



DEPARTMENT OF THE NAVY

NAVAL RESEARCH LABORATORY
WASHINGTON, D.C. 20375-5000

Leonard

IN REPLY REFER TO:

3900
Ser 6180-601
05 October 1988

From: Commanding Officer, Naval Research Laboratory
To: Commander, Naval Sea Systems Command (Code 05M4)

Subj: PROPOSED MILITARY SPECIFICATION, MIL-F-24385D,
AQUEOUS FILM FORMING FOAM (AFFF)

Encl: (1) Two copies of proposed Military Specification,
MIL-F-24385D, Aqueous Film Forming Foam (AFFF)
(2) Two copies of statements justifying changes to
Military Specification, MIL-F-24385D

1. Enclosures (1) and (2) are forwarded herewith for your information and retention. The justifications for the proposed revisions to the subject specification are given in enclosure (2).

WILLIAM B. FOX
By direction

Copy to (w/copy of encls (1) and (2)):
NAVSEASYS COM Code 56Y6 (Darwin)

6180-601A:CF
27 September 1988

MIL-F-24385D

SUPERSEDING
MIL-F-24385C
12 March 1981
(See 6.7)

MILITARY SPECIFICATION

FIRE EXTINGUISHING AGENT, AQUEOUS FILM-FORMING FOAM (AFFF) LIQUID CONCENTRATE, FOR FRESH AND SEAWATER

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for aqueous film-forming foam (AFFF) liquid concentrate fire extinguishing agents consisting of fluorocarbon surfactants and other compounds, as required to conform to this specification. At the time of use the concentrates shall be diluted with fresh or ocean water to form a fire-extinguishing solution. Certain proportioning equipment may produce AFFF solutions of extreme concentrations; requirements of such concentrations are specified herein.

1.2 Classification. Concentrates shall be of the following types, as specified (see 6.2.1):

Type 3 - To be used as three parts concentrate to ninety-seven parts water by volume solution.

Type 6 - To be used as six parts concentrate to ninety-four parts water by volume solution.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise indicated, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

- O-D-1407 - Dry Chemical, Fire Extinguishing, Potassium Bicarbonate.
- NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).
- RR-S-366 - Sieve Test.
- TT-E-489 - Enamel, Alkyd, Gloss (For Exterior and Interior Surfaces).
- VV-G-1690 - Gasoline, Automotive, Leaded or Unleaded.
- PPP-D-1860 - Drums, Plastic, Molded Polyethylene.

MILITARY

- MIL-I-17214 - Indicator, Permeability; Low-Mu (Go-No-Go).
- MIL-D-43703 - Drums, Shipping and Storage, Molded Polyethylene.
- MIL-L-19140 - Lumber and Plywood, Fire Retardant Treated.

STANDARDS

FEDERAL

- FED-STD-313 - Material Safety Data Sheets, Preparation and the Submission of.
- FED-STD-595 - Colors.

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-130 - Identification Marking of U.S. Military Property.
- MIL-STD-147 - Palletized Unit Loads.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise indicated, the issues of documents not listed in the DoDISS shall be the issues of the nongovernment documents which are current on the date of the solicitation.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- 412 - Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.

(Application for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 96 - Standard Test Methods for Water and Sediment in Crude Oils.
(DoD adopted)
- D 445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (And the Calculation of Dynamic Viscosity). (DoD adopted)
- D 1141 - Standard Specification for Substitute Ocean Water. (DoD adopted)
- D 1218 - Standard Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids.
- D 1331 - Standard Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents.
- D 1821 - Standard Test Method for Inorganic Chlorides in Askarels.
- E 70 - Standard Test Method for pH of Aqueous Solutions with the Glass Electrode. (DoD adopted)
- E 260 - Standard Practice for Packed Column Gas Chromatography.
- E 527 - Standard Practice for Numbering Metals and Alloys (UNS).
- E 729 - Standard Practice for Conducting Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians.
- G 1 - Recommended Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN PUBLIC HEALTH ASSOCIATION

Standard Methods for the Examination of Water and Waste Water.

(Application for copies should be addressed to the American Public Health Association, 1015 15th Street, N.W., Suite 300, Washington, DC 20005.)

UNIFORM CLASSIFICATION COMMITTEE AGENT

Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

DEPARTMENT OF LABOR (OSHA)

Code of Federal Regulations (CFR), CFR 29, Part 1910.1200 - Hazard Communication Standard.

DEPARTMENT OF TRANSPORTATION

Code of Federal Regulations (CFR), CFR 49, Parts 100-199 - Hazardous Material Regulations.

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

(Nongovernment standards and other publications are normally available from

the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Liquid concentrate fire extinguishing agents furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.2 Materials. Concentrates shall consist of fluorocarbon surfactants plus other compounds as required to conform to the requirements specified herein. The material shall have no adverse effect on the health of personnel when used for its intended purpose.

3.2.1 Material safety data sheet. The contracting activity shall be provided a material safety data sheet (MSDS) at the time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313 and 29 CFR 1910.1200, Hazard Communication. When FED-STD-313 is at variance with the CFR, 29 CFR 1910.1200 shall take precedence, modify and supplement FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 5.5 and 6.4). Test facilities performing QPL testing shall also be provided a MSDS of the product.

3.3 Concentrate characteristics. Concentrates shall conform to the chemical and physical requirements shown in table I.

TABLE I. Chemical and physical requirements for concentrates or solutions.

Requirement	Values		Applicable
	Type 3	Type 6	
Refractive index, minimum	1.3630	1.3580	ASTM D 1218
Viscosity, centistokes maximum at 5°C	20	10	ASTM D 445
minimum at 25°C	2	2	ASTM D 445

f

TABLE I. Chemical and physical requirements for concentrates or solutions.
- Continued

Requirement	Values		Applicable document
	Type 3	Type 6	
Hydrogen ion concentration (pH)	7.0 to 8.5	7.0 to 8.5	ASTM E 70
Spreading Coefficient minimum	1.0	1.0	ASTM D 1331
Foamability:			
Foam expansion minimum	6.0	6.0	NFPA 412 (method A)
Foam 25 percent drainage time, minutes, minimum	4.0	4.0	NFPA 412 (method A)
Corrosion rate:			
General: metal coupons			
Cold rolled, low carbon Steel (UNS G10100), mils/year maximum	2.5	2.5	ASTM E 527 ASTM G 1
Copper-nickel (90-10) (UNS C70600), mils/year maximum	1.0	1.0	ASTM E 527 ASTM G 1
Monel (UNS N04400), mils/year maximum	1.0	1.0	ASTM E 527 ASTM G 1
Bronze (UNS C90500), mils/year maximum	1.0	1.0	ASTM E 527 ASTM G 1
General: metal ions dissolved in AFFF			
Cold rolled, low carbon Steel (UNS G010100), ppm maximum, Fe	35.0	35.0	ASTM E 527 ASTM G 1
Copper-nickel (90-10) (UNS C70600), ppm maximum, Cu	5.0	5.0	ASTM E 527
maximum, Ni	2.0	2.0	ASTM G 1
Monel (UNS N04400), ppm maximum, Ni	5.0	5.0	ASTM E 527
maximum, Cu	2.0	2.0	ASTM G 1

TABLE I. Chemical and physical requirements for concentrates or solutions.
- Continued

Requirement	Values		Applicable document
	Type 3	Type 6	
Bronze (UNS C90500), ppm			
maximum, Cu	7.0	7.0	ASTM E 527
maximum, Zn	2.0	2.0	ASTM G 1
Localized, corrosion- resistant (CRES) steel (UNS S30400)	No pits	No pits	
Total halides, ppm maximum	500	250	ASTM D 1821
Dry chemical compatibility, burnback resistance time, seconds minimum	480	480	_____
Environmental impact: Toxicity, median lethal concentration (LC ₅₀), mg/L			
minimum	500	1000	ASTM E 729
COD, mg/L maximum	1000K	500K	ASTM E 729
BOD ₂₀ COD minimum	0.65	0.65	ASTM E 729

£

3.3.1 Film formation and sealability. A film produced by a 3 percent AFFF solution of type 3 or a 6 percent AFFF solution of type 6 shall spread over the fuel surface and seal off vapor production to prevent sustained ignition (see 4.7.7).

3.3.2 Stability. Both the concentrate (type 3 or type 6) and a 3 percent AFFF solution of type 3 or a 6 percent AFFF solution of type 6 as applicable shall conform to the following requirements after being stored for 10 days at 65°C ± 2.0°C (see 4.7.11):

- (a) Spreading coefficient: (see table I).
- (b) Foamability: (see table I).
- (c) Film formation and sealability: As specified in 3.3.1.

- (d) Fire performance, 28 square-foot fire, using solutions of aged concentrates 1.5, 3 and 6 percent of type 3 and 3, 6 and 12 percent of type 6 in ocean water as specified in 3.4: (see tables II and IIIA).
- (e) Stratification: No visible evidence following test (see 4.7.16).
- (f) Precipitation: 0.05 percent by volume (see 4.7.17).

3.3.3 Inter-agent compatibility. The concentrate of one manufacturer shall be compatible in all proportions with concentrates of the same type furnished by other manufactures listed on the qualified products list. The material shall also be compatible with materials in inventory which were acquired under previous issues of this specification and are known to still be in use in significant quantities. Information regarding these materials may be obtained from the Naval Sea Systems Command (NAVSEA) at the address listed in 6.3. The concentrate, when mixed in the proportions determined by NAVSEA, shall conform to the following requirements after 10 days storage at $65^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ (see 4.7.11):

- (a) Foamability: (see table I).
- (b) Film formation and sealability: As specified in 3.3.1.
- (c) Fire performance 28 square-foot: 3 percent of type 3 and 6 percent of type 6 ocean water solutions as specified in 3.4 (see tables II and IIIA).
- (d) Stratification: No visible evidence following test (see 4.7.16).
- (e) Precipitation: 0.05 percent by volume (see 4.7.17).

3.3.4 Total fluorine content. The total fluorine content of the AFFF shall not deviate more than 15 percent of the value determined and recorded at time of qualification (see 4.7.18).

3.4 Fire performance. The foam shall meet the fire performance requirements shown in tables II, IIIA and IIIB. No foam shall fail more than 10 percent of the total number of tests performed, nor shall there be more than 1 failure permitted in any one category.

3.4.1 Multiple inter-agent compatibility testing. If a concentrate is to be run with more than one qualified agent for compatibility testing, then one additional failure in this category for each additional qualified agent will be permitted. However, the total number of failures still may not exceed 10 percent of the total number of tests run.

3.5 Marking. Identification marking shall be in accordance with MIL-STD-130. In addition, the marking on the containers (see 5.4) shall be in white characters against a green background for type 3, a blue background for the type 6 (see 5.2.1.3).

TABLE II. Fire performance.

<u>Fire Tests</u>	<u>Number of Tests to be performed</u>	<u>Test Procedure</u>
<u>28 sq. ft Fire Tests</u>		
1) Full strength solution		
a) Ocean water solution	6	4.7.14.5
b) Fresh water solution	4	4.7.14.5
2) PKP compatibility, full strength solution	4	4.7.10
3) Half strength solution	4	4.7.14.5
4) Double strength solution	4	4.7.14.5
5) Inter-agent compatibility, full strength solution	6	4.7.12
6) Quintuple strength solution	2	4.7.14.6
7) Aged concentrate		
a) Half strength solution	4	4.7.11
b) Full strength solution	4	4.7.11
c) Double strength solution	4	4.7.11
<u>50 sq. ft Fire Tests</u>		
8) Full strength solution	2	4.7.15

£

TABLE IIIA. Application, extinguishment and burnback times.
for 28 square-foot fire tests.

