generated by compressed air foam delivery technology in this table provides clarification on the progress that has been made to understand the capability of this technology and how it would be used to extinguish Class I and II hydrocarbon fires.

Response Message: SR-46-NFPA 11-2020

Public Comment No. 12-NFPA 11-2019 [Section No. 5.7.3.2]

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Second Revision No. 31-NFPA 11-2020 [Section No. 6.5.2.2.1]

6.5.2.2.1

The design discharge density shall be in accordance with the applicable occupancy standard for water or foam-water systems but in no case less than 0.16 gpm/ft^2 (6.5 mm/m^2).

6.5.2.2.1.1

When using SFFF, the user shall refer to Annex H and the manufacturer's recommendations to determine application rates.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 15:06:35 EST 2020

Committee Statement

Committee Statement: Research test data indicates higher application rates might be needed for SFFF. See CI 36.

Response Message: SR-31-NFPA 11-2020

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Second Revision No. 60-NFPA 11-2020 [Section No. 6.7]

6.7 Inspection, Testing, and Maintenance.

Inspection, testing, and maintenance shall be in accordance with ~~Section 12.10~~ Chapter 13 .

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Thu Jun 04 13:51:40 EDT 2020

Committee Statement

Committee Statement: This section referenced inspection testing and maintenance which is now located in Chapter 13. This revision incorporates the correct reference.

Response Message: SR-60-NFPA 11-2020

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Second Revision No. 22-NFPA 11-2020 [Section No. 8.9.1]

8.9.1

Compressed air foam systems conforming to this chapter shall be fixed deluge-type systems, ~~or~~ fixed spray-type systems, or fixed or semi-fixed pipe Type II and Type III applications , wherein compressed air foam shall discharge simultaneously from all nozzles or devices upon system activation.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 08:41:28 EST 2020

Committee Statement

Committee Statement: Paragraph 3.3.17.1 Compressed Air Foam Systems (CAFS) now states Type II and Type III applicators are inclusive of CAFS . It should be that the divination of Section 8.9.1 Compressed Air Foam Systems be clear and aliened with paragraph 3.3.17.1. This change clarifies that foam delivered by Compressed Air Foam Systems (CAFS) can be also used for Type II and III applications

Response Message: SR-22-NFPA 11-2020

Public Comment No. 14-NFPA 11-2019 [Section No. 8.9.1]

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Second Revision No. 7-NFPA 11-2020 [Section No. 10.8.1]

10.8.1

A ½ in. (15 mm) ~~FNPT (~~ female National Pipe Thread~~)~~ (FNPT) ~~plugged~~ threaded connection for a pressure gauge ~~connection~~ shall be provided at the most remote fixed foam discharge outlet.

10.8.2

The ½ in. (15 mm) connection for foam makers and foam chambers shall be installed 2 to 4 pipe diameters upstream of the discharge device inlet.

10.8.3

Where galvanized piping is used in accordance with 4.7.2.2 , the threaded connection shall be installed on the spool piece prior to being treated to prevent localized corrosion at the connection.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 11:08:48 EST 2020

Committee Statement

Committee Statement: The current section requires more detail be provided for designers. The current wording does not prevent someone from adding a flange tap connection on the outlet flange of the most remote fixed foam discharge outlet. This would not provide the pressure of the foam solution at the most remote chamber before being aspirated, which is the intent of this section.

The proposed changes provide direction to designers and installers to provide a 1/2" connection on the foam solution piping spool piece before the foam chamber. The change also provides direction for installers to have the connection installed prior to hot-dipping the piping (if galvanized pipe is used) rather than compromising the galvanized coating after fabrication in order to add this connection and introducing another corrosion point within the system.

Response Message: To provide clarification for the installer.

Public Comment No. 18-NFPA 11-2019 [Section No. 10.8.1]

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Second Revision No. 32-NFPA 11-2020 [Section No. 11.13.1]

11.13.1

Piping shall be in compliance with ~~Table 11.13.1 ; other materials shall be permitted to be used provided they have physical properties and corrosion resistance equivalent to the piping identified in Table 11.13.1 and are approved by the AHJ~~ Section 4.7 , except as provided in 11.13.1.1 .

