NFPA No.

412

EVALUATING

FOAM FIRE EQUIPMENT

AIRCRAFT RESCUE & FIRE FIGHTING VEHICLES

1965

Sixty Cents

NATIONAL FIRE PROTECTION ASSOCIATION
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Official NFPA Definitions

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

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Standard for

Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles

NFPA No. 412 — 1965

1965 Edition of NFPA No. 412

This standard, prepared by the NFPA Sectional Committee on Aircraft Rescue and Fire Fighting and submitted to the Association through the NFPA Committee on Aviation, was approved by the Association at its 1965 Annual Meeting held May 17–21 in Washington, D.C. The changes made in this standard as compared with the 1964 edition concern Paragraphs 112, 113, 224, 227, 321.a. (Note), 323, 324, 325.a., 334 (Table), 341, 342, 344, and the addition of Appendix B. Editorial changes have been made in references as needed.

Origin and Development of No. 412

Work on this material started in 1955 when the NFPA Subcommittee on Aircraft Rescue and Fire Fighting (as then constituted) initiated a study on methods of evaluating aircraft rescue and fire fighting vehicles. A tentative text was adopted by the Association in 1957. A revision was made in 1960 to clarify the intent of the text and a rewrite was made in 1964 based on improved test procedures. This edition contains added improved guidance and represents the latest advances.

Companion NFPA publications dealing with aircraft rescue and fire fighting services include: NFPA No. 402 on Standard Operating Procedures, Aircraft Rescue and Fire Fighting; NFPA No. 403, Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports; and NFPA No. 414, Standard for Aircraft Rescue and Fire Fighting Vehicles.

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Table of Contents

Standard for

Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles

NFPA No. 412

100. GENERAL

110. Purpose

111. This standard provides standard test procedures for evaluating the foam fire fighting equipment installed on aircraft rescue and fire fighting vehicles designed in accordance with the applicable portions of the NFPA Standard for Aircraft Rescue and Fire Fighting Vehicles (No. 414) and used for the purposes described in the NFPA Suggestions for Aircraft Rescue and Fire Fighting Services of Airports and Heliports (No. 403). Standard Operating Procedures for Aircraft Rescue and Fire Fighting are given in NFPA No. 402.

112. The test procedures are for field application and are intended to produce standardized data useful for determining the capability of the foam fire fighting equipment to meet the operational requirements likely to be imposed on such equipment prior to an actual emergency. It is acknowledged that in actual emergencies many variables are involved (weather and terrain are two obvious variables encountered in every accident), so that these test procedures are summarily incomplete. It is also acknowledged that all users of this equipment will not be in a position to conduct all of the tests described. Whenever possible this data should be sought from the equipment manufacturer prior to procurement. In addition to obtaining the standardized data, using these test procedures offers an excellent opportunity for the local operating personnel to become familiar with the basic capabilities and limitations of the foam fire fighting equipment they are using and teach them to operate such equipment to maximum advantage.

113. In order to provide a background on the usage of foam, the following material is reprinted from NFPA No. 403 (complete reference in Paragraph 111):

113. Foam

a. Foam used for aircraft rescue and fire fighting consists of an aggregation of bubbles of lower specific gravity than oil or water possessing tenacious qualities for covering and clinging to vertical or horizontal surfaces. It should be able to cool hot surfaces, flow over a burning liquid surface and form a long lasting, air-excluding blanket that seals off volatile flammable vapors from access to air or oxygen. Good quality foam should be homogeneous, resisting disruption due to wind and draft or heat and flame attack. It should be capable of resealing in event of mechanical rupture of an established blanket. Foam, when applied to the fuselage of an aircraft, insulates, cools and reflects radiant heat, providing protection to occupants. Mechanical foam (air foam) is the principal type used for aircraft rescue and fire fighting. This type of foam is produced by the physical agitation of a mixture of water, air and a foam liquid concentrate. The concentrates are produced in two approved strengths: one is for use in a nominal proportion of 3 per cent in water and a second for use in a nominal 6 per cent proportion. Both types can be used to produce a suitable mechanical foam but the manufacturer of the foam-making equipment should be consulted as to the correct concentrate to be used in any particular system (the proportioners installed must be properly designed and/or set for the concentrate being used). Mixing foam liquids of different types or different manufacture should not be done unless it is established that they are completely compatible.

b. Mechanical foam (air foam) is particularly suited for aircraft rescue and fire fighting because the basic ingredients, water and foam liquid concentrate, can be carried in bulk to the scene of the accident and brought into operation with the minimum of delay. The most serious limitation of foam for aircraft rescue and fire fighting is the problem of quickly supplying large quantities of foam to the fire in a gentle manner so as to form an impervious fire-resistant blanket on large flammable liquid spills. The hazards of disrupting established foam blankets by turbulence, water precipitation and heat baking can be overcome by firemen's training and the purchase of a good quality of the basic foam ingredient.

c. Mechanical foam (air foam) may be produced in a number of ways. The methods of foam production selected should be carefully weighed considering the techniques of employment best suited to the equipment concerned, the rates and patterns of discharge desired and the manpower needed to properly dispense the foam capabilities of the vehicles. The principal methods of foam production in use are:

(1) Nozzle Aspirating Systems. Foam is produced by pumping a proportioned solution of water and foam liquid concentrate under high pressure into a specialized discharge appliance or nozzle which draws in atmospheric air and mixes it mechanically with the solution. Various devices are used to shape the discharge pattern between a straight stream and a spray.

