NFPA No.
412
File: 400 Series
Aviation

Suggested Standard Test Procedures for

AIRCRAFT RESCUE and FIRE FIGHTING VEHICLES UTILIZING FOAM

June
1959

Fifty Cents*

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston 10, Mass.

3M-6-59-FP-R&S

*Discount for quantities

Printed in U.S.A.

National Fire Protection Association

International

Executive Office: 60 Batterymarch St., Boston 10, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes two hundred national and regional societies and associations (list on outside back cover) and seventeen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This pamphlet is one of a large number of publications on fire safety issued by the Association including periodicals, books, posters and other publications; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in six volumes of the **National Fire Codes** which are re-issued annually and which are available on an annual subscription basis. The standards, prepared by the technical committees of the National Fire Protection Association and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

NFPA standards are purely advisory as far as the Association is concerned, but are widely used by law enforcing authorities in addition to their general use as guides to fire safety.

Definitions

The official NFPA definitions of shall, should and approved are:

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon=0.83 Imperial gallons=3.785 liters.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The standards are prepared, as far as practicable, in terms of required performance, avoiding specifications of materials, devices or methods so phrased as to preclude obtaining the desired results by other means. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada and the Factory Mutual Laboratories test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

Aircraft Rescue and Fire Fighting Vehicles Utilizing Foam

NFPA No. 412 — 1959

These Suggested Standard Test Procedures, prepared by the NFPA Sectional Committee on Aircraft Rescue and Fire Fighting and submitted to the Association through the NFPA Committee on Aviation, were approved by the Association at its 1959 Annual Meeting, held June 1–5.

History

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.

The intent of these Suggested Standard Test Procedures is to produce test data useful to those in the field in determining the suitability of existing equipment to meet the operational requirements which might be imposed on the equipment during an actual emergency. It is not the intent of these Test Procedures to establish specifications of equipment or to set performance requirements, but merely to provide guidance on appropriate test methods to evaluate the capabilities and limitations of equipment in service.

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

Grateful acknowledgement is made to the assistance given by the NFPA Committee on Foam who supplied valuable technical guidance and personnel to aid in the preparation of this text. Mr. Richard L. Tuve of the Naval Research Laboratory was chairman of the Conference Committee thus formed and he deserves special recognition for his valuable guidance on this project. Other members of the Foam Committee who served faithfully in completing this project were Messrs. J. Faulkner (now deceased), P. E. Johnson, C. H. Lindsay, J. F. O'Regan and O. L. Robinson.

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Suggested Standard Test Procedures for

Aircraft Rescue and Fire Fighting Vehicles Utilizing Foam

NFPA No. 412

Article 100. General

110. Purpose

111. These suggested test procedures are intended to fully evaluate in standard terms of reference, the degree of capability of aircraft rescue and fire fighting vehicles in accomplishing their designed mission as described in NFPA Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports (NFPA No. 403).*

112. The test procedures are intended to produce data useful to authorities in the field in determining the suitability of equipment for meeting the operational requirements imposed upon them.

120. Scope

121. It is acknowledged that many requirements in this area encompass variables which are difficult to standardize and as a result these tests are summarily incomplete but accumulation of further knowledge will generate a wider scope of usefulness.

122. The suggested test procedures covered herein may be divided into four categories as follows:

(a) Ease of Equipment Operation Testing (Article 200)

(b) Vehicular Performance Testing (Article 300)

(c) Principal Agent (Foam) Performance Testing (Article 400)

(d) Supplementary Agent and/or Supporting Equipment Specification (Article 500)

An Appendix is included to present suggested test methods and calculations.

*Published in National Fire Codes, Vol. VI and in separate pamphlet form.

Article 200. Ease of Equipment Operation Testing

210. Purpose. The ease with which qualified fire fighters are able to operate a vehicle and its rescue and fire fighting equipment will be an indication of the vehicle's utility during an actual emergency. Attention should be given to all vehicle and crew operations which are either difficult to comprehend or require extensive practice before skill in operation is acquired.