<u>Test</u>	<u>Total Application Time(s)</u>	<u>Maximum Extinguishment Time(s)</u>	<u>Minimum 15 % Burnback Time(s)</u>
1	60	55	840
2	60	55	540
3	75	70	720
4	60	60	720
5	60	55	840
6	90	55	720
7a	75	70	720
7b	60	55	840
7c	60	60	720

£

TABLE IIIB. Application, extinguishment and burnback time for 50 square-foot fire test.

Test	Total Application Time(s)	Maximum Extinguishment Time(s)	Minimum 25 % Burnback Time(s)	Minimum 40 s Summation
8	90	50	840	320

f

3.5.1 Additional marking. Two identical markings, as shown on figures 1 and 2, shall be applied to containers so that the markings are located diametrically opposite. The markings shall be applied on the containers in such a manner that water immersion contact with the contents of the containers, or normal handling shall not impair the legibility of the marking. Paper labels shall not be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command. Qualification inspection shall consist of the tests shown in table IV. A permanent visual record of all fire performance tests by video, as well as recorded heat flux data shall be retained for review.

4.3.1 Samples for qualification inspection. One hundred gallons of type 3 and 200 gallons of type 6 are required for the qualification inspection.

4.4 Quality conformance inspection. The samples selected in accordance with 4.4.1 shall be subjected to the quality conformance inspection specified in table IV. For the 28 square-foot fire test, 3 tests shall be performed (as described in 4.7.14.5 using a full strength solution. All three of these tests shall be passed using the criteria set forth in table IIIA. If the sample tested fails any of the quality conformance tests outlined in table IV, then the lot represented by the sample shall be rejected.

Table IV. Qualification and quality conformance inspections.

Examination or test	Requirement	Test	Qualifi- cation	Quality conformance
Refractive index	3.3	4.7.2	X	X
Viscosity	3.3	4.7.3	X	X
pH value	3.3	4.7.4	X	X
Spreading coefficient	3.3	4.7.5	X	X
Foamability	3.3	4.7.6	X	X
Film formation and sealability	3.3.1	4.7.7	X	X
General corrosion	3.3	4.7.8.1	X	
Localized corrosion	3.3	4.7.8.2	X	
Total halides	3.3	4.7.9	X	X
Fluorine content	3.3.4	4.7.17	X	X
Dry chemical compatibility	3.3	4.7.10	X	
Stability	3.3.2	4.7.11	X	
Inter-agent compatibility	3.3.3	4.7.12	X	
Environmental impact	3.3	4.7.13	X	
28 square-foot fire test	3.4	4.7.14	X	X
50 square-foot fire test	3.4	4.7.15	X	
Examination of filled containers		4.6		X
Torque to remove cap	5.2.1.1(j)	4.7.19.2	X	X

£

4.4.1 Sampling for quality conformance inspection. Three filled 5 gallon containers shall be selected at random from each lot and used as one composite sample for the tests specified in 4.5, or three 5 gallon containers of the product shall be withdrawn from an agitated mixing tank prior to packaging.

4.4.2 Quality conformance inspection report. When specified in the contract or order, a quality conformance inspection report shall be prepared (see 6.2.2).

4.5 Examination of filled containers. Each sample-filled container shall be examined for defects of construction of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each filled container shall also be weighed to verify the amount of contents. Any container in the sample having one or more defects or less than required fill shall not be offered for delivery, and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan as specified in MIL-STD-105, this shall be the cause for rejection of the lot represented by the sample.

4.5.1 Sampling for examination of filled containers and palletization. A random sample of filled containers shall be selected from each lot in accordance with MIL-STD-105 at inspection level I. The acceptable quality level (AQL) of 2.5 percent defective shall be used to verify conformance to all requirements regarding fill, closure, marking, and other requirements not requiring tests (see 4.6, 5.2.1.1, 5.2.1.2, and 5.3.2).

4.6 Inspection lot. A lot shall consist of all foam concentrate manufactured as one batch and transferred from one mixing tank to the shipping container.

4.7 Test procedure. Test procedures shall be as specified in 4.7.2 through 4.7.19.2.

4.7.1 Test Materials. Except as listed below, all materials used for testing of physical and fire characteristics shall be as specified in the referenced document or standard (see table I).

4.7.1.1 Ocean water. When ocean water is required for tests, synthetic ocean water in accordance with ASTM D 1141 shall be used.

4.7.1.2 Heptane for fire performance tests. When heptane is required for fire performance tests (see 4.7.14 and 4.7.15), the fuel shall be not less than 95 percent n-heptane as determined by gas chromatograph in accordance with ASTM E 260.

4.7.1.3 Heptane for physical characteristics. When heptane is required for the laboratory determination of physical characteristics (see 4.7.5 and 4.7.7), the fuel shall not be less than 99 weight percent n-heptane as determined by gas chromatograph in accordance with ASTM E 260.

4.7.2 Refractive index. The refractive index shall be determined at $25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ in accordance with ASTM D 1218.

4.7.3 Viscosity. The viscosity shall be determined at temperatures of $5^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ and $25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ in accordance with ASTM D 445, using capillary viscosimeters of the appropriate size.

4.7.4 pH value. The pH value shall be determined potentiometrically, using a pH meter with a glass electrode and a reference electrode, at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ in accordance with ASTM E 70.

4.7.5 Spreading coefficient. The spreading coefficient shall be determined with reference to n-heptane in accordance with the following relationship:

$$S_{a/b} = \gamma_b - \gamma_a - \gamma_i$$

where: $S_{a/b}$ = spreading coefficient, (dynes per cm)
 γ_b = surface tension of n-heptane as determined in 4.7.5.1.
 γ_a = surface tension of AFFF solution as determined in 4.7.5.1.
 γ_i = interfacial tension between liquids as determined in 4.7.5.2.

4.7.5.1 Surface tension. The surface tension of AFFF solution 3 ± 0.05 percent of type 3 or 6 ± 0.1 percent of type 6 by volume in distilled water, as appropriate, and of pure grade n-heptane (99.0 percent minimum purity) shall be determined with a DuNouy tensiometer, or equal, at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ in accordance with ASTM D 1331.

4.7.5.2 Interfacial tension. The interfacial tension of AFFF solution between 3 ± 0.05 percent of type 3 or 6 ± 0.1 percent of type 6 by volume in distilled water, as appropriate, and pure grade n-heptane (99.0 percent minimum purity) shall be determined with a DuNouy tensiometer, or equal, at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ until the readings come to equilibrium in accordance with ASTM D 1331.

4.7.6 Foamability. The foam shall be generated by means of a special 2 gallon per minute (gal/min) test nozzle as described in 4.7.6.1. The foam solution shall be premixed at a temperature of $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$. The nozzle shall be mounted on a support stand similar to that shown in figure 3. The nozzle assembly and stand shall be positioned so that the wing tip spreader is located 36 ± 0.5 inches above the floor and 24 ± 0.5 inches away from the near edge of the foam collection backboard. The nozzle assembly shall be mounted in the stand so that the foam barrel is parallel to the floor. The test procedure shall be in accordance with NFPA 412, test method A, except as noted above. Foamability shall be run on AFFF solution of 3 ± 0.05 percent of type 3 and 6 ± 0.1 percent of type 6 by volume in ocean water.

4.7.6.1 Two gallon per minute nozzle. The basic nozzle as made by National Foam System, Inc., or equal, shall be modified by shortening the length of the foam barrel from 2-1/2 to 1-1/4 inches, and by adding a wing-tip spreader on the outlet, as shown in figure 4. The spreader shall have a 1/8-inch wide by 1-7/8 inch long oval orifice (it may be made by slightly compressing a Bernz-o-matic TX-1527, or equal, flame spreader). A detailed drawing of the nozzle construction is available from the Naval Research Laboratory, Code 6180, Washington, DC 20375-5000. During foam sample collection, the nozzle inlet pressure shall be maintained at a gauge pressure of 100 pounds per square inch (lb/in²).

4.7.7 Film formation and sealability. The film formation and sealability shall be determined in accordance with the test procedure specified in

4.7.7.1. Tests shall be conducted at temperatures of 23°C ± 2.0°C.

4.7.7.1 Test procedure. Forty milliliters (ml) of n-heptane (minimum 99.0 percent purity) shall be placed in a borosilicate glass petri dish (diameter 100 millimeters (mm) by height 20 mm). In the approximate center of the dish a 3/4 inch, no. 8 flat-head wood screw shall be placed on its head. The screw shall be made of stainless steel, chrome plated brass, or brass. Using a microsyringe, 0.25 ml (250 microliters) of test solution 3 ± 0.05 percent of type 3 or 6 ± 0.1 percent of type 6 by volume in ocean water shall be carefully applied to the tip of the screw from a height of about 1/4 inch above the screw. The microsyringe shall have a needle gauge of 22 (outside diameter, 0.028 inch, inside diameter, 0.016 inch). The fully formed droplets shall be applied at a rate of approximately one per second. Bubbles shall be avoided as their presence can alter the spreading. Reflected light can be used as an aid in observing the spreading of the aqueous solution film over the surface of n-heptane. Two minutes after applying the first drop of AFFF solution to the screw, a pilot flame shall be passed over the fuel surface at a height of about 1/2 inch. A small flash may be permitted, but no sustained ignition shall result if an effective vapor seal is present. A 1 inch long pilot flame shall be provided with a hand-held propane cylinder fitted with a capillary tubing outlet.

4.7.8 Corrosion. The following shall be used to assess the potential corrosivity of the AFFF solution:

- (a) General corrosion rate.
- (b) Dissolved metal ions.
- (c) Localized corrosion.

4.7.8.1 General corrosion. General corrosion shall be tested as specified in 4.7.8.1.1 through 4.7.8.1.7.

4.7.8.1.1 Test medium. The test medium for immersion of the metal specimens for general corrosion shall consist of the concentrate diluted 10 percent by volume with ocean water in accordance with ASTM D 1141 except for

steel metal specimens (1010 cold rolled, UNS G10100) which shall be immersed in AFFF concentrate only.

4.7.8.1.2 Test specimens. The test specimens shall consist of the following metals, in accordance with UNS designations (as specified in ASTM E 527):

- (a) Steel, 1010 cold rolled, UNS G10100
- (b) Monel, 400, Ni/Cu (70/30), UNS N04400
- (c) Bronze, 905, UNS C90500
- (d) Cu/Ni (90/10), 706, UNS C70600

Metal coupon specimens except for bronze shall be milled to finished dimensions of 1/16 inch thick, 1/2 inch wide, and 3 inches long. Bronze coupons shall have finished dimensions of approximately 3/8 inch thick, 1/2 inch wide, and 3 inches long. All metal specimens shall have a 1/16 inch diameter hole, centered, 3/16 inch from top of metal coupon.

NOTE: Metal test specimens can be obtained through Metaspec Company, P.O. Box 6715, San Antonio, Texas 78209.