(2) In-Line Foam Pump Systems. A proportioned solution of water and foam liquid concentrate is injected at atmospheric or higher

pressure into a positive displacement type pump which sucks in atmospheric air and mixes it with the solution to generate foam. The foam is formed in the discharge piping or hose as in the in-line aspirating and in-line compressed air systems. Nozzles serve only to distribute the foam in various patterns.

(3) In-Line Aspirating Systems. An inductor in the pump discharge line receives a proportional solution of water and foam liquid concentrate under pressure, or water only if the inductor is designed also to draft the correct amount of foam liquid concentrate. The liquid in passing through the inductor draws in atmospheric air which is mixed with the solution to form foam in the discharge lines. Nozzles serve only to distribute the foam in various patterns.

(4) In-Line Compressed Air Systems. These are similar to in-line aspirating systems except that air under pressure is injected into the solution. The air is supplied by a compressor on the vehicle.

d. Foam is currently applied in two principal pattern configurations, solid stream and dispersed patterns. Normally both methods of application are available using variable nozzles. Training and experience will determine the best method of application under a given set of circumstances. Foam when dispersed in wide, uniformly dispersed patterns (sometimes called "fog-foam" or "snow-foam") is used principally for direct application to a large area of burning fuel or while securing the rescue area. It falls very gently on the surface, giving radiation protection to the fire fighter and cooling and smothering the fire in a short time. Solid streams of foam are used principally for fire situations requiring long distance reach or where the foam may be deflected from a solid barrier to facilitate gentle application. Solid stream foam is not recommended for close-in rescue operations.

e. The quality of water to be used in making foam may affect foam performance. No corrosion inhibitors, freezing point depressants or any other additives should be used in the water supply without prior consultation and approval of the foam liquid concentrate manufacturer.

200. EASE OF OPERATION OF CONTROLS

210. Purpose

211. The ease with which qualified fire fighters are able to operate the controls on equipment available to them will be an indication of the utility of the equipment during an actual emergency.

212. Vehicular performance test procedures are given in the NFPA Standard on Aircraft Rescue and Fire Fighting Vehicles (No. 414).

213. This article outlines the tests to be conducted to evaluate the ease of operation of controls for the foam fire fighting equipment supplied on the vehicle.

220. Testing Foam Equipment Controls

221. Tests shall include all crew functions in operating, servicing and charging the foam extinguishing system supplied.

222. Following indoctrination, crews should perform complete fire fighting cycles with studies made of the operational procedures, the time factors involved, any difficulties experienced, and the teamwork needed to gain maximum efficiency in the operation of the foam equipment.

223. Selection and operation of controls should be as required under anticipated service usage. Turrets should be operated over their entire area of coverage and in all available ranges, while hand lines should be fully extended, moved as required in actual emergencies, and put back.

224. Charging and servicing the vehicle should include discharge, flushing, and recharging. Replenishing of agents should also be evaluated under emergency conditions such as would be expected at the scene of a major fire and away from the normal servicing facilities. "Nurse" trucks supplying water and/or foam concentrate shall also be run at installations where such apparatus is available.

225. During the tests, fire fighters should wear their standard protective clothing and masks or headgear and assume at the start of the test their assigned positions on the vehicle.

226. Simulated runs to an accident site should be accomplished in each instance and varied imaginary accident locations selected.

227. Tests should also include operation of the vehicle under reduced manpower conditions, e.g., the crew chief may have to be the turret operator, therefore there should be ease of movement from his seat (normally front right) to the turret; the vehicle may have to be "one-man operated," therefore the driver should be able to move with ease (once he has positioned the vehicle) from his seat to the turret and return quickly; the operating controls should be easily accessible and readily identifiable.

300. FOAM PERFORMANCE TESTING

310. Purpose

311. Effective performance of the foam available for fire fighting depends on its physical characteristics of expansion, the viscosity of the foam, the heat and solvent resistance of the foam, and the concentration of the foam concentrate required. All of these characteristics cannot be readily determined by field tests. However, expansion, 25 per cent drainage time (which is an indication of the viscosity of the foam), and foam concentration are measurable properties that give a relative indication of foam quality and are the characteristics that should be determined during the performance tests. The equipment used to dispense the foam should provide for optimum utilization of good quality foam. The tests recommended are designed to gage:

a. the physical properties of the foam dispensed;

b. the foam patterns that are established; and

c. the effectiveness of the application in reducing heat radiation and the calculated fire control area which the vehicle can handle.

320. Testing Procedures

321. Foam Physical Property Tests — Turrets:

a. Starting with full tank contents and with the turrets in normal fire fighting position, generate foam, discharging it on a hard, paved surface at the recommended pressures and rates for the particular equipment being tested.