220. Test Procedures

221. Tests should include all crew functions and all vehicle components such as:

a. driving the vehicle;

b. identification and operation of all equipment controls;

c. charging and servicing the extinguishing agent system.

222. Following indoctrination, the crew 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 vehicle.

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. Rescue equipment should be removed from the vehicle, used and returned in realistic fashion; power and hand tools for forcible entry should be tested on actual scrap fuselages to develop proper knowledge of usage.

225. Charging and servicing the vehicle should include discharge, flushing and recharging.

226. 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.

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

228. A full and complete report should be submitted giving the results of such tests with particular attention given to any difficult operations encountered (see Article 600).

Article 300. Vehicular Performance Testing

310. Purpose

311. Vehicular performance, which contributes to early arrival at the scene of an emergency before the fire has reached maximum intensity and while trapped personnel may still be alive, favors greater extinguishing effectiveness and possible rescue with any amount of agent. It is, therefore, of prime importance that vehicular performance requirements be established after due consideration of the airport's particular environmental conditions which may impede vehicle movements or delay expeditious arrival at emergencies within the area to be protected. The overall performance capabilities of a vehicle are dependent upon the aggregate of a number of design features.

312. The following test procedures are intended to evaluate in standard terms of reference, the vehicular performance of aircraft rescue and fire fighting vehicles in accomplishing their intended mission as described in NFPA Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports (NFPA No. 403).

320. Test Procedures

321. Protected Area. Mark a grid map to show the immediate operating and service areas of the airport and adjacent areas to which protection will be extended. This area shall be examined for obstructions and hindrances to vehicle movement, such as culverts, grades, pools, rough ground, marshy and sandy soil, underpasses, forests, bridges, fences and sharp turns. Response routes should be as direct as possible. Bridges and access roads should be constructed and other remedial measures taken to eliminate remaining obstacles. The vehicle should then be run over each response course to determine the overall construction characteristics of the vehicle. Note should be made of any instances of drive line interference, rubbing of tires on sheet metal, or any other mechanical defect.

322. Dimensions, Weights, Components and Features. All important dimensions and weights, pertinent data relative to the various important components and features, their make, model and part number and ratings, shall be checked against the information furnished by the manufacturer. Sample forms to record vehicle characteristic data are included in Section A-600 in the Appendix.

323. Speedometer Test. The vehicle's speedometer shall be checked for accuracy at the speeds at which the vehicle will be operated during testing. Run the vehicle over a measured mile of improved roadway or check it against a vehicle having a speedometer of known accuracy. Correction factors thus found will be used in conducting other tests involving vehicle speeds.

324. Braking Ability Test. The test shall be conducted on level dry paved road and the minimum distance required to bring the vehicle to a stop shall be recorded. Three successive stops from 20 mph shall be made and one stop from 50 mph. Any fading of brakes should be recorded.

325. Acceleration Test. The vehicle shall be accelerated from a stand-still to 50 mph speed on dry level paved roadway, with turns made in both directions, and the time recorded and averaged.

326. Maximum Speed Test. The maximum speed on level paved road shall be attained and recorded for runs made in both directions and averaged. The engine governor shall be set in accordance with the engine manufacturer's recommendations.

327. Gradability Test. Calculated maximum gradability data on paved road shall be provided by the manufacturer for all combinations of transfer case and transmission ratios. The percent of grade of the most difficult grade in the protection area should be measured. The vehicle shall then be tested on this grade and the gear ratio or ratios necessary to negotiate the grade recorded and checked against the information furnished by the manufacturer.

328. Grade Speed Test. The maximum speed that can be maintained on an 8 per cent grade shall be determined and recorded. The 8 per cent grade shall be located by the Highway Department or determined by gradeometer or protractor method.

329. Slope Performance Test. With the vehicle fully loaded, the wheels or axles on one side and then the other side of the vehicle shall be jacked up until the elevated wheels are a height from the ground not to exceed 30 percent of the width of tread (between center of right and left treads). The vehicle should not turn over, and slack restraining cables should be placed to avoid possible damage. If the vehicle withstands this static test to 30 percent, it should then be operated on a 20 percent side slope to determine its stability during such operation.