4.7.8.1.3 Preparing and cleaning test specimens. Cleaning and preparing of test specimens shall be in accordance with ASTM G 1. Metal coupons shall be chemically or electrolytically cleaned before and after corrosion testing. Special care shall be taken while handling the metal specimens to prevent error in weighing. Handling of all metal specimens shall be done with either plastic or teflon covered tweezers. Cleaning time for Cu/Ni alloys and for iron/steel shall be consistent throughout the entire test procedure. Metal coupons shall be rinsed thoroughly with distilled water and dried in an oven for 15 minutes. Specimens shall be cooled to room temperature before weighing. The coupons shall be weighed to the nearest 0.01 milligram (mg). The weight of each coupon shall be recorded. (Note: Recalibrating the balance every 6 to 10 weighings is recommended to maintain a high degree of accuracy.) Removal of solid metal during the cleaning of metal coupons can result in a error in the determination of the corrosion rate. This can be checked by recleaning the weighed specimens by the same method and reweighing them.

4.7.8.1.4 Preparing and cleaning of glassware. Glassware and sample vials shall be made of borosilicate glass to prevent adsorption of metal ions onto glass surface. Glassware shall be rinsed in 1:1 nitric acid (HNO_3) for 15 minutes, then rinsed with distilled water and oven dried.

4.7.8.1.5 Test procedure. Three weighed coupons of each metal type shall be fully immersed in the test medium in separate 600 ml beakers. Metal coupons shall be suspended in the test medium so that the coupons do not touch the bottom of the beaker or each other. Suspending the metal coupons may be accomplished by using small wooden rods laid across the top of the beaker with polyester string looped through hole in metal coupon. Five-hundred and fifty ml of test medium shall be used in each 600 ml beaker. The coupons and test medium shall be held at $35^\circ\text{C} \pm 2.0^\circ\text{C}$ for 28 days. An inverted petri dish (150

by 20 mm) or a watch-glass cover used in conjunction with a plastic film shall be used to retard evaporation. The test medium shall be stirred at least every third day for 10 minutes. At the end of the exposure period, the metal coupons shall be removed and examined for any abnormal corrosion effects. The metal coupons after visual inspection shall then be immersed in their appropriate cleaning solution, rinsed thoroughly with distilled water and oven dried for 15 minutes. The coupons shall be weighed to the nearest 0.01 mg. The total medium volume shall be recorded after the coupons have been removed. The test medium shall be stirred and filtered through a Whatman grade 6 filter paper or equivalent. Two 15 ml samples shall be taken for analysis from each test medium. One of the 15 ml samples collected from the test medium shall be diluted with 1:1 nitric acid (HNO_3) to dissolve any metal salts that may have formed. The other 15 ml sample may be used as a backup to the first, if needed.

4.7.8.1.6 Analyzing for metal content. Analyzing corrosion test sample solutions shall be done by any of the following methods:

- (a) DCP atomic emission spectrometry.
- (b) Atomic absorption spectrometry.

The metal coupon solutions shall be analyzed for the following elements with results being reported for the total amount of metal in the original solution (i.e. corrected for dilutions):

	Elements
(a) Steel, 1010, cold rolled no. UNS G10100, maximum	Fe
(b) Monel, 400, Ni/Cu no. UNS N04400, maximum	Ni, Cu
(c) Bronze, 905 no. UNS C90500, maximum	Cu, Zn
(d) Cu/Ni Alloy 760 no. UNS C70600, maximum	Cu, Ni

4.7.8.1.7 Calculating corrosion rate of test metal coupons. The corrosion rate shall be calculated by the following formula and shall be reported in mils per year (mils/year):

$$\text{Corrosion rate} = (K \times \text{WTL}) / (A \times T \times D)$$

where:

- K = a constant of 534.
- T = time of exposure in hours to the nearest 0.5 hour.
- A = total exposed metal surface area in square inches to the nearest 0.001 square inch.
- D = density of metal specimen in grams per cubic-centimeter (g/cm^3).

WTL = $W_1 - W_2$ = the total mass lost of metal coupon to the nearest 0.01 mg after a 28-day exposure to test medium.

W_1 = weight of metal coupon after cleaning.

W_2 = weight of metal coupon after exposure to test medium and cleaning.

4.7.8.2 Localized corrosion. Localized corrosion shall be tested as specified in 4.7.8.2.1 through 4.7.8.2.4.

4.7.8.2.1 Test specimens. The test specimens shall consist of UNS S30400 CRES milled to finished dimensions of approximately 1/16 inch thick, 1/2 inch wide, and 3 inches long, without holes. After degreasing with acetone, rinsing with distilled water, and air drying before exposure, the specimens shall be pretreated by immersion in a 1:9 concentrated nitric acid-water solution for 5 minutes.

4.7.8.2.2 Test medium. The test medium for immersion of the metal specimens for localized corrosion shall consist of the concentrate diluted 10 percent by volume with ocean water in accordance with ASTM D 1411.

4.7.8.2.3 Procedure. Five specimens shall be girdled lengthwise with a clean 1/16 to 1/8 inch wide band of gum rubber of a size such that the band is taut during the test. Because of the poor quality of most commercial rubber bands, it is recommended that the bands for this test be cut from 1-3/4 inch flat width pure gum amber tubing, Gooch type (Preiser Scientific Rubber tubing, 1/32 inch thin wall, Stock No. 139080, or equal). This tubing is most easily cut into uniform strips with a blade-type paper cutter, but may also be cut with sharp shears. The specimens girdled with the rubber bands shall be placed in a 600 ml beaker so that no contact is made between individual, banded specimens. A 1/4 inch layer of glass beads at the bottom of the beaker or a coupon suspension system as outlined in paragraph 4.7.8.1.5 shall be used to stabilize the specimen position. Enough liquid shall be added to completely immerse the specimens, and a watch-glass or equal shall be placed over the beaker to retard evaporation (but allow air access) and act as a dust cover. The assemblies shall be allowed to stand at a temperature of $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 28 days.

4.7.8.2.4 Results. The specimens shall be monitored daily over the 28-day period to ascertain the presence or absence of pitting. These daily examinations shall be made without disturbing the test (other than removing the cover). Corrosion is customarily signaled by the appearance of a dark spot which, if removed after sufficient exposure, discloses a corrosion pit. If the suspected area cannot be positively identified by the naked eye, a magnification of 10X shall be used. At the end of the test, each specimen shall be inspected carefully with particular attention being given to the edges of the specimens and those areas of the specimens under, or adjacent to the rubber bands. 10X magnification shall be used, if necessary.

4.7.9 Total halides. The halide content shall be determined in accordance with ASTM D 1821, except for the following modifications:

- (1) 4 ± 0.1 grams shall be weighed, or 4 ± 0.1 ml shall be added, into a 250 ml beaker.
- (2) 75 ml of acetone shall be added. Add 2 ml of dilute nitric acid (one volume of concentrated acid to 60 volumes of water) shall be added.
- (3) The calculation shall be modified as follows:
halide content, parts per million (ppm) = $44.4(A-B)$.

4.7.10 Dry chemical compatibility. The foam's compatibility with potassium bicarbonate dry chemical extinguishing agent shall be determined by measuring the burnback time in the presence of the dry chemical.

4.7.10.1 Test materials. The fuel shall be not less than 95 percent n-heptane as specified in 4.7.1.2. The dry chemical agent shall conform to Federal Specification O-D-1407. The sieve shall be an 8 inch diameter 40-mesh sieve conforming to type I, style A of Federal Specification RR-S-366.

4.7.10.2 Test procedure. A 28 square-foot fire test shall be conducted in accordance with 4.7.14.5 using an ocean water solution of type 3 or 6 AFFF concentrate, as required, to extinguish the fire. Before placing the burnback pan, 1 pound of dry chemical agent shall be evenly distributed over the foam blanket with the aid of a sieve (as described in 4.7.10.1) on a long handle. This shall be accomplished within a 30 second period so that the total time from end of foam application to placement of the burnback pan shall be no longer than 90 seconds. The burnback time shall be determined in accordance with 4.7.14.7 and 4.7.14.8.

4.7.11 Stability. The stability of the concentrates shall be determined by testing samples after they have been subjected to an artificial aging process.

4.7.11.1 Sample preparation. Samples of the concentrate, and type 3 or type 6 AFFF ocean water solutions, as appropriate, shall be prepared in sufficient quantity to perform the required tests (approximately four liters for type 3 and eight liters for type 6 concentrates). All samples shall be placed in lightly stoppered borosilicate glass cylinders. Samples shall be subjected to a stability test at $65^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ for 10 days. The samples shall then be subjected to the following tests:

- | | |
|---|--------|
| (a) Spreading coefficient | 4.7.5 |
| (b) Foamability | 4.7.6 |
| (c) Film formation and sealability | 4.7.7 |
| (d) Fire performance (28 square-foot)
(see tables II and IIIA) | 4.7.14 |
| (e) Stratification | 4.7.16 |
| (f) Precipitation | 4.7.17 |

4.7.11.1.1 Precipitation test sample preparation. In the preparation of the samples to be used for the precipitation test, the ocean water shall be filtered prior to use.

4.7.12 Inter-agent compatibility. The Government will provide samples of appropriate type qualified products to manufacturers officially authorized to submit candidate material for qualification (see 3.3.3). Mixtures of the type 3 and type 6 concentrates to be tested shall be prepared in sufficient quantities to perform the required tests. (For qualification testing, NAVSEA shall determine the number of product mixtures to be evaluated and the mixture ratios of the products). Additionally, 3 percent of type 3 or 6 percent of type 6 AFFF ocean water solutions shall be prepared from each concentrate mixture. One liter of each shall be placed in lightly stoppered borosilicate glass cylinders. The samples shall be subjected to a stability test at $65^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ for 10 days. The samples shall then be subjected to the following tests:

- | | |
|---|--------|
| (a) Foamability | 4.7.6 |
| (b) Film formation and sealability | 4.7.7 |
| (c) Fire performance (28 square-foot)
(see tables II and IIIA) | 4.7.14 |
| (d) Stratification | 4.7.16 |
| (e) Precipitation | 4.7.17 |

4.7.13 Environmental impact. Environmental impact shall be tested as specified in 4.7.13.1 through 4.7.13.3.

4.7.13.1 Toxicity. Toxicity test shall be performed on the killifish (*fundulus heteroclitus*) in accordance with ASTM E 729, using dynamic procedures. The minimum acceptable dissolved oxygen content of water used in this procedure shall be 5 ppm.

4.7.13.2 Chemical oxygen demand (COD). COD shall be determined in accordance with procedures in Standard Methods for the Examination of Water and Waste Water.

4.7.13.3 Biodegradability. Biodegradability shall be determined by dividing the value expressed in milligrams per liter (mg/L) for the 20 day biological oxygen demand (BOD_{20}) test by the value expressed in mg/L for chemical oxygen demand (COD) determined as specified in 4.7.13.2. The BOD_{20} shall be conducted in accordance with the procedure specified for the 5 day BOD test in Standard Method for the Examination of Water and Waste Water (latest applicable Edition).

4.7.14 Twenty-eight square-foot fire test. The 28 square-foot fire test procedure shall consist of two phases. The number of tests and the order in which they are to be performed shall be as shown in table II. The first phase shall test the agent's extinguishing ability and the second phase shall test it's resistance to burnback. The passing criterion for the extinguishing

phase of the test shall be 100 percent extinguishment (as visually observed) in the allotted time as specified in 3.4 (see table IIIA). The passing criterion for the burnback phase of the test shall be a maximum of 15 percent reinvolverment at the times specified in 3.4 (see table IIIA). The judgment of 15 percent burnback shall be based on data collected by the instrumentation setup specified in 4.7.14.3.4 which shall be analyzed using the techniques specified in 4.7.14.8.

4.7.14.1 Test building. The fire tests shall be conducted indoors in a test building of sufficient size and ventilation capacity to ensure reliable and reproducible test results.