NOTE: The foam liquid concentrate, the ratio of the concentrate introduced, and the water used shall be the same as would be employed in actual emergencies. Any change in these factors should result in new performance tests. In order to standardize results, the temperatures of the foam concentrate and water should be between 60° and 80° F.

b. Obtain foam samples in duplicate according to the methods given in Section A-210 of the Appendix.

c. Analyze the foam samples for expansion and viscosity (drainage rate) according to the methods given in Sections A-220 and A-230 of the Appendix.

d. Analyze the concentration of foam liquid in the foam solution which drains from the foam samples taken according to Section A-240 in the Appendix.

e. If variations are to be expected when only part of the foam generating equipment is operated, the above tests shall be repeated to evaluate the effect of these variations. If rates of discharge vary during operation, foam samples shall be taken at several points during the run.

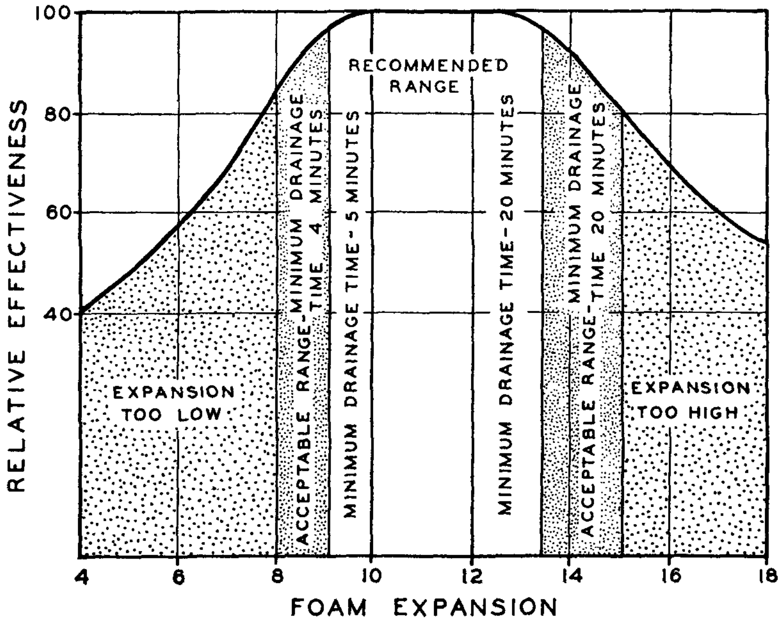
NOTE: All these foam physical property tests may be conducted with the foam pattern tests outlined in Paragraph 324.

322. Foam Physical Property Test — Hand Lines:

a. Operate the nozzles in a manner outlined in Paragraph 325 and obtain foam samples as done in the turret tests (Paragraph 321). Tabulate the results for expansion, viscosity and concentration.

323. Judging Foam Property Test Results:

a. According to fire tests run with foam spray patterns on gasoline spill fires by the Naval Research Laboratory, it has been found that certain foam properties result in better fire extinguishing action. These findings have also been confirmed by the experience of the foam equipment manufacturers. From this background the following chart has been drawn to serve as a guide in judging the results of the foam physical properties from the tests outlined herein.



b. It should be noted that the recommended foam properties indicated in the chart are materially different than those given in the NFPA Standard for Foam Extinguishing Systems (No. 11). The reason for this lies in the different methods of foam application. In aircraft fire fighting, foam is normally applied from turrets or handline nozzles which can be moved to allow directing the foam on the burning area. In fixed foam systems (e.g., oil tank fire fighting) a different type foam works best because of the distances it must spread from a few fixed points of application.

324. Foam Pattern Tests — Turrets:

a. These tests should be run under "no wind" conditions or as close to this as possible. The turrets should be elevated to 30 degrees (maximum stream reach position) and foam generated on a paved surface at the different nozzle settings available (such as, dispersed-stream, mid-position and straight-stream). Foam generation should be continued for 30 seconds to clearly define the foam pattern falling on the ground. By the use of a grid of guide stakes set on 3-foot centers, the foam depth is measured at 3-foot intervals throughout the pattern area. Foam measurements to the nearest inch are then plotted on a scaled grid laid out on cross section paper. Points of equal depth are joined together in the manner of a contour map. This plot will indicate the uniformness of foam distribution from the nozzle. The vertical axis should show the reach in feet and the horizontal axis the pattern width in feet for each nozzle setting. (See Figures in Sectiôn A-300 of the Appendix as typical pattern plots.)

NOTE: The maximum effective range stream may *not* provide the most efficient fire-fighting streams under any given fire condition.

325. Foam Pattern Tests — Hand Lines and Auxiliary Nozzles:

a. These tests should be handled in a similar manner to those for the turrets. Hand-line nozzles should be held at approximately hip height and elevated to 30 degrees to the horizontal. Outlines of the ground patterns established for straight stream and maximum dispersed-stream should be noted as done in the turret tests (Paragraph 324.a.). Measure the outlines secured and plot them on cross-section paper.

b. Auxiliary nozzles such as bumper and undertruck nozzles (if any) should be operated elevated for maximum range (if applicable) to establish their protective patterns. If variation is to be expected in nozzle performance due only to partial component operation, this condition should be reproduced and tested.