330. Gear Shifting Test. The vehicle shall be operated at various speeds, including reverse, over different types of difficult terrain to determine the ease of shifting and control. Irregularities such as excessive backlash or hanging of the control system should not be present.

331. Maneuvering Test. In vehicles so designed, discharge of the foam turret(s) shall be started and continued while the vehicle is being decelerated to a stop from a speed above 30 mph. The vehicle will then be maneuvered forward and backward at speeds of at least 5 mph. Any irregularities such as difficult shifting and nonuniform foam discharge rate while maneuvering should be noted.

332. Maximum Wheel Motion. The maximum wheel height each individual wheel can be raised from the ground without interference or lifting of any other wheel from the ground shall be measured and recorded.

333. Off-Road Performance Tests. The most desirable method of determining the capabilities of a vehicle to negotiate off-road terrain is to test run the vehicle over especially prepared mud, sand and difficult terrain test courses over which the limits of performance of off-road vehicles have previously been determined and comparative evaluations with other vehicles can then be most readily obtained by experienced test personnel. In the event that it is not feasible to conduct testing over such prepared test courses, the following test should be conducted to determine whether the tire ground pressure is low enough to permit negotiation of soft sand and muddy terrain: inflate all tires to the minimum pressure recommended by the vehicle manufacturer; then each wheel should successively be jacked up and the tire tread smeared with oil and then the tire let down on a clean sheet of paper. The area of the tire foot print should be calculated in square inches, this area should then be divided into the weight imposed on this wheel and the ground tire pressure determined in pounds per square inch of area.

Article 400. Principal Agent (Foam) Performance Testing

410. Purpose. 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 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 here are designed to gauge:

(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.

420. Test Procedures

421. Foam Physical Property Tests

a. Physical Property Tests — Turrets: Starting with full tank contents and with the turret or turrets in normal fire fighting position, generate foam on a hard surface at recommended pressures or rates using the recommended foam-forming concentrates. In order to standardize results the temperatures of the foam concentrate and water should be between 70° and 80° F. Obtain foam samples in duplicate according to the methods given in Section A-210. in the Appendix. Analyze the foam samples for expansion and viscosity (drainage rate) according to the test methods given in Section A-220. and A-230. in the Appendix. In addition, analysis should be made of the concentration of the foam concentrate in the foam-making solution which drains from the foam samples according to the test methods given in Section A-240. in the Appendix. Assume the full range of operating conditions for this test. If variation is to be expected when only part of the foam generating equipment is operated, this must be tested. In the case of certain vehicles where the rates vary during operation, the rates for the duration of a full run should be measured and foam samples taken at several points during the run. [These tests may be conducted simultaneously with the pattern determinations (Par. 422.a. below) if desired.]

b. Physical Property Tests — Hand Line and Auxiliary Nozzles: Operate the nozzles in a manner outlined in Par. 422.b. below and obtain foam samples as done in the turret tests (Par. 421.a. above). Tabulate the results for expansion, viscosity and concentration.

422. Foam Pattern Tests

a. Foam Pattern Tests — Turrets: These tests should be run under "no wind" conditions or as close to this as possible. The turrets should be elevated to 30 degrees and foam generated on a hard ground 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-ft. centers the foam depth is measured at 3-ft. 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. Figures 4 and 4A, 4B and 4C show typical pattern plots (see Appendix).

b. Foam Pattern Tests — Hand Line and Auxiliary Nozzles: These tests should be handled in a similar manner to those for the turrets. Hand line nozzles should be mounted on a stand 3 feet above the ground 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 (Par. 422.a.). Measure the outlines secured and plot them on cross section paper. 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.