~~Table 11.13.1 Piping Materials~~

Service	Pipe	Valves	Fittings	Takedown Joints
~~Seawater or foam solution (up to 225 psi (15.5 bar) and 350°F (177°C)~~	~~Carbon steel, seamless or electric resistance weld, standard wall, galvanized *,† . ASTM A53/A53M, Type E or S, Gr. A or ASTM A106/A106M, Gr. A Schedule 40 minimum~~	~~*Body:* Carbon steel, ASTM A216/A216M Gr. WCB or ductile iron, ASTM A395/A395M~~ ~~*Trim:* Bronze or 316 SS~~ ~~*Ends:* Flanged ASME B16.5 Class 150~~	~~*3 in. and larger:* Wrought steel, standard wall, galvanized per ANSI B16.9, 150 lb minimum~~ ~~*2 in. and smaller:* Socket weld steel, 2000#, galvanized per ANSI B16.11~~ ~~ASTM A234/A234M Gr. WPB~~	~~*3 in. and larger:* Slip-on or buttweld flange~~ ~~*2 in. and smaller:* Socket weld flange~~ ~~ASME B B16.5 Class 150, ASTM A105/A105M~~
~~Foam concentrate (in the hazard area)~~	~~Carbon steel, seamless or electric resistance weld, standard wall. ASTM A53/A53M, Type E or S, Gr. A or ASTM A106/A106M, Gr. A~~ ~~OR~~ ~~Stainless steel, seamless, standard wall pipe~~ ~~ASTM A312 Gr. TP304L or TP316L~~	~~*Body:* Carbon steel, ASTM A216/A216M Gr. WCB or ASTM A 105~~ ~~*Trim:* 304L or 316L SS~~ ~~*Ends:* Flanged ASME B16.5 Class 150 or screwed~~ ~~OR~~ ~~*Body:* Forged stainless steel, ASTM A182/A182M Gr. F304L or F316L~~ ~~*Trim:* 304L or 316L SS~~ ~~*Ends:* Flanged ASME B16.5 Class 150 or screwed~~	~~Socket weld or threaded carbon steel, 2000# per ASME B16.11 A234/A234M Gr. WPB~~ ~~OR~~ ~~Socket weld or threaded stainless steel, 2000# per ASME B16.11 ASTM A182/A182M Gr. F304L or F316L~~	~~Screwed or socket weld flange per ASME B16.5 Class 150 ASTM A105/A105M or ASTM A182/A182M Gr. 304L or Gr. 316L~~ ~~OR~~ ~~Screwed or socket weld union, 2000# per ASME B16.11~~ ~~ASTM A105/A105M or ASTM A182/A182M Gr. 304L or Gr. 316L~~

~~For SI units: 1 psi = 6.895 kPa; 5/9 (degrees F – 32) = degrees C.~~

~~Note: Standards shown are minimum acceptable. Equivalent foreign standards can be used if approved.~~

~~* System can be assembled using black steel pipe and fittings, hot dip galvanized after fabrication.~~

~~† Where pipe and fittings are galvanized, all disturbed areas are to be repaired using a cold galvanizing product.~~

11.13.1.1

Unprotected carbon steel pipe shall not be used for foam solution piping.

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Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 17:00:00 EST 2020

Committee Statement

Committee Statement: Piping should be in accordance with Chapter 4 and revised section 4.7. See CI 47 Piping Task Group Report.

Response Message: SR-32-NFPA 11-2020

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Second Revision No. 33-NFPA 11-2020 [New Section after 11.13.5]

11.13.6

When foam solution piping is assembled using unprotected steel pipe and fittings, it shall be hot-dip galvanized after fabrication.

11.13.7

Where pipe and fittings are galvanized, all disturbed areas shall be repaired using a cold galvanizing product.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 17:03:12 EST 2020

Committee Statement

Committee Statement: Coordinates piping requirements with that of Chapter 4. See CI 47 Piping Task Group.

Response Message: SR-33-NFPA 11-2020

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Second Revision No. 48-NFPA 11-2020 [Chapter 12 [Title Only]]

Acceptance Testing ~~and Acceptance~~

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Fri Mar 20 15:16:37 EDT 2020

Committee Statement

Committee Statement: New title to align with reformatting.
Response Message: SR-48-NFPA 11-2020

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Second Revision No. 54-NFPA 11-2020 [Section No. 12.6.3]

12.6.3*

The following data shall be required:

(1) Static water pressure

(2) Residual water pressure at the control valve and at a remote reference point in the system

(3) Actual discharge rate

(4) Consumption rate of foam-producing material

(5) Concentration of the foam solution

A.12.6.3

Recording the expansion ratio and drain time of SFFF and comparing them to the manufacturer's listing report or manufacturer's specifications can help to ensure system performance. See Annex H .