330. Judging Effectiveness of Foam Patterns from Turrets

331. Pattern tests of the foam-making equipment shall be conducted as described in Paragraphs 324 and 325. The outline of the 1-inch foam depth on the contour plot (see Appendix A-311) shall determine the boundary and dimensions of the effective foam patterns. These can be compared for conformance with the requirements expressed in the Table in Paragraph 334 according to turret discharge rate.

332. The characteristics for foam discharge patterns differ according to the particular application need. The straight stream is normally used for long reach and/or height application of a "spot" nature. This dictates a well-consolidated stream, and a "rooster tail" or weeping characteristic is undesirable. Therefore, the farthest out point of the 1-inch depth contour shall be at least that required in the Table under the "Far Point" column. The nearest distance from the turret to the 1-inch depth contour with the nozzle in the same elevated position shall not be closer than that required in the Table under the "Near Point" column.

333. The fully dispersed or spray pattern is that most commonly used for extinguishing areas of spilled fuel. This pattern provides the most gentle application of foam and covers the largest area. Extreme reach is not important because the pattern is continuously variable to the straight stream pattern; however, a certain reach is necessary in order to permit the vehicle to remain at a safe distance from the fire. The total area of effective pattern should be large enough that the foam solution (water) application density be held to 0.60 gpm per sq. ft. or lower (see Table in Paragraph 334). Higher densities will require more turret movement and greater operator skill. Therefore, the pattern requirements are set up in the Table in Paragraph 334 so that the width of the 1-inch effective contour shall be at least that required under the "Full Width" column; the full width of the 1-inch depth contour shall extend outward from the turret to at least the distance required under the "Full Width Extend Out" column; the foam solution application density shall not exceed that given in the "Solution Density" column.

334. The NFPA Standard on Aircraft Rescue and Fire Fighting Vehicles No. 414, establishes that turrets shall be capable of discharging foam or water in continuously variable streams from a straight stream to a fully dispersed or spray stream in accordance with the following table:

TURRET FOAM PATTERN REQUIREMENTS

Foam Solution Discharge Rate (gpm)	Straight Stream		Fully Dispersed or Spray		
	Far Point at Least (ft.)	Near Point No Closer Than (ft.)	Full Width at Least (ft.)	Full Width Extend Out at Least (ft.)	Maximum Solution Density ($gpm/ft.^2$)
250–400	125	60	25	25	0.30
500–800	130	40	35	65	0.33
1000	175	40	35	70	0.60

Actual turret flow rates may be determined by measuring the water level drop in the water tank while timing the discharge. Interpolation may be used to determine the requirements for turrets having flow capacities between those shown in the table.

340. Basic Extinguishing Capability

341. As with the pattern tests, the extinguishing tests should be run under as close to "no wind" conditions as possible. Position the vehicle to discharge foam from one turret onto a paved surface. Outline the perimeter of the maximum dispersed-stream pattern or that pattern judged most effective (established for the turret from the tests outlined in Paragraph 321) with a mud dike 1½ to 2 inches in height. Flood the area with fuel to a depth of ½ inch.

NOTE 1: The type of fuel employed should be recorded and only fire tests made on the same type of fuel can be directly compared. Gasoline type aviation fuels are generally considered to produce the most difficult spill fire to extinguish. Jet B turbine fuels, being blends of gasoline and kerosene, are generally considered to produce the next most difficult spill fires to extinguish. Jet A turbine fuels, being kerosene grade, are generally considered to be the easiest spill fires to extinguish. (For full information on the fire hazard properties of aviation fuels, see Appendix A to the NFPA Standard on Aircraft Fueling on the Ground, No. 407.)

NOTE 2: The effect of the fuel and the subsequent fires can have a detrimental effect on bituminous (asphalt) paved surfaces. It is suggested that wherever possible, the tests be conducted on concrete.

342. After the entire fuel area has become fully involved in flame allow a 15-second preburn and then apply foam from the previously positioned turret *without further movement of the turret or vehicle.* The foam should reach all areas of fire in a fairly uniform manner under such conditions. Application should continue until the fire is virtually extinguished (95 per cent or more).

343. During the extinguishment process, the rate of radiation decline should be noted by radiation heat recording device similar to that described in Section A-410 in the Appendix.

344. From the foam application time and the water application rate, the total amount of water consumed for the fire of measured area is calculated. From the number of square feet of fire area extinguished and the total water used, calculate the number of gallons of water required to extinguish one square foot of burning fuel, divide the gallons of water aboard the vehicle by this figure and record this value.

345. A chart should then be made to indicate the rapidity of the reduction in heat radiation. Plot the per cent of total radiation (based on full radiation just before foam application was started) against the time of foam application.

NOTE: See Section A-420 in the Appendix for typical calculations of the number of gallons of water used to extinguish a square foot of fire with a method of relating this to the total water aboard an ordinary crash truck and a chart showing a typical rate of reduction of radiation from a test fire.

350. Supplementary Tests

351. Article A-500 in the Appendix gives test methods for foam "burnback" characteristics on new foam, aged foam, and fire-aged foam.

400. REPORT OF RESULTS OF TESTS

410. Content of Reports

411. All test reports should include a statement of the operating conditions encountered (such as pressures, temperatures, wind velocities, etc.) and a full description of the materials and equipment used.