423. Determination of Basic Extinguishing Capability Figure and Rate of Reducing Heat Radiation:

a. Position the vehicle to discharge foam from one turret onto a hard-surfaced area. Outline the perimeter of the maximum dispersed-stream pattern or that pattern judged most effective (established for the turret from the tests outlined in Par. 422.a.) with a mud dike 1½ to 2 inches in height. Flood the area with gasoline to a depth of ½ inch.

b. After ignition of the gasoline and a 15-second preburn period, 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).

c. 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.

d. 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 this figure into the gallons water aboard the vehicle and record this value.

e. 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. (Figures 5 and 6)

424. Supplementary Tests

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

Article 500. Supplementary Agent and/or Supporting Equipment Specifications

510. Purpose. In order to fully describe the potentialities of an aircraft rescue vehicle the supplementary fire extinguisher equipment and auxiliary rescue devices available should be evaluated in terms of their capability of improving on or, possibly, detracting from the primary mission of the vehicle. The variables encountered in such an evaluation are a function of the combination of conditions to be met under actual usage and the degree of excellence of performance of the principal agent with which the truck is equipped. It is not possible to adequately describe these conditions in simulated field tests within the economic barriers normally applying. As a consequence, the following requirements are in the form of detailed performance specifications of the supplementary agents and/or supporting equipment available on the vehicle. The authority having jurisdiction must judge the adequacy of the supplementary equipment for his requirements on the basis of other available information concerning such equipment.

520. Test Procedures

521. Built-in Equipment on Vehicle. Supplementary agents and/or equipment installed as an integral part of the vehicle should be fully evaluated on a basis of their individual performance. Water, although used principally for foam generation, may be considered also as an optional agent; carbon dioxide, dry chemical, vaporizing agents and others should be evaluated in terms of their basic extinguishing effectiveness. This entails a complete description in terms of minimum rates or density of coverage, minimum total discharges, optimum techniques in terms of flexibility and versatility of equipment and other collateral characteristics which improve the principal function of the vehicle. A full and complete technical description specification for each agent available should be so compiled and submitted.

522. Portable Equipment. In the case of supporting and auxiliary equipment available on the vehicle for portable or semi-portable use such as special extinguishers for magnesium fires, dry chemical hand extinguishers, portable metal-cutting saws and torches, forcible-entry tool kits, medical first-aid kits and other rescue aids, each unit should be fully described in terms of size, weight and any information necessary for complete identification. A complete technical description specification for all such equipment should be submitted.

Article 600. Report of Results of Tests

610. Content of Reports

611. 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.

620. Submission of Reports

621. In the interest of promoting the program of standardization of performance tests for aircraft rescue and fire fighting vehicles utilizing foam, 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 10, Mass., U. S. A. with photographs and diagrams as may be available.

Appendix — 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 Article 400. of these Suggested Standard Test Procedures.

A-122. Sample forms for recording vehicle characteristic data are presented in Section A-600 of the Appendix as called for in Paragraph 322.

A-200. Foam Physical Property Tests

A-210. Foam Sampling (Reference Par. 421.a. and b.)

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.