4.7.14.2 Test results retention. A permanent record of all test results and instrumentation data collected shall be kept for future inspection. These records may be kept either on handwritten data collection sheets or on computer diskettes. Because of the nature of the data collection and analysis that is to be done for the burnback portion of the testing, it is recommended that some sort of computerized data acquisition equipment be used. A sample program can be obtained from the Naval Research Laboratory, Code 6180, Washington, DC 20375-5000. This program will have to be modified to run on the particular system used. In addition to radiometer data, a videotape or motion picture record shall be made of each test performed. These records shall be kept for at least 2 years.

4.7.14.3 Test equipment. The fire test shall be conducted using the test pan and AFFF delivery system shown in figures 5 and 6 and specified in 4.7.14.3.1 and 4.7.14.3.4.

4.7.14.3.1 28 square-foot test pan. This test pan shall be 6 feet in diameter and shall be made of 1/4 inch thick stainless steel and shall conform to the dimensions and configurations shown in figures 5 and 6.

4.7.14.3.2 AFFF delivery system. The nozzle system shall be a fixed type system having four application points. It shall consist of a flow control/aspiration device, four low flow spray nozzles spaced equally around the perimeter of the pan, and the required connecting piping as shown in figures 5 and 6.

4.7.14.3.2.1 Flow control/aspirating device. This device is a modification of the nozzle described in 4.7.6. The wing tip spreader is removed from the nozzle which is then connected in line with the system piping as shown in figures 5 and 6. The flow shall be controlled by operating the device at 100 pounds per square-inch (lb/in^2) gauge on the intake side. This flow rate should be checked and adjusted daily.

4.7.14.3.2.2 System piping. The piping downstream of the flow control device shall be nominal 1 inch diameter, schedule 40 galvanized steel. It shall be installed as shown in figures 5 and 6.

4.7.14.3.2.3 Nozzle type. The nozzles shall be Floodjet type 1/4 K 20 brass spray nozzles or equal (available from Spraying Systems Co., Wheaton, IL 60187). They shall be installed in the piping so that they project a horizontal, 60 degree fan shaped pattern as shown on figure 7.

4.7.14.3.3 Burnback pan. The burnback pan shall be 1 foot in diameter and shall be made entirely of 1/8 in thick stainless steel except for the bottom piece which shall be 1/4 in thick. It shall conform to the dimensions and configurations shown in figure 8.

4.7.14.3.4 Instrumentation. The instrumentation used to measure 15 percent burnback times shall consist of four radiometers which are to be located around the test pan as shown in figures 9 and 10.

4.7.14.3.4.1 Radiometers. The four radiometers shall be of a Gardon type, water cooled, and shall be fitted with a sapphire window so that only radiative heat is measured. Additionally they shall have 90 degree view restrictor attachments installed to limit the viewing angle so that background noise from the surroundings is limited. The maximum range shall be at least 10 British Thermal Units per second per square foot (Btu/s/ft²), and the sensitivity of the transducer shall not be reduced by more than 60% when the sapphire window attachment is installed (for example, Medtherm model 64TP-10-23 or equal). They shall be spaced evenly around the perimeter of the pan, 12 feet radially out from the edge, and at a 12 foot elevation. They shall be mounted so that the front face is perpendicular to the floor and the window is aimed at the vertical centerline of the test pan.

4.7.14.4 Test materials. Foam shall be generated from AFFF solutions premixed at 23°C ± 2°C. All solutions shall be made with ocean water conforming to ASTM D 1141 except for full strength solutions which shall be made using either fresh or ocean water for the tests specified in table II. All solutions shall have the concentration values shown in table V. The fuel used for the fire test shall be 10 gallons of 95 percent purity n-heptane conforming to 4.7.1.3. The fuel used in the burnback pan shall be 1/2 gallon of motor gasoline conforming to Federal Specification VV-G-1690.

TABLE V. AFFF test concentration values.

<u>Solutions</u>	<u>Type 3</u>	<u>Type 6</u>
Half strength	1.5 ± .03	3.0 ± .05
Full strength	3.0 ± .05	6.0 ± .10
Double strength	6.0 ± .10	12.0 ± .20
Quintupled strength	15.0 ± .20	30.0 ± .20

4.7.14.5 Extinguishment phase test procedures for half, full and double strength solutions. The nozzles shall be covered and the system pre-flowed for 20 seconds to ensure that all foam from the previous test has been expelled from the system's piping, and also to ensure that good quality foam is ready to be discharged from the nozzles. The fuel shall then be poured within 30 seconds, and the fire lit within 15 seconds of the completion of fueling. A preburn period of 10 seconds shall be allowed before the foam system is activated. The fire extinguishment time shall be measured as the elapsed time from system activation to complete cessation of all flame, as visually observed. Foam application shall continue for the times listed in table IIIA regardless of what happens with extinguishment. If the fire is 100 percent extinguished in the allotted time, then the burnback test as specified in 4.7.14.7 shall be performed.

4.7.14.6 Extinguishment phase test procedure for quintuple strength solutions. Extinguishment using quintuple strength solutions shall be effected manually by an experienced firefighter using the handheld nozzle described in 4.7.6. The nozzle shall be preflowed for 20 seconds to purge the supply line. The fuel shall then be poured within 30 seconds, and the fire lit within 15 seconds of the completion of fueling. A preburn period of 10 seconds shall be allowed prior to foam discharge. After the preburn period, the fire shall be attacked and extinguished as expeditiously as possible. Movement of the fire fighter around the perimeter of the pan shall be limited to 90 degrees in either direction from the starting point. The extinguishment time shall be measured as the elapsed time from beginning of discharge to complete cessation of all flame, as visually observed. Foam application shall continue for a total of 90 seconds. If the fire is 100 percent extinguished in the allotted time, then the burnback test specified in 4.7.14.7 shall be performed.

4.7.14.7 Burnback phase test procedure for all tests. Within 30 seconds of the completion of foam application, the burnback pan (as described in 4.7.14.3.3) shall be placed in the center of the 28 square-foot test pan. The burnback pan shall contain 0.5 ± 0.1 gal. of motor gasoline conforming to Federal Specification VV-G-1690. As soon as the pan is positioned it shall be lit and data collection begun. Flux level data shall be collected every 5 seconds. The burnback pan shall be left in for the entire duration of the burnback phase of testing. Once the fire has spread to involve approximately 50 percent of the test pan, the fire may be extinguished and the pans drained and cleaned for the next test. The data shall then be evaluated using the procedure described in Section 4.7.14.8.

4.7.14.8 Determination of 15 percent burnback time. The time at which 15 percent (4.2 square-feet) of the 28 square-foot test pan is reinvolved in fire shall be determined by evaluating at each data collection time step, the percent increase of the flux level over an initial background average. For the purposes of the evaluation, the flux level at each time step shall be the average of the four individual radiometer readings obtained at that time step. The evaluation shall be performed using the steps outlined below.

4.7.14.8.1 Calculation of average background flux. The average background flux level of the burnback pan fire shall be determined for a two minute interval. The two minute interval shall start one minute after the burnback pan has been lit. The first and last reading used to calculate this average shall not differ by more than 100 percent of the first reading.

4.7.14.8.2 Calculation of the percent increase. Starting with the time step immediately following the two minute background interval, evaluation will begin to determine the percent increase of the flux level over the average background reading. A three point average around each time step shall be used for the comparison. The three point average will include the flux levels for the time step of interest, the time step just prior to the time step of interest, and the time step just after the time step of interest, as shown in the equation:

$$F_{avg}(i) = \frac{F(i-1) + F(i) + F(i+1)}{3}$$

where:

i = the time step of interest
 $F_{avg}(i)$ = the three point average flux for the time step of interest
 $F(i)$ = the flux level for time step i

The three point average obtained above for each time step shall be compared to the two minute average background reading and the percent increase calculated as follows:

$$\text{percent increase} = \frac{F_{avg} - F_{bkg}}{F_{bkg}} * 100 \%$$

where:

F_{avg} = the three point average flux for the time step of interest
 F_{bkg} = the two minute average background flux level

When the percent increase is equal to or greater than 300 percent, then the burnback criterion shall have been met and the time corresponding to the time step of interest shall be recorded as the burnback time.

4.7.15 Fifty square-foot fire test. The 50 square-foot fire test procedure shall consist of two phases. The number of tests to be performed and the passing criterion shall be as shown tables II and IIIB. The first phase shall test the agents extinguishing ability and the second phase shall test its resistance to burnback. The passing criteria for extinguishment shall be 100 percent extinguishment (as visually observed) in the required time, as well as a 40 second summation time (also visually observed) of 320

seconds. The 40 second summation value shall be determined as described in 4.7.15.4. The passing criteria for the burnback tests shall be a maximum of 25 percent reinvolvement at the times specified in table IIIB.

4.7.15.1 Test site. The fire test shall be conducted on a level, circular area 8 feet in diameter. The base and surrounding wall shall be suitable for containment of the fuel on a substrate of water. The water depth shall be the minimum required to ensure complete coverage of the area with fuel. If the tests are to be run outdoors, the temperature must be above 10°C and the winds may not be in excess of 2-3 knots.

4.7.15.2 Test equipment. The nozzle used to apply the foam shall be the 2 gallon per minute device specified in 4.7.6. It shall be operated at an inlet pressure of 100 pounds per square-inch.

4.7.15.3 Test materials. The foam shall be a full strength solution as specified in 4.7.14.4. The test fuel shall be 15 gallons of n-heptane as specified in 4.7.1.2.

4.7.15.4 Test procedure. The fuel shall be poured into the test area within 60 seconds and ignited within 30 seconds of completion of pouring. After allowing a preburn period of 10 seconds the fire shall be manually attacked by an experienced firefighter and extinguished in an expeditious manner. Movement of the firefighter shall be limited to 90 degrees in either direction of the initial point of attack. At 10 second intervals after the start of foam application, an observer shall visually estimate the percentage of fire area extinguished. The percent extinguished at 10, 20, 30, and 40 seconds shall then be totaled to give the 40 second summation value. The exact extinguishing time shall also be recorded at the cessation of all flame, but foam application shall continue for a total of 90 seconds.

4.7.15.5 Burnback procedure. Within 60 seconds of the completion of foam application, the burnback pan described in 4.7.14.3.3, containing 1/2 gallon of motor gasoline as described in 4.7.14.4, shall be placed in the center of the foam blanket and lit. Timing shall begin when the burnback pan is lit and the pan shall remain in place for the duration of the test. The burnback time is that time at which it is estimated that 25 percent (12.5 square-feet) of the pool has become reinvolved in fire.

NOTE: Intermittent "flashovers" may occur across the foam surface. They are characterized by faint blue or nearly invisible flames creeping around the foam surface, and are usually self-extinguished. They shall not be considered as part of the burnback area unless sustained burning occurs as a result. In that case all isolated, sustained burning areas shall be included in arriving at the 25 percent area.

4.7.16 Stratification. The presence of stratification shall be determined by visual examination of the samples contained in 1 liter borosilicate glass cylinders.

4.7.17 Precipitation. The amount of precipitation shall be determined by centrifuging a 100 ml sample withdrawn from a 1 liter sample after thorough agitation in accordance with ASTM D 96.

4.7.18 Fluorine content. The total fluorine content shall be determined as specified in 4.7.18.1 through 4.7.18.4. The fluoride ion content reported shall be the average of three separate tests on each AFFF concentrate.