420. Submission of Reports

421. In the interest of promoting this program of standardization to indicate the effectiveness of foam fire fighting equipment on aircraft rescue and fire fighting vehicles, a full and complete report of the tests conducted on such equipment should be submitted to the Committee on Aviation, National Fire Protection Association, 60 Batterymarch Street, Boston, Mass. 02110, U. S. A. with photographs and diagrams as may be available.

Appendix A — Suggested Test Methods and Calculations

A-100. GENERAL

A-110. Purpose of Appendix

A-111. The following field tests for foam agent capabilities on aircraft rescue and fire fighting vehicles are given in order that standardization may be achieved in testing procedures.

A-120. Organization of Appendix

A-121. The test methods given are presented in the order of their mention in this Standard (see Section 300).

A-200. FOAM PHYSICAL PROPERTY TESTS

A-210. Foam Sampling (Reference Paragraphs 321.b. and 322.a.)

A-211. The treatment of a foam after it has left the turret or nozzle has an important bearing on its physical properties. It is, therefore, extremely important that the foam samples taken for analysis represent as nearly as possible the foam reaching the burning surface in normal fire fighting procedure. Foam for analysis from a straight stream should be collected from the center of the ground pattern formed with the nozzle aimed for maximum reach. Similarly, for dispersed stream application foam should be sampled from the center of the resulting ground pattern area with the nozzle set for dispersed stream operation. In order to standardize and facilitate the collecting of foam samples a special collector is used as shown in Figure 1.

A-212. The collector should be placed at the proper distance from the nozzle to be in the center of the pattern to be sampled. The nozzle should be placed in operation with the foam pattern off to one side of the collector until equilibrium is reached and then swung over onto the center of the backboard. When sufficient foam volume has accumulated to fill the sample containers (usually only a few seconds), a stop watch should be started for each of the samples to provide the zero time for the drainage tests described in Section A-230 and then the foam pattern should be directed off to one side again. Immediately after the nozzle has been swung away from the board, the sample pans are removed, the top struck off with a straight edge, and all foam wiped off from the outside of the container. The sample is then ready for analysis.

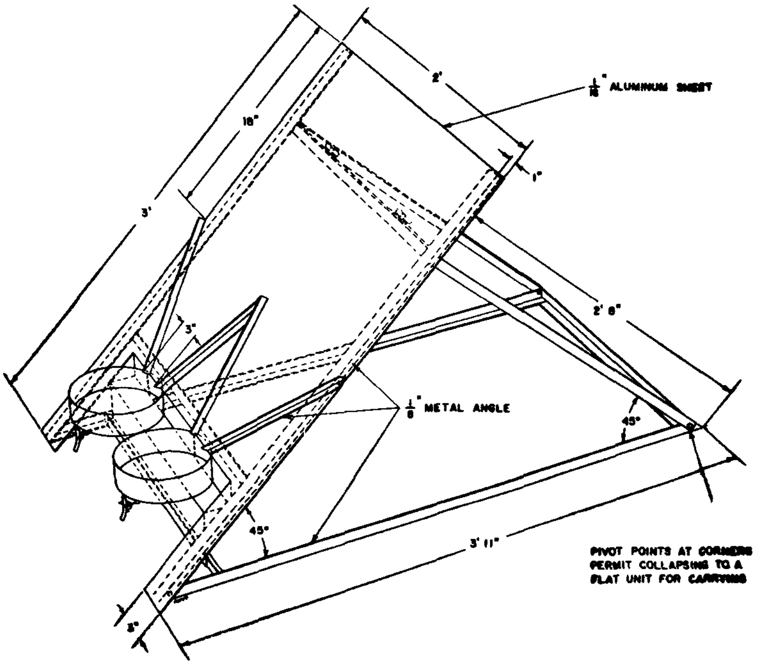


Figure 1. Foam Collector

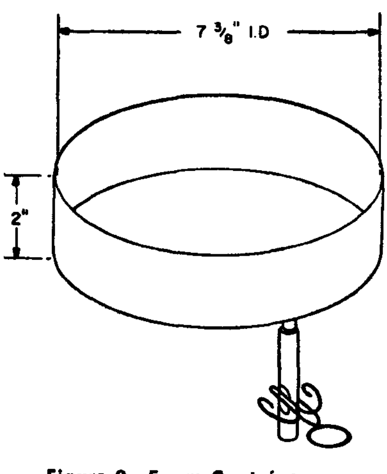


Figure 2. Foam Container

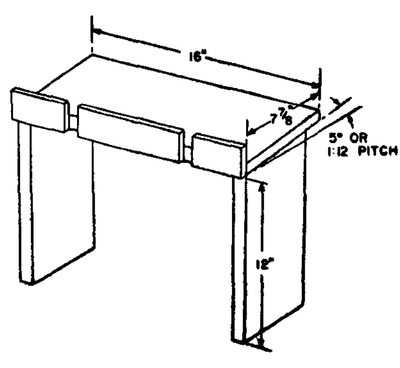


Figure 3. Stand

A-213. The standard sample container is 2 inches deep and 7⅜ inches inside diameter (capacity of 1400 milliliters) preferably made of 1/16 inch thick aluminum or plastic. In the bottom at the edge, a ¼-inch drain tube with a rubber tube and pinch cock is provided to draw off the foam solution as it accumulates. This device is shown in Figure 2.