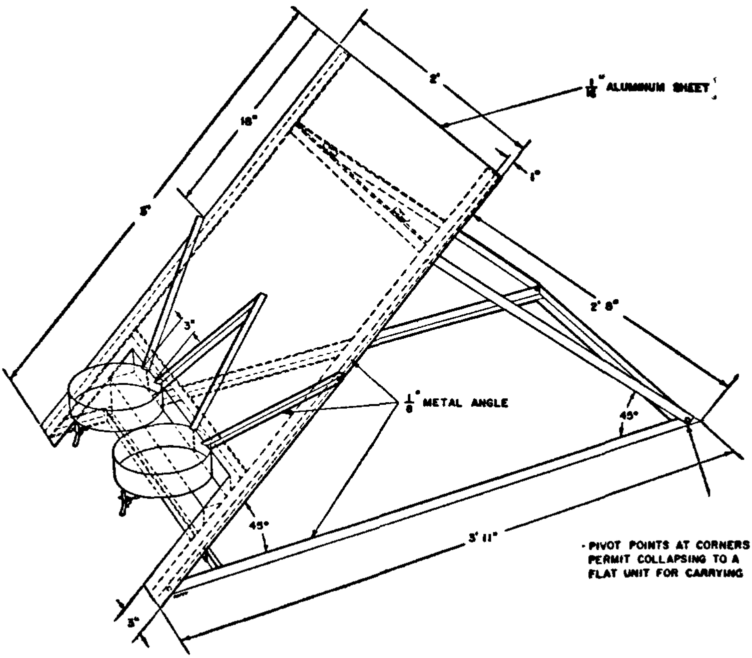


Figure 1. Foam Collector

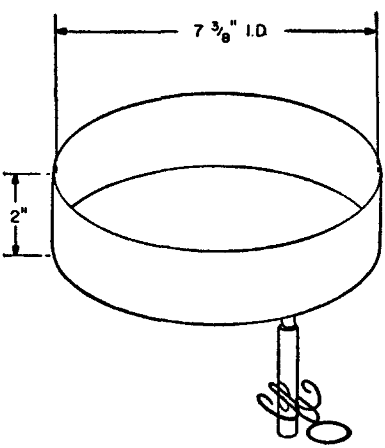


Figure 2. Foam Container

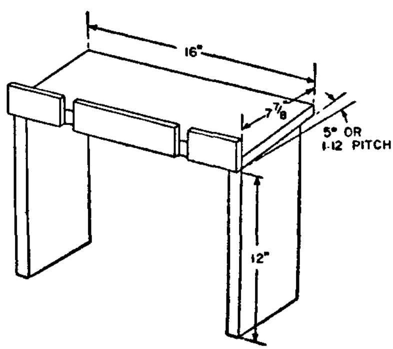


Figure 3. Stand

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.

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 Par. 421.a. and b.)

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 Par. 421.a. and b.)

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:

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

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 despatch 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 Par. 421. a. and b.)

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 6 per cent concentration is used for purposes of illustration.

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 Par. 422.a.)

A-311. Figures 4, 4A, 4B and 4C 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.