4.7.18.1 Test apparatus. The following items shall be used to determine the fluoride content of AFFF concentrate:

- (a) Balance Mettler H51 or equal.
- (b) Gelatin capsules (0.6 ml capacity).
- (c) Schöniger combustion flask, quartz, 1000 ml.
- (d) Wrist action mechanical shaker, Burnell model 75 or equal.
- (e) Volumetric flasks, 100 ml.
- (f) Polyethylene beakers, 150 ml.
- (g) Plastic bottle, 125 ml.
- (h) Magnetic stirrer and stirring bars.
- (i) Fluoride electrode - Orion 94-09 or equal.
- (j) Single junction electrode - Orion 90-01 or equal.
- (k) Sample wrapper (42 ashless filter paper).
- (l) Ionanalyzer - Orion 901 or equal pH meter with expandable scale capable of reading 0.1 millivolt.

NOTE: Schöniger combustion flask (drawing no. 027007) can be obtained through Kontes Flask Corporation, Vineland, NJ 08360.

4.7.18.2 Test reagents. The following reagents shall be used to determine the fluoride content of AFFF concentrate:

- (a) Deionized water.
- (b) Total ionic strength adjusting buffer (TISAB) II:
Orion 94-09-09A or equal shall be prepared as follows:
 - (1) Place 500 ml distilled water in a 1 liter beaker.
 - (2) Add 57 ml glacial acetic acid, 58 grams NaCl and 4 grams cyclohexylene dinitrilo tetraacetic acid (CDTA). Stir to dissolve.
 - (3) Place beaker in a water bath for cooling. Immerse a calibrated pH electrode into the solution, and slowly add 5M NaOH (about 150 ml) until the pH is between 5.0 and 5.5. Cool to room temperature.
 - (4) Pour into a 1 liter volumetric flask and dilute to mark with distilled water.
- (c) Fluoride standards (100, 10, 1 ppm) Orion 94-09-07 or equal.

4.7.18.3 Calibration of equipment. Pipet 5 ml of 100 ppm fluoride standard and 50 ml of TISAB into a 100 ml volumetric flask. Add distilled water to the mark and mix solution thoroughly. This solution shall be designated as "10 ppm" standard solution. Pipet 10 ml of the 10 ppm standard

solution and 45 ml of TISAB into a 100 ml volumetric flask then fill to the mark with distilled water to make a "1 ppm" standard solution. These solutions shall be used as standards to calibrate the electrodes. Electrodes shall be placed into the 10 ppm standard while the standard is being stirred. The Ionanalyzer shall be set to read millivolts and shall be properly calibrated (set readings to 000.0 on calibration controls). The electrodes shall be rinsed, blot dried, and placed in the 100 ppm standard. Record the millivolt reading after it has become stable. This procedure shall be repeated for 1 ppm standard. The millivolt reading (linear axis) shall be plotted against concentration (log axis) on standard 3 cycle semi-logarithmic paper. (Note: Direct reading of the concentration can be obtained on some pH/Ion meters.

4.7.18.3.1 Test procedure. A sample of 20 mg of AFFF concentrate shall be weighed into gelatin capsule. The capsule shall be wrapped in sample paper and placed in the platinum basket of the Schöniger head. Twenty ml of deionized water shall be transferred with a pipette into the combustion flask, and the flask shall be flushed with oxygen for 30 seconds. The sample paper shall be ignited in a flame and the Schöniger head shall be inserted into the combustion flask, which is simultaneously inverted so that the solution inside the flask forms a seal around the head. (Note: Proper safety procedures shall be followed at all times. The inserting of the ignited Schöniger paper into combustion flask shall be done behind a safety shield.) The Schöniger head and flask shall be held firmly together during the few seconds that combustion takes place. (Note: During the combustion process, a positive pressure is generated.) After combustion is complete, a few ml of distilled water shall be added to combustion flask/head lip to seal it. The combustion flask shall be placed on a mechanical shaker for 25 minutes at speed 4. After 25 minutes of mechanical shaking, the flask shall be slowly opened to allow distilled water sealing the lip to flow in. Quantitatively transfer the contents of the combustion flask to a 100 ml volumetric flask. Repeatedly, rinse the Schöniger head and combustion flask with small amounts of distilled water and transfer the washings to the 100 ml volumetric flask until flask is nearly full. Complete filling of volumetric flask with distilled water to the 100 ml mark. This solution shall be mixed well and transferred to a plastic bottle. This part of the procedure shall be repeated to obtain at least three samples of the same AFFF concentrate for analysis. Fifty ml of sample and 50 ml TISAB shall then be transferred to a polyethylene beaker and stirred thoroughly. The electrode shall be rinsed, blot dried, and placed in sample while the sample is being stirred. The reading shall not be recorded until it is stable. The fluoride ion concentration shall be determined from the calibration curve. The Ionanalyzer shall be re-calibrated after 1 to 2 hours of use. If the ambient temperature has not changed, electrodes shall be placed in a 10 ppm standard and the analyzer shall be re-zeroed. If ambient temperature has changed, procedure for calibration of equipment shall be repeated (see 4.7.18.3).

4.7.18.4 Calculating of fluoride ion content. To determine the percent F- in the AFFF concentrate sample, the following calculation shall be used:

$$\text{Percent F- in sample} = \frac{\text{SA}}{\text{SW}} \times 10$$

where:

SA = sample amount of fluoride in ppm (taken from calibration curve or by direct reading of Ionanalyzer.
SW = sample weight in mg.

The fluoride ion content reported on each AFFF concentrate shall be the average of the three samples.

4.7.19 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

4.7.19.1 Magnetic permeability (metal handles of 5 gallon containers). The metal handles for the 5 gallon containers shall be checked to determine conformance to the magnetic requirements of 5.1.1.1(d) using a permeability indicator, low- μ (Go-No-Go) in accordance with MIL-I-17214.

4.7.19.2 Torque test (pour cap of 5 gallon container). The pour cap of the 5 gallon container shall be subjected to a torque test to determine conformance to 5.2.1.1(j). The torque test shall be conducted 48 hours after initial installation of cap.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition).

5.1 General

5.1.1 Navy fire-retardant requirements for lumber and plywood. Unless otherwise specified (see 6.2.1), all lumber and plywood including laminated veneer material used in shipping container construction members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II, weather resistant.
Category I, general use.

Level C - Type I, non-weather resistant.
Category I, general use.

5.2 Preservation-packaging. Preservation-packaging for level A shall be as specified herein.

5.2.1 AFFF liquid concentrate. The AFFF liquid concentrate shall be furnished in a 5 gallon or in a 55 gallon plastic container as specified (see 6.2.1).

5.2.1.1 Five gallon plastic container. The container shall be molded polyethylene as specified herein. The container shall be as follows:

- (a) Capacity shall be 5 gallons (minimum).
- (b) Height, body (overall) shall be 15 inches (maximum).
- (c) Diameter, body (overall) shall be 11-3/4 inches (maximum).
- (d) Pour opening (inside dimension) shall be 1-1/2 inches (minimum).
- (e) Shall be stackable and self-supporting.
- (f) Shall be provided with a threaded-type plastic cap fitted with a gasket for the pour opening.
- (g) May be provided with a vent opening having an easily punctured membrane. When furnished, vent opening shall be provided with a threaded plastic cap.
- (h) Shall be provided with an integrally molded or recessible plastic or metal handle. Metal handles shall not exceed a magnetic permeability of 2.
- (i) Shall have colors conforming to 5.2.1.3.
- (j) The torque required to remove the pour opening cap shall not exceed 50 inch pounds.
- (k) Shall be provided with a tamper-proof seal

The container shall meet the requirements of Department of Transportation Specification Number 34 as specified in the Code of Federal Regulations, Title 49, Part 178.19.

5.2.1.2 Fifty-five gallon container. The 55 gallon container shall be molded polyethylene, size 4, conforming to MIL-D-43703 or 55-gallon capacity conforming to Federal Specification PPP-D-1860.

5.2.1.3 Exterior color and coatings. The green color (see 3.5) shall be an approximate match to color number 14187 of FED-STD-595. The blue color (see 3.5) shall be an approximate match to color number 15123 of FED-STD-595. Exterior coating for steel drum overpacks shall conform to Federal Specification TT-E-489.

5.3 Packing. For level A, no further packing is required.

5.3.1 Method of shipment. Method of shipment shall be in accordance with the Uniform Freight Classification Ratings, Rules and Regulations or other carrier rules as applicable to the mode of transportation.

5.3.2 Palletization. Thirty-six 5 gallon plastic containers shall be palletized in accordance with the requirements of MIL-STD-147, load type XVII. Pallets conforming to Federal Specification NN-P-71, type V, class 1, wood group optional, size 2, are acceptable. Containers shall be properly and firmly nested and arranged to ensure a snug, non-shifting load. Pallet dimensions may be adjusted to assure a snug, non-shifting load, but shall not exceed 43 by 52 inches.

5.4 Marking. In addition to the marking specified in 3.5 and any special marking required (see 6.2.1). containers and palletized unit loads shall be marked in accordance with MIL-STD-129.

5.5 Material safety data sheet. A copy of the material safety data shall be attached to the shipping document for each destination (see 3.2.1).

6. NOTES

6.1 Intended use. The concentrate is intended for use in mechanical foam generating equipment such as fire fighting trucks or foam sprinkler systems for extinguishing fires in flammable liquids such as gasoline or fuel oils. Type 6 is intended for use in proportioners designed to dispense only the 6 percent solution (usually shipboard fire protection systems). Type 3 may be used in any equipment capable of proportioning at variable rates or at fixed 3 percent solution.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type of concentrate required (see 1.2).
- (c) When fire retardant packaging material is not required (see 5.1.1)
- (d) Size of container required (see 5.2.1).
- (e) Special marking, if required (see 5.4).

6.2.2 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.475.1 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification are cited in the following paragraph.

Paragraph no.	Data requirement title	Applicable DID no.	Option
4.5.1	Inspection and test reports	DI-T-5329	

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5010.12-L., AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL-24385 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6". Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Form Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 Material safety data sheets. Contracting officers shall identify those activities requiring copies of the completed Material Safety Data Sheet (MSDS). The pertinent government mailing addresses for submission of the MSDS are listed in appendix B of FED-STD-313. In order to obtain the MSDS, federal acquisition regulation (FAR) clause 52.2223-3 must be in the contract.

6.5 Subject term (key word) listing.

Burnback time
Fire performance
Fluorocarbon surfactant
Foamability

6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

MIL-F-24385D

Custodians:

Navy - SH

Air Force - 99

Preparing activity:

Navy - SH

(Project 4210-0386)

Review activities:

Navy - YD

Air Force - 04

DLA - CS

User activities:

Army - CE

Navy - AS, MC, OS, CG

MIL-F-24385D

MIL-F-24385D

THIS END UP

U. S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

MILITARY SPECIFICATION MIL-F-24385D

TYPE 3 (3%)

THIS FIRE EXTINGUISHING CONCENTRATE IS FOR USE BY DILUTION WITH WATER IN FIXED OR MOBILE SYSTEMS. IT MAY BE USED ALONE OR IN COMBINATION WITH "TWINNED" DRY CHEMICAL EQUIPMENT. THE CONCENTRATE MAY BE DILUTED FOR USE IN FLOW PROPORTIONING EQUIPMENT WITH SEAWATER OR FRESH WATER AT VOLUME PROPORTIONS OF 3 GALLONS CONCENTRATE TO 97 GALLONS WATER. IT MAY ALSO BE DILUTED FOR READY-USE STORAGE AT A 3-PERCENT PREMIX SOLUTION WITH FRESH WATER. FOR READY USE DO NOT STORE BELOW 32°F. AVOID PROLONGED STORAGE ABOVE 120°F. DO NOT MIX WITH OTHER THAN LIQUID CONCENTRATE IN ACCORDANCE WITH MIL-F-24385D (AND PREVIOUS ISSUES) AND WATER.