A-220. Foam Expansion Determination (Reference Paragraphs 321.c. and 322.a.)

A-221. The sample obtained as described previously should be accurately weighed to the nearest gram. The expansion of the foam in the sample is calculated as follows:

$$\frac{1400}{\text{full wt. minus empty weight}} = \text{expansion}$$

(all weights expressed in grams)

A-222. Apparatus Needed

a. 2 — 1400 milliliter sample containers
b. 1 — foam collector
c. 1 — balance, triple beam, 1000 gram capacity

A-230. Foam Drainage Rate Determination (Reference Paragraphs 321.c. and 322.a.)

A-231. The rate at which the liquid drops out from the foam mass is called the drainage rate and is a direct indication of degree of stability and the viscosity of the foam. A single value used to express the relative drainage rates of different foams is the "25 per cent Drainage Time." It is the time in minutes that it takes for 25 per cent of the total liquid contained in the foam in the sample containers to drain out.

A-232. This test is performed on the same sample as used in the expansion determination. Dividing the net weight of the foam sample by four will give the 25 per cent volume in milliliters of liquid contained in the foam. In order to find the time required for this volume to drain off, the sample container should be placed on a stand as shown in Figure 3 and at regular suitable intervals the accumulated solution in the bottom of the pan is drawn off into a graduate. The time intervals at which the accumulated solution is drawn off are dependent on the foam expansion. For foams of expansion 4 to 10, one minute intervals should be used and for foams of expansion 10 and above, two minute intervals should be used because of the slower drainage rate of foams in this category. In this way a time-drainage volume curve is obtained and after the 25 per cent volume has been exceeded, the 25 per cent drainage time is interpolated from the data. The following example shows how this is done:

The net weight of the foam sample has been found to be 200 grams.

$$\text{Expansion} = \frac{1400\text{g}}{200\text{g}} = 7$$

$$25\%\ \text{Volume} = \frac{200\text{g}}{4} = 50\ \text{ml.}$$

Then if the time-solution volume data has been recorded as follows:

Time Min.	Drained Solution Volume Ml.
0	0
1.0	20
2.0	40
3.0	60

It is seen that the 25 per cent volume of 50 ml. lies within the 2 to 3 minute period. The increment to be added to the lower value of 2 minutes is found by interpolation of the data:

$$\frac{50\ \text{ml. (25\% Volume)} - 40\ \text{ml. (2 min. Volume)}}{60\ \text{ml. (3 min. Volume)} - 40\ \text{ml. (2 min. Volume)}} = \frac{10}{20} = 0.5$$

Therefore, the 25 per cent drainage time is found by adding 2.0 min. + 0.5 min. and gives a final value of 2.5 min.

A-233. In the handling of unstable foams it must be remembered that they lose their liquid rapidly and the expansion determination must be carried out with speed and dispatch in order not to miss the 25 per cent drainage volume. It may even be necessary to defer the expansion weighing until after the drainage curve data has been recorded. The stop watch is started at the time the foam container is filled and continues to run during the time the sample is being weighed.

A-234. Apparatus Needed

a. 2 — 100 milliliter graduates

b. 2 — stop watches

c. 1 — sample stand

A-240. Concentration Determination (Reference Paragraphs 321.d. and 322.a.)

A-241. This test is to determine the concentration of foam liquid in the water being used to generate foam. It is useful for checking the accuracy of a unit's proportioning system and also if the concentration deviates too widely from the 6 per cent level,* it will abnormally influence the expansion and drainage time values. The test is based on the change of refractive index of the solution with change in concentration as measured by a refractometer.

A-242. The first step in this procedure is to prepare a calibration curve for the intended use. This has been found necessary because the source of water and brand or mixture of foam concentrate will affect the results. Using water from the tank and foam concentrate from the tank, standard solutions of 3, 6, and 9 per cent are made up by pipetting 3, 6, and 9 milliliters of foam concentrate respectively into three 100 milliliter graduates and then filling to 100 milliliter mark with the water. After thoroughly mixing, a refractive index reading is taken of each standard. This is done by placing a few drops of the solution on the refractometer prism with a medicine dropper, closing the cover plate and observing the scale reading at the dark field intersection. A plot is made on graph paper of scale reading against the known foam solution concentrations and serves as a calibration curve for this particular foam test series. Portions of solution drained out during the previously described drainage rate test are conveniently used as a source of sample for the refractometer in analysis. Refractive readings of the unknown are referred to the calibration curve and the corresponding foam solution concentration read off.

A-243. Apparatus Needed

- **a.** 3 — 100 milliliter graduates
- **b.** 1 — measuring pipette (10 milliliter capacity)
- **c.** 1 — 100 milliliter beaker
- **d.** 1 — 500 milliliter beaker
- **e.** 1 — Refractometer (Hand Juice Refractometers such as made by Bausch and Lomb are convenient for this use) with a range of 0 to 25 per cent sugar content (1.3330 to 1.3723 index of refraction).