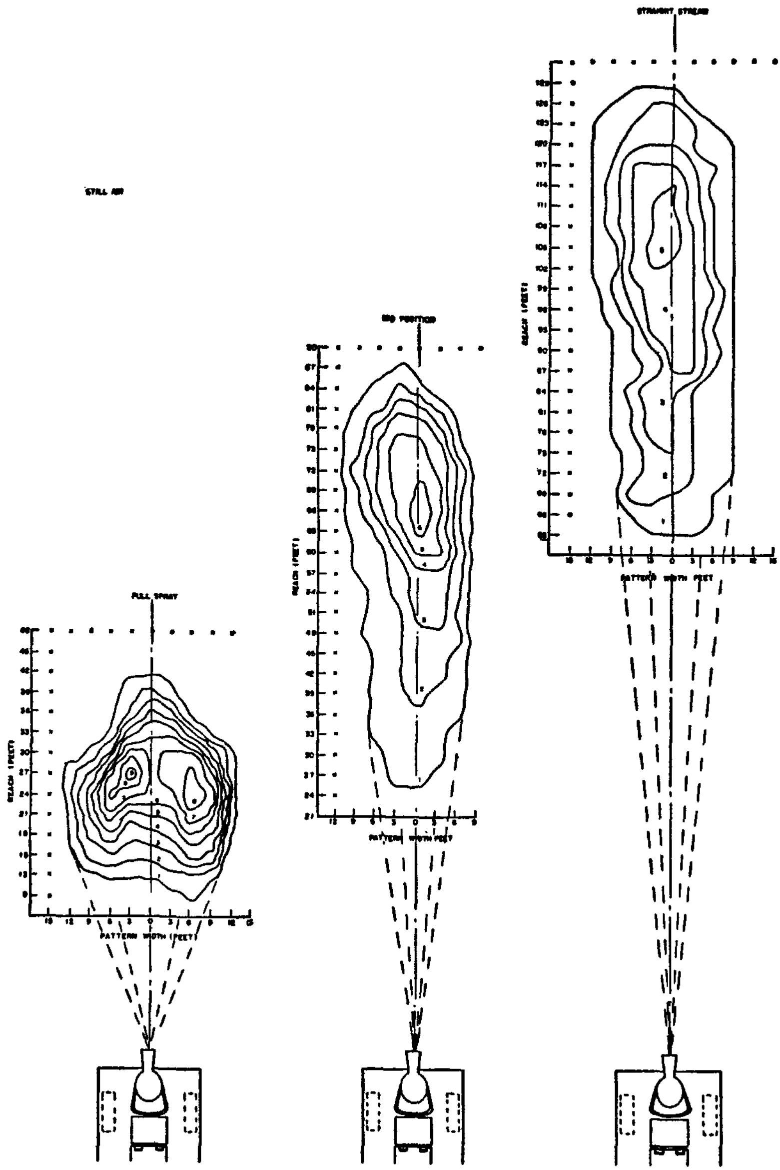
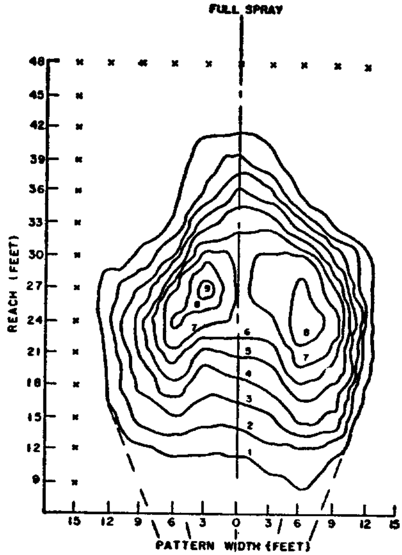
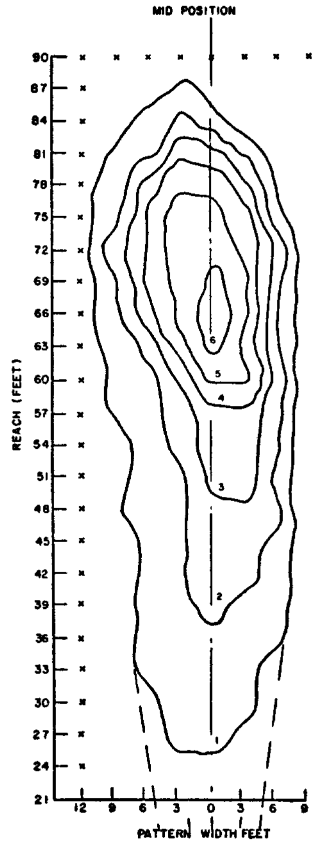


Figure 4. Ground patterns of foam discharge from turret nozzle (see Figs. 4A, 4B and 4C for individual pattern designs).





Figures 4A (top) and 4B (right)

Illustrations of typical turret patterns for full stream (4A) and mid position (4B) showing depth of foam build-ups. Still air conditions existed during these sample tests. (See also Figures 4 and 4C.)

A-400. Heat Radiation Tests

A-410. Description of Radiation Device (Reference Par. 423.c.)

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.

A-420. Determination of Basic Extinguishing Capability Figure and Rate of Reducing Heat Radiation — Typical Calculations and Radiation Charting Methods (Reference Par. 423.)

A-421. The following calculations are typical of those used in the determination of the basic capability figure of foam on a fire using an aircraft rescue and fire-fighting vehicle of 1000 gals. water capacity:

Fire Area (and Pattern Area) = 500 ft²

$$\text{Average Water Application Rate} = \frac{275 \text{ gpm}}{500 \text{ ft}^2} = 0.55 \text{ gpm/ft}^2$$