MANUFACTURER'S NAME
ADDRESS
BATCH NO.
DATE OF MANUFACTURE

FIGURE 1. Type 3 container markings.

MIL-F-24385D

MIL-F-24385D

THIS END UP

U. S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

MILITARY SPECIFICATION MIL-F-24385D

TYPE 6 (6%)

THIS FIRE EXTINGUISHING CONCENTRATE IS FOR USE BY DILUTION WITH WATER IN FIXED OR MOBILE SYSTEMS. IT MAY BE USED ALONE OR IN COMBINATION WITH "TWINNED" DRY CHEMICAL EQUIPMENT. THE CONCENTRATE MAY BE DILUTED FOR USE IN FLOW PROPORTIONING EQUIPMENT WITH SEAWATER OR FRESH WATER AT VOLUME PROPORTIONS OF 6 GALLONS CONCENTRATE TO 94 GALLONS WATER. IT MAY ALSO BE DILUTED FOR READY-USE STORAGE AT A 6-PERCENT PREMIX SOLUTION WITH FRESH WATER. FOR READY USE DO NOT STORE BELOW 32°F. AVOID PROLONGED STORAGE ABOVE 120°F. DO NOT MIX WITH OTHER THAN LIQUID CONCENTRATE IN ACCORDANCE WITH MIL-F-24385D (AND PREVIOUS ISSUES) AND WATER.

MANUFACTURER'S NAME
ADDRESS
BATCH NO.
DATE OF MANUFACTURE

FIGURE 2. Type 6 container markings.

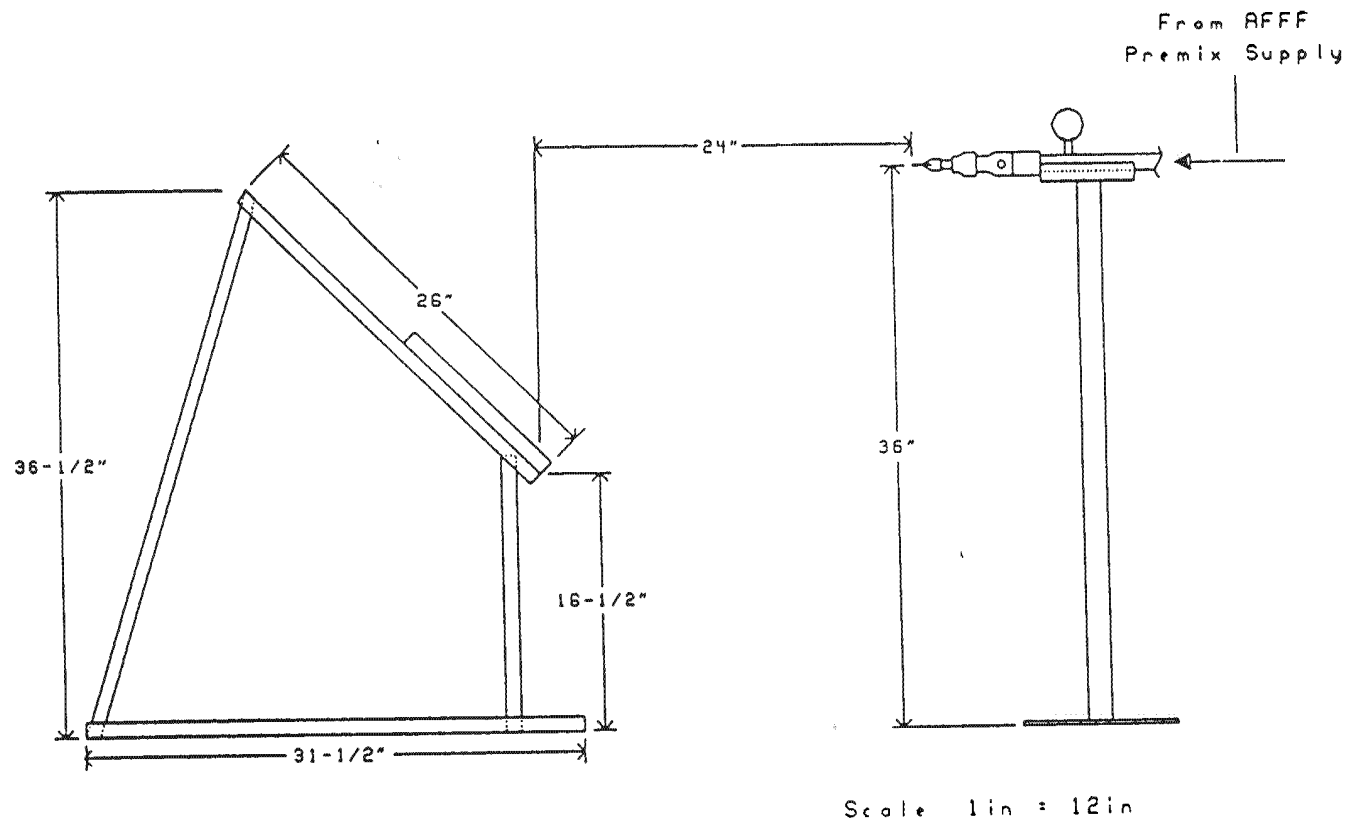
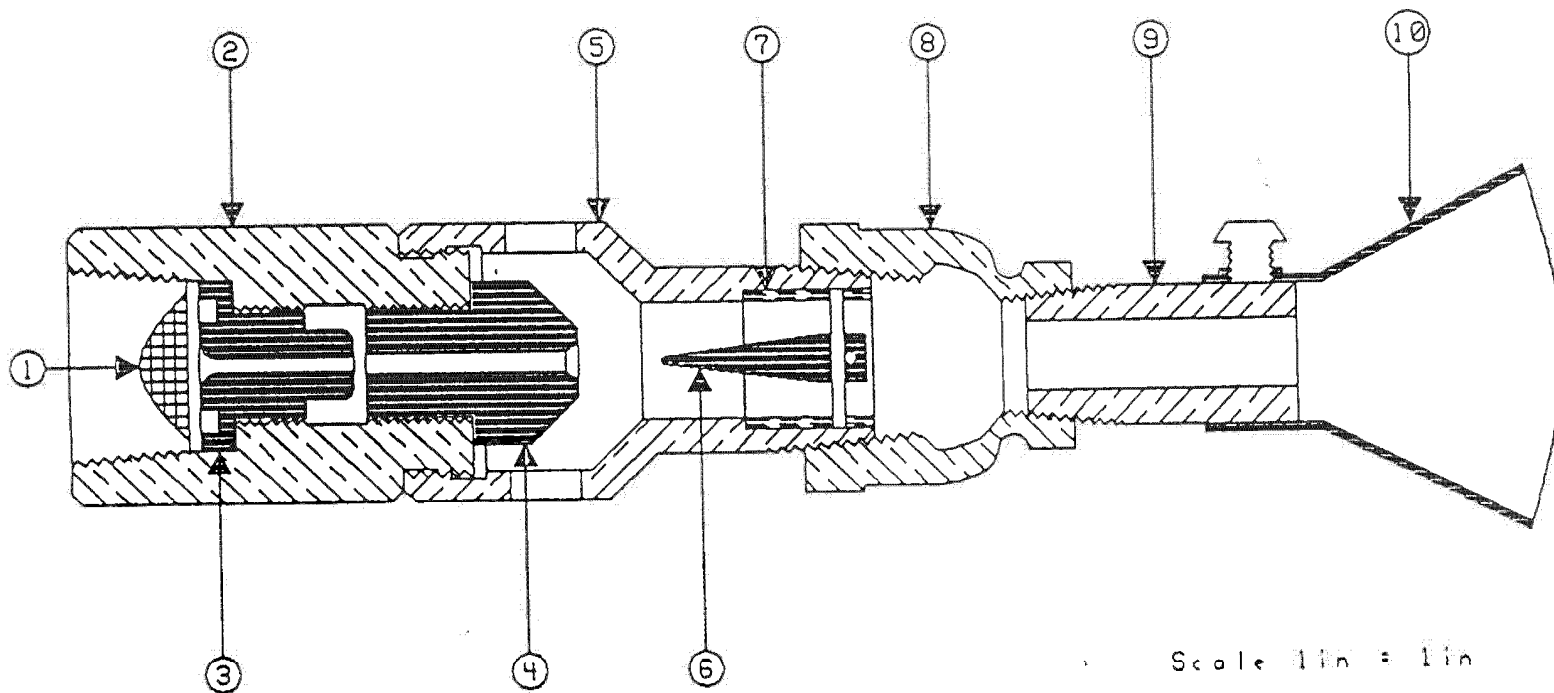


FIGURE 3. Equipment setup for expansion and drainage tests

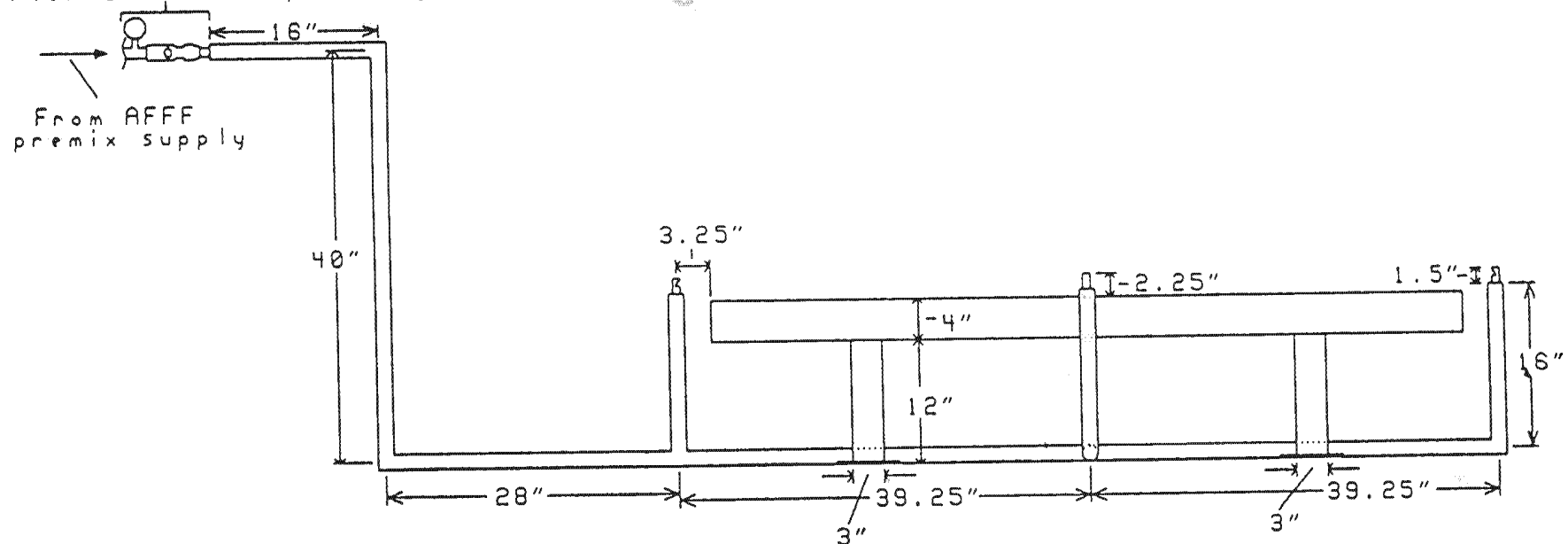


- 1 - Strainer screen
- 2 - Foam maker body
- 3 - Flow control jet
- 4 - Receiver
- 5 - Air aspirator
- 6 - Dispensal cone

- 7 - Dispensal cone adapter
assembled with 6 and installed
into 5 with silver solder
- 8 - Reducer, 3/4in to 3/8in
- 9 - Nipple, 3/8in x 1 1/4in
- 10 - Spreader tip

FIGURE 4. Two GPM air aspirating nozzle assembly.