A-300. FOAM PATTERN TESTS

A-310. Typical Turret Pattern Plot (Reference Paragraph 324)

A-311. Figures 4A, 4B, 4C and 4D show typical plots of the ground patterns of the foam discharge of a turret nozzle which may be used as a model for reporting these and similar patterns. Figure 4E shows how stakes are laid out for measuring the pattern, Figure 4F illustrates a foam turret application, and Figure 4G how measurements are made.

*A 6 per cent concentration is used for purposes of illustration.

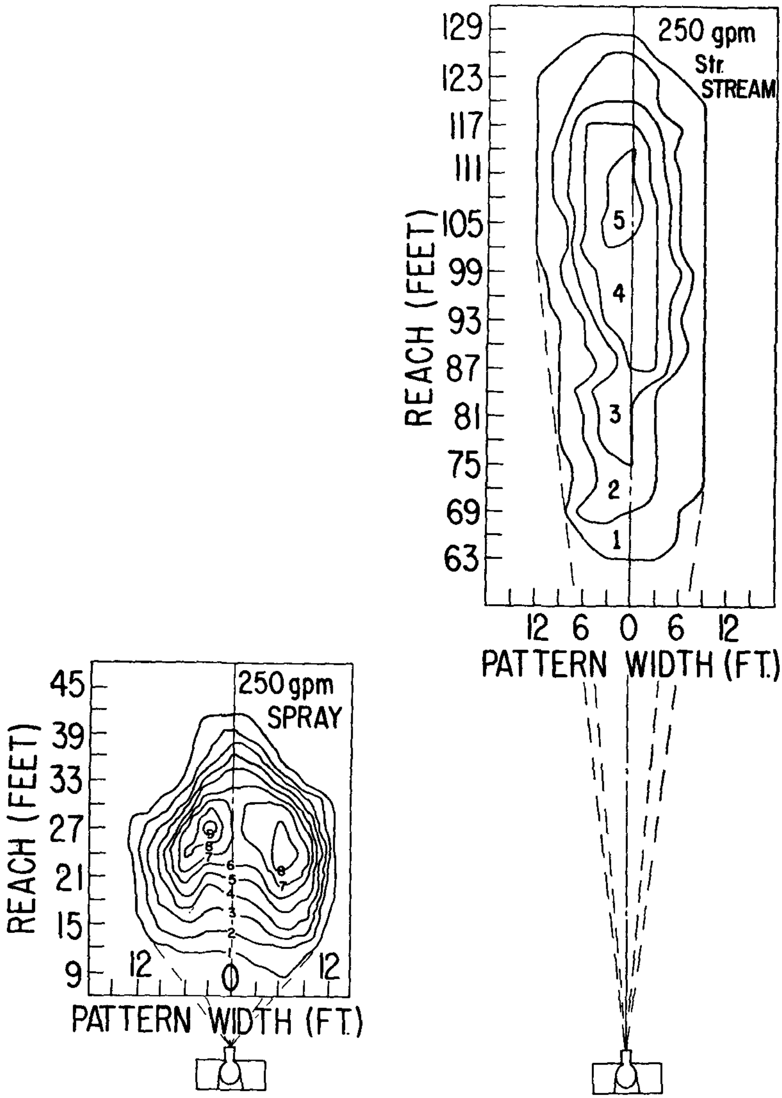


Figure 4A (left) and 4B (right). A plot of the values from a foam pump discharge looks like this. The discharge rate is 250 gpm of foam solution. The straight stream pattern (4B) is compact and of good range and shows a minimum of "weeping." The full spray pattern (4A) shows a width of about 25 ft. out to a distance of about 28 ft. Area within the 1-inch depth line is slightly over 800 square feet. Water density 0.30 gpm per square foot.