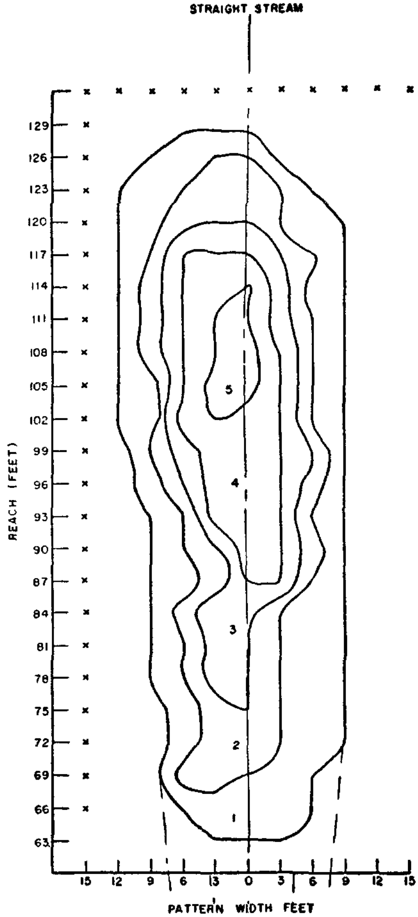


Figure 4C. Typical turret pattern for straight stream foam discharge. (See also Figures 4, 4A and 4B.)

Foam Application Time = 12 sec. = 0.20 min.

Total Water (in foam) Applied = 0.55 gpm/ft² × 0.20 min. = 0.11 gal/ft²

$$\text{Basic Extinguishing Capability Figure of Vehicle (no obstructions)} = \frac{1000 \text{ gal.}}{0.11 \text{ gal/ft}^2} = 9100 \text{ ft}^2$$

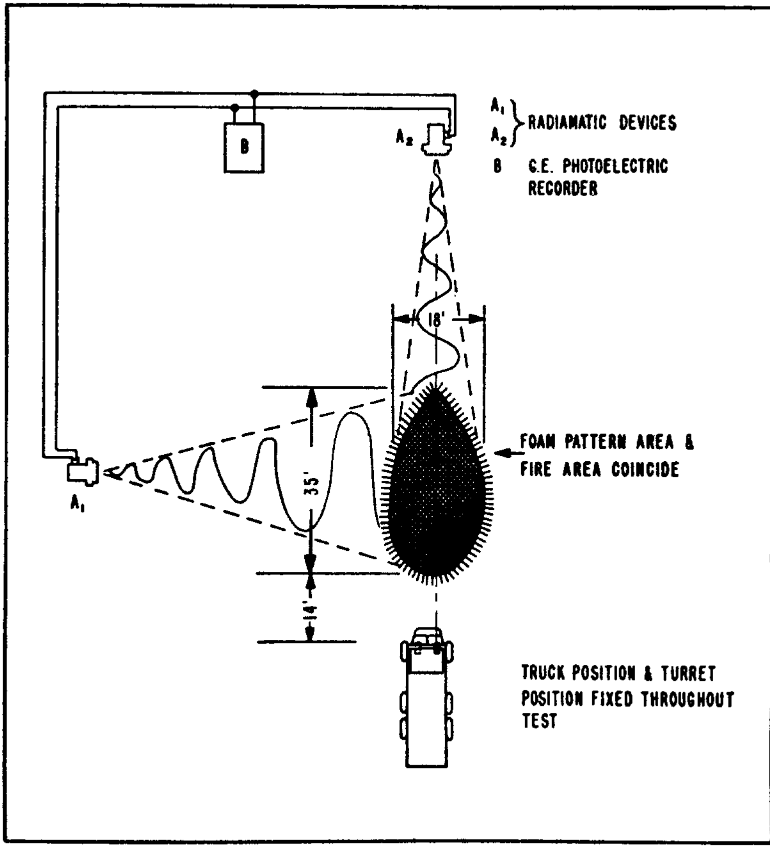


Figure 5. Plan View Diagram of Test Set-up

A-422. Figure 5 shows a plan view diagram of the radiation reduction test and Figure 6 a graph of values obtained for two separate tests on a typical vehicle. These may be used as a model for reporting these tests.