Flow Control/Aspirating Device*

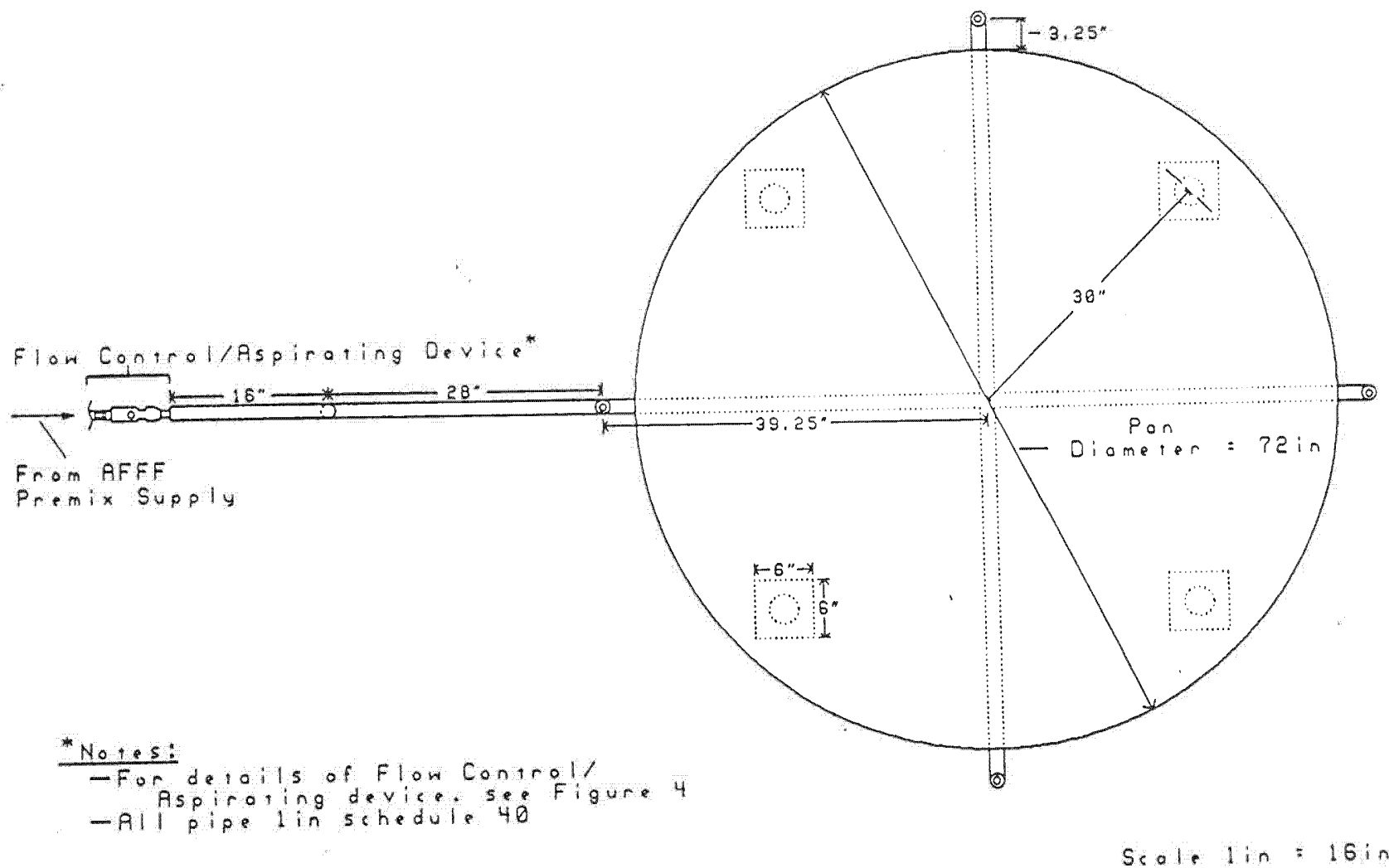


*Notes:

- For details of flow Control/Aspirating device, see Figure 4
- All pipe 1in schedule 40

Scale 1in = 16in

FIGURE 5. AFFF delivery system and test pan (side view).



*Notes:

- For details of Flow Control/Aspirating device, see Figure 4
- All pipe 1 in schedule 40

FIGURE 6. AFFF delivery system and test pan (top view).

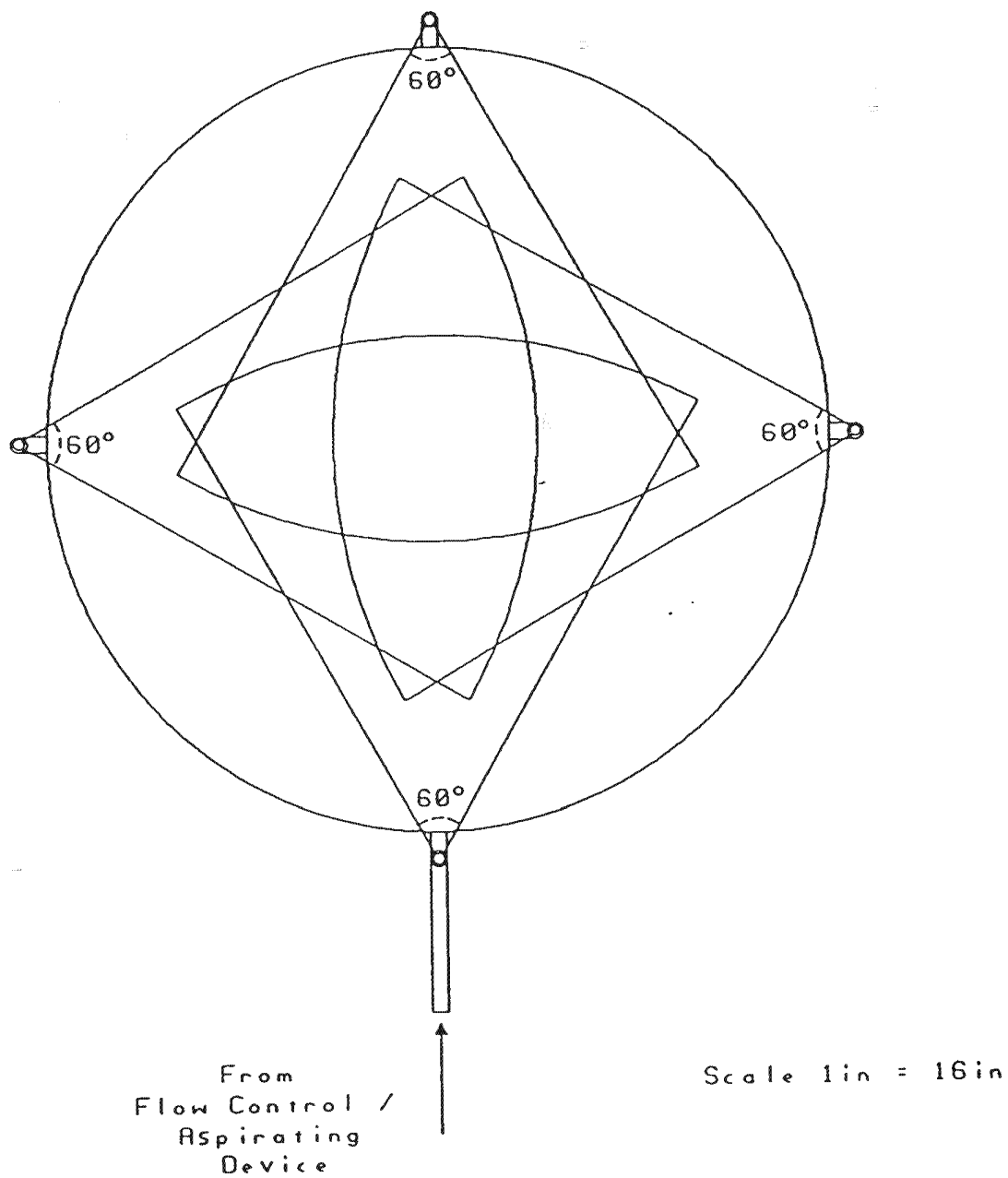
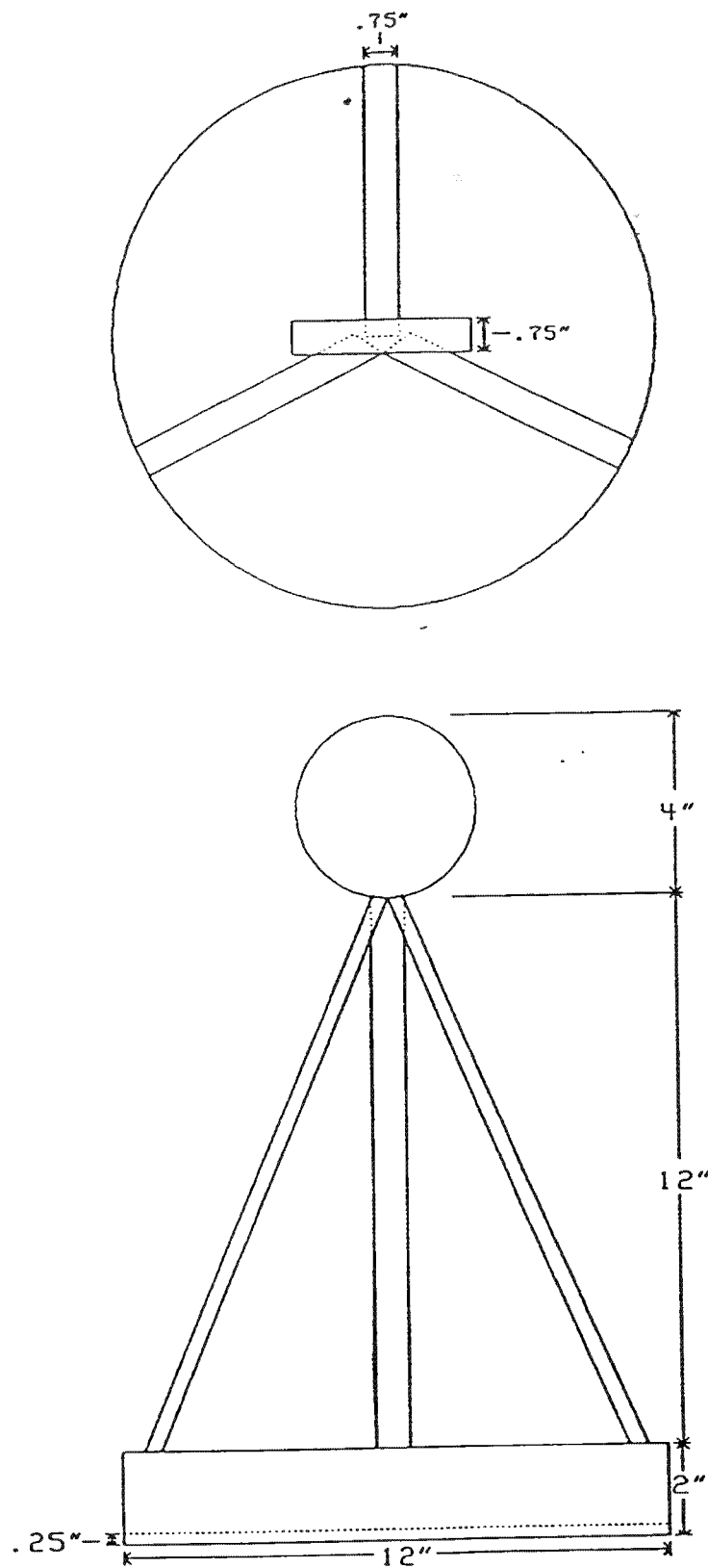


FIGURE 7. Spray pattern to be properly adjusted nozzles.