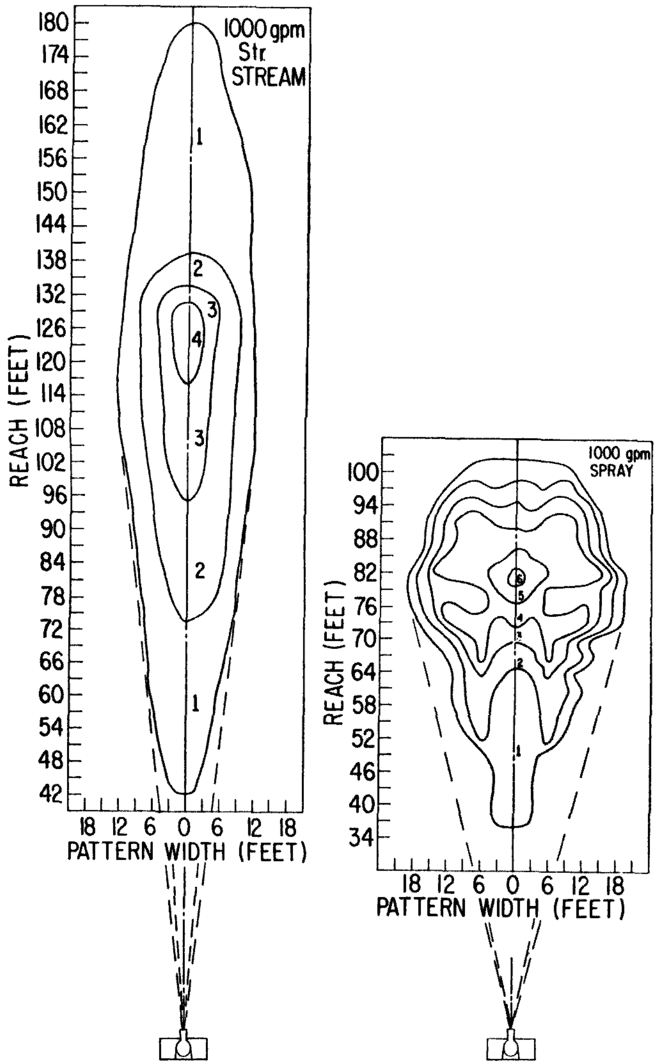


Figure 4C (left) and 4D (right). This shows a 1,000 gpm dual capacity, aspirating nozzle discharge. For the straight stream (4C) note the maximum and minimum reach. For the spray (4D), note the maximum width and best reach.

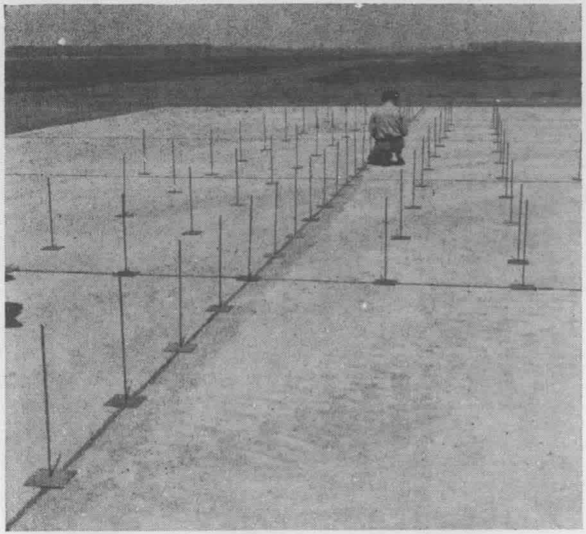


Figure 4E. Stakes are laid out on 3-foot centers forming a grid over the expected foam ground pattern.

Figure 4F. Foam is discharged over the grid area for a period of 30 seconds.

Figure 4G. Immediately after applying foam, measurements are taken of the foam at each marker. Speed is important here as the foam tends to slide around as the foam solution drains out and begins to run off.

A-400. HEAT RADIATION TESTS

A-410. Description of Radiation Device (Reference Paragraph 343)

A-411. Fire intensity during the extinguishment process is measured by means of a total radiation pyrometer. Such devices are available commercially as the Brown Instrument's Radiamatic Series 939A1 Type RH. Radiation energy from the fire, proportional to its size, is converted through a thermopile to electrical energy which may be conveniently measured and recorded against a time axis. Two radiation receivers may be connected in parallel electrically (as shown in Figure 5) and mounted so that two response circles, of equal diameter and at right angles to each other, result in a complete radiation picture of the test fire.

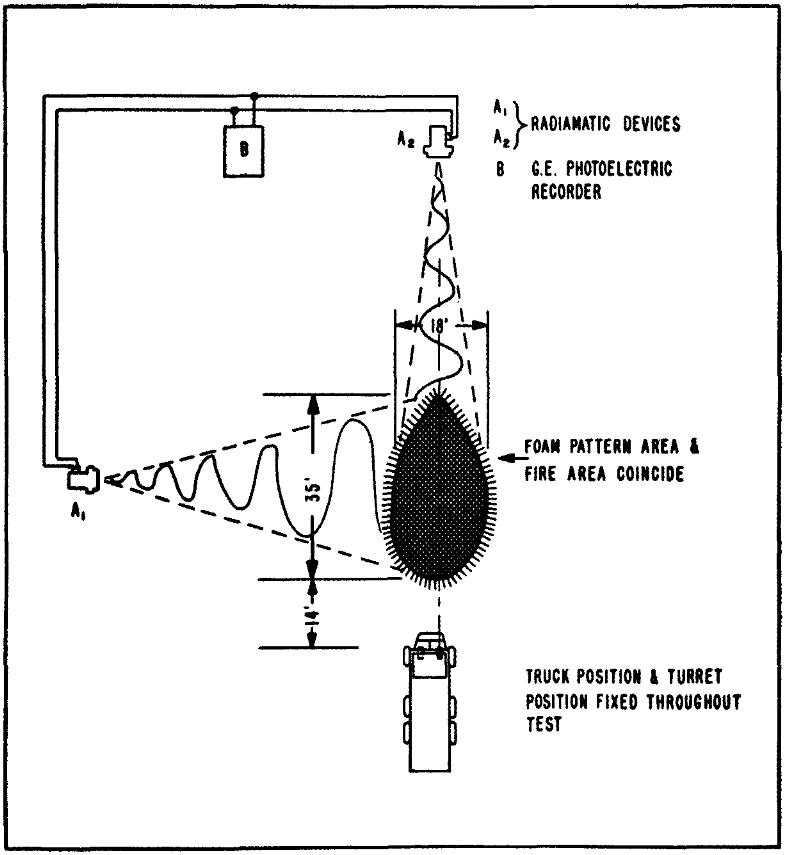


Figure 5. Plan View Diagram of Test Set-up