12.6.3.1

For compressed air foam systems, the following data shall be recorded as part of any discharge test:

(1) Static water pressure

(2) Residual water pressure at the control valve

(3) System air pressure

(4) Concentration of the foam solution

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 25 16:48:47 EDT 2020

Committee Statement

Committee Statement: Expansion and drain time of SFFF is critical based on the FPRF and LASTFIRE test reports.

Response Message: SR-54-NFPA 11-2020

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Second Revision No. 35-NFPA 11-2020 [Section No. A.3.3.5.1]

A.3.3.5.1 In-Line Eductor.

This eductor is used for installation in a hoseline, usually at some distance from the foam maker or playpipe, as a means of drafting air foam concentrate from a container. *(See Figure A.3.3.5 and Figure A.3.3.5.1.)*

Figure A.3.3.5.1 ~~Air Foam Hose Nozzle with Built-in Eductor~~ Foam Tanker .



The in-line eductor must be designed for the flow rate of the particular foam maker or playpipe with which it is to be used. The device is very sensitive to downstream pressures and accordingly is designed for use with specified lengths of hose or pipe located between it and the foam maker.

The pressure drop across the eductor is approximately one-third of the inlet pressure.

The elevation of the bottom of the concentrate container should not be more than 6 ft (1.8 m) below the eductor.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Feb 05 19:07:08 EST 2020

Committee Statement

Committee Replaced figure with more modern equipment for illustrative purposes per CI 53 and Photo

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Statement: Task Group

Response Message: SR-35-NFPA 11-2020

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Second Revision No. 36-NFPA 11-2020 [Section No. A.3.3.17.2.1.1]

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A.3.3.17.2.1.1 Foam-Water Deluge System.

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Foam-water sprinklers are open-type sprinklers designed to do the following:

(1) Receive foam solution (water plus liquid concentrate)

(2) Direct the solution through an integral foam maker, the nozzle action of which breaks the solution into spray and discharges it into a mixing tube, where it combines with air drawn in through openings in the housing

(3) Provide mixing chamber capacity for development of the air foam

(4) Direct the formed foam discharging from the open end of the mixing tube against a deflector, shaped to distribute the foam in a pattern essentially comparable to the water distribution pattern of present-day standard sprinklers (nomenclature from NFPA 13) and to do so with essentially no impingement of the foam on the ceiling

(5) Develop a water distribution pattern directly comparable to that of standard sprinklers, in the case of discharge of water only (i.e., in the absence of foam)

The normal direction of discharge from foam-water sprinklers is downward. To provide a choice in installation design, foam-water sprinklers are produced for installation in the upright position and in the pendent position with the pattern of discharge in either case in the downward direction. Sprinkler deflectors are formed to produce the required discharge pattern, which could mean differing shapes of deflectors for each of the two positions of installation. The variation in the shape of deflectors is illustrated in Figure A.3.3.17.2.1.1.

When the valve in a foam-water deluge system opens, water flows into the piping system and discharges from all discharge devices attached thereto.

Figure A.3.3.17.2.1.1 Variations in Deflector Shape.



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Supplemental Information

File Name	Description	Approved
FWS_A.3.3.17.2.1.jpg	Updated sprinkler photo. For staff use	

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Feb 05 19:17:17 EST 2020

Committee Statement

Committee Statement: New high resolution photo per Photo Task Group CI #53.
Response Message: SR-36-NFPA 11-2020

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Second Revision No. 28-NFPA 11-2020 [Section No. A.5.2.5.2.1]

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A.5.2.5.2.1

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It is recommended that, for tanks greater than 200 ft (61 m) in diameter, at least one additional discharge outlet should be added for each additional 5000 ft^2 (460 m^2) of liquid surface or fractional part thereof. Since there has been limited experience with foam application to fires in fixed-roof tanks greater than 140 ft (43 m) in diameter, requirements for foam protection on such tanks are based on the extrapolation of data from successful extinguishments in smaller tanks. Tests have shown that foam can travel effectively across at least 100 ft (30 m) of burning liquid surface. On fixed-roof tanks of over 200 ft (61 m) diameter, subsurface injection can be used to reduce foam travel distances for tanks containing hydrocarbons only. Unless subsurface foam injection is utilized, a properly sized flanged connection should be installed on all atmospheric pressure storage tanks, regardless of present intended service, to facilitate the future installation of an approved discharge outlet if a change in service should require such installation. Figure A.5.2.5.2.1(a) and Figure A.5.2.5.2.1(b) are typical fixed foam discharge outlets or foam chambers.

Figure A.5.2.5.2.1(a) ~~Air Foam Maker in Horizontal Position at Top of Storage Tank~~ Foam Chamber .



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Figure A.5.2.5.2.1(b) Foam Chamber ~~and Foam Maker~~ Deflector .



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Supplemental Information

File Name	Description	Approved
Figure_A.5.2.5.2.1_a_.JPG	Foam Chamber. For staff use	
Figure_A.5.2.5.2.1_b_2_.JPG	Foam Chamber Deflector. For staff use	

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Wed Feb 05 14:11:40 EST 2020

Committee Statement

Committee Statement: Delete Figure A.5.2.5.2.1(a) as it is obsolete as per Photo Task Group and CI 53.
Response Message: SR-28-NFPA 11-2020

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Second Revision No. 45-NFPA 11-2020 [Section No. A.5.4.2]

A.5.4.2

The decision to provide ~~rimseal~~ rim seal and/or full surface protection foam systems should include consideration of the tank roof and seal structure and the relative risk associated with potential fire scenarios. See Annex I for additional information on the rim seal fire test protocol.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed Mar 11 10:39:51 EDT 2020

Committee Statement

Committee Statement: A new annex was developed as a methodology to demonstrate that a non-metallic floating roof structure has sufficient fire resistance to withstand the effects of a foreseeable rimseal and/or spill on roof fire to such an extent to maintain its integrity for sufficient time to allow extinguishment of a rimseal fire. It was developed by an industry group developing best practice guidance for storage tank fire hazard management.

Response Message: SR-45-NFPA 11-2020

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Second Revision No. 56-NFPA 11-2020 [Section No. A.12.6.4]

A.12.6.4

FM Approvals 5138~~, *Assessment Standard for Proportioning Testing*~~ , should be consulted for possible listing requirements.

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Thu Apr 23 11:41:00 EDT 2020

Committee Statement

Committee Statement: Deleted title of document for consistency of style for other referenced documents.

Response Message: SR-56-NFPA 11-2020

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Second Revision No. 58-NFPA 11-2020 [Section No. H.1.2.2]

J.1.2.2 AIChE Publications.

American Institute of Chemical Engineers, 120 Wall Street, FL 23, New York, NY 10005-4020.

Guidelines for Safe Warehousing of Chemicals, Center for Chemical Process Safety, 1998 .

Submitter Information Verification

Committee: FOM-AAA
Submittal Date: Thu Apr 23 11:48:24 EDT 2020

Committee Statement

Committee Statement: Added year of publication.
Response Message: SR-58-NFPA 11-2020

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Second Revision No. 9-NFPA 11-2020 [Section No. H.1.2.4]

J.1.2.4 ASTM Publications.

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

ASTM ~~D 1141~~ D1141 , *Standard Practice for the Preparation of Substitute Ocean Water*, 1998, reapproved 2013 .

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Tue Feb 04 12:08:16 EST 2020

Committee Statement

Committee Statement: date update Editorial.

Response Message: SR-9-NFPA 11-2020

Public Comment No. 4-NFPA 11-2019 [Section No. H.1.2.4]

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Second Revision No. 57-NFPA 11-2020 [Section No. H.1.2.10]

J.1.2.10 TC Publications.

Transport Canada, 330 Sparks Street, Ottawa, ON K1A 0N5, Canada.

TP 127 E, *Ships Electrical Standards*, Revision 02, May ~~2008~~ 2018 .

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Thu Apr 23 11:45:34 EDT 2020

Committee Statement

Committee Statement: Updated reference document to most current to comply with NFPA Manual of Style.

Response Message: SR-57-NFPA 11-2020

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Second Revision No. 59-NFPA 11-2020 [Section No. J.3]

J.3 References for Extracts in Informational Sections.

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

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

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

Submitter Information Verification

Committee: FOM-AAA

Submittal Date: Wed May 27 11:49:52 EDT 2020

Committee Statement

Committee Statement: Revision based on new text in A.6.5.2.6.1.

Response Message: SR-59-NFPA 11-2020