Notes:

All parts except bottom made from
1/16 in stainless steel

Scale 1 in = 4 in

FIGURE 8. Burnback pan.

↑
Radiometer
(1 of 4)

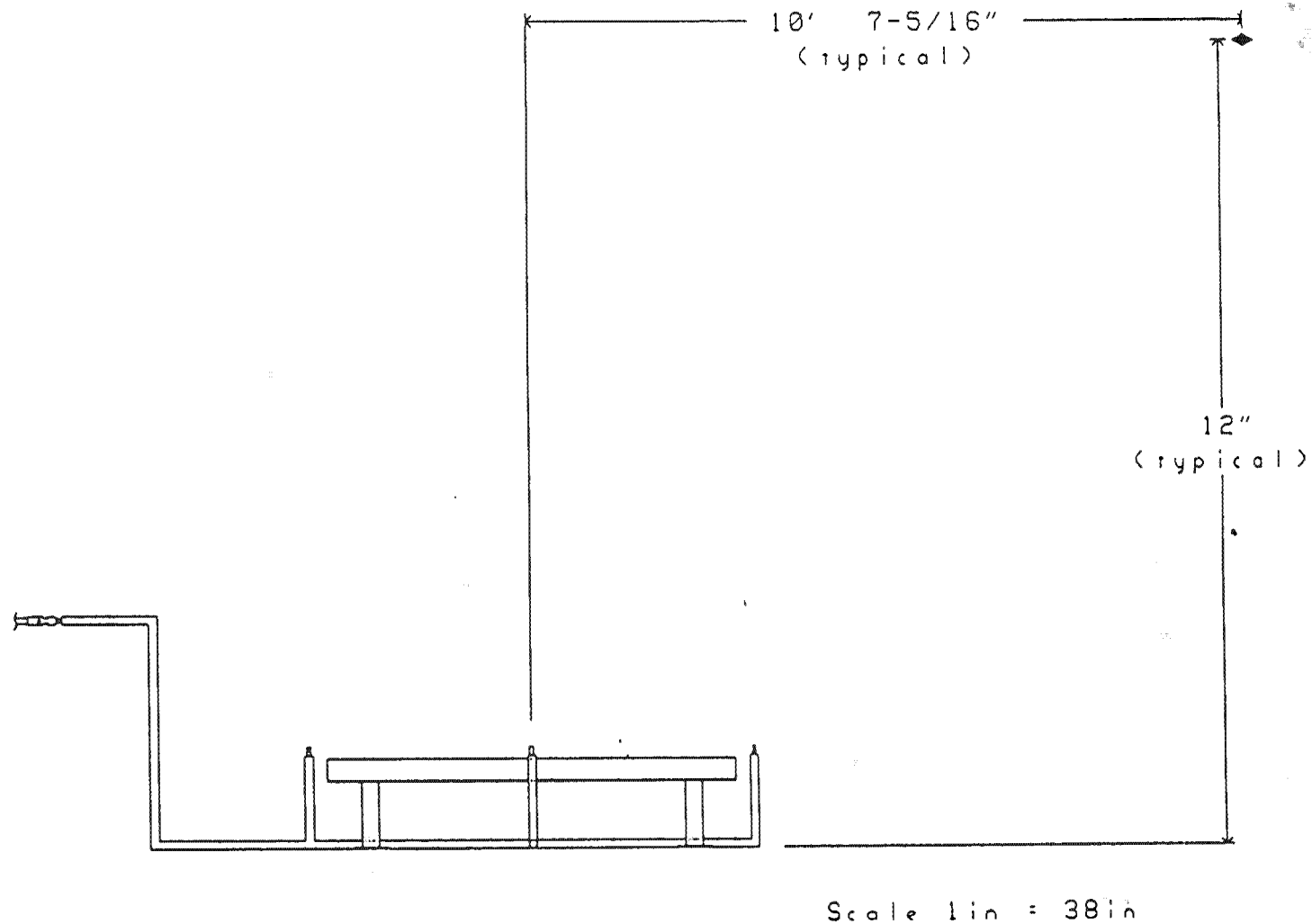
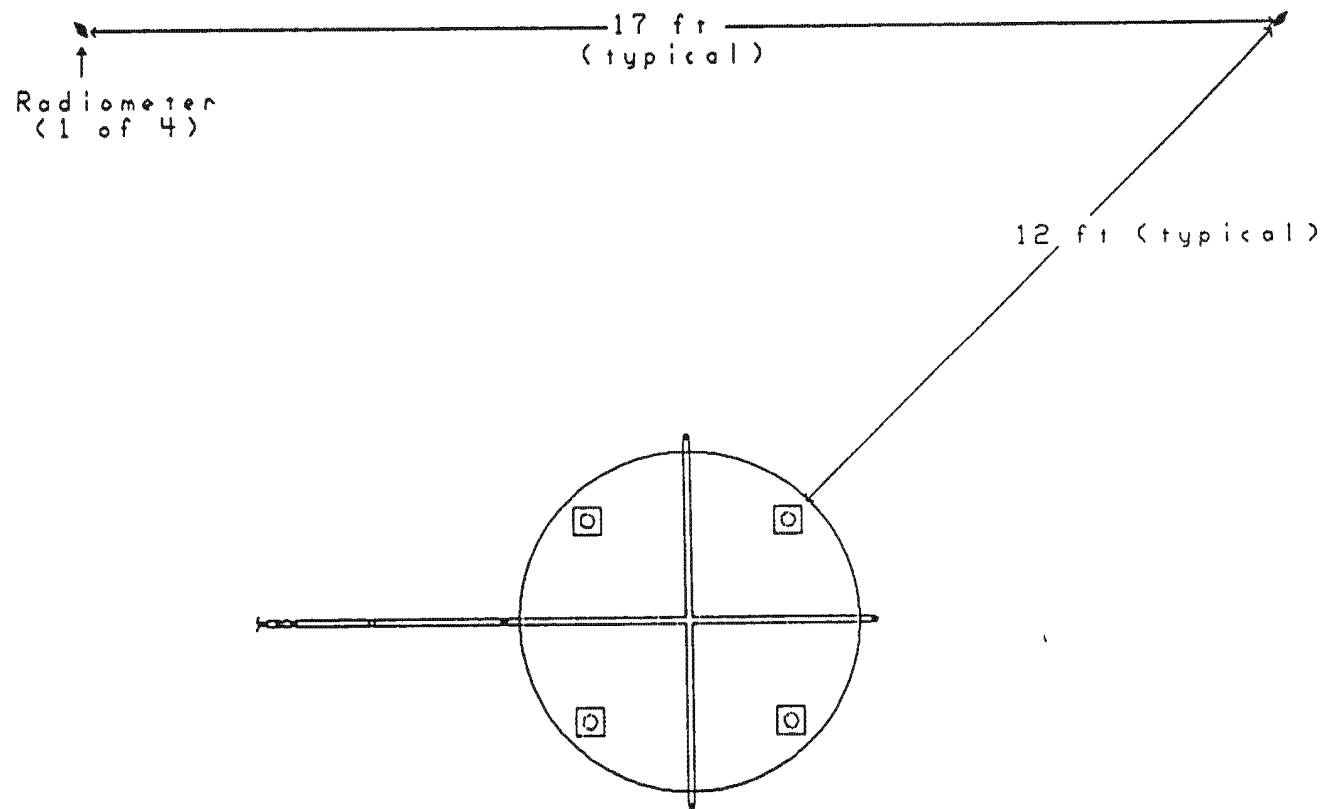


FIGURE 9. Side view of radiometer in relation to test pan.



Scale
1 in = 40 in

FIGURE 10. Top view of radiometers in relation to test pan.

Justification Statements for MIL-F-24385D

"C" Spec. Section	"D" Spec. Section	Justification Statement
2.1	2.1.1	- Change in the wording of applicable documents paragraph to conform with current military specification language. - Deletion of MIL-G-5572, which is no longer required in test specifications. - Addition of MIL-L-19140, FED-STD-313, have been incorporated into specification.
2.2	2.2	- Addition of ASTM D 1218, E 70, E 260, G1, into section because of changes in test methods and procedures to the specification.
2.2	2.3	- Addition of paragraph concerning the order of precedence between this specification and other documents.
---	3.2.1	- Addition of paragraph concerning material safety data sheet on all shipments of AFFF which is needed to conform with Department of Transportation regulations.
3.3	3.3	- Decrease in the spreading coefficient to 1.0 because of surface tension of n-heptane is less than cyclohexane. - Increase in the minimum 25% foam drainage time to 4 minutes. Data collected from old and new qualification tests showed that all AFFF agents had 25% drainage times greater than 4 minutes. - Increase in the corrosion rate allowed for steel coupons because the higher temperature required in the corrosion test method, 4.7.8.1. - Addition of corrosion test for metal ions in AFFF. Evidence indicates that metal ions affect fire performance for AFFF.

		- Increase in minimum dry compatibility, burnback resistance time because a different fuel, n-heptane instead of motor gasoline, is being used to test AFFF. - Decrease in the minimum BOD₂₀/COD allowed which is an Environmental Protection Agency regulation.
3.3.1	3.3.1	- Addition of statement in film formation and sealability paragraph on types of AFFF concentrates to be tested.
3.3.2	3.3.2	- Addition in stability test for double strength AFFF solution for both type 3 and 6 AFFF concentrates. Performance characteristics of half and double strength AFFF solutions need to be known because proportioning equipment operates within this range. - Deletion of AFFF solutions made with fresh water. Fresh water AFFF solutions will be tested in 3.4, fire performance section. - Deletion of testing aged (stability) AFFF solutions in the 28 square-foot fire performance test.
3.3.3	3.3.3	- Change in title to Inter-agent compatibility. - Addition and deletions the same as in 3.3.2.
3.4	3.4	- Change in the fire performance requirements to a failure of no more than 10 percent of the total number of fire tests performed, with no more than 1 failure permitted in any one category. Application, extinguishment and burnback times have been changed because of the new test fuel; n-heptane.
---	3.4.1	- Addition of paragraph on multiple inter-agent compatibility testing.
---	4.4.1	- Addition of paragraph on responsibility for compliance in the quality assurance provision section.
4.0	4.0	- Change in order of paragraphs on quality
4.4.3	4.4.1	assurance provisions to give the section a more
4.5	4.4	logical and coherent structure.
4.5.1	4.4.2	

4.6	4.5	- Change in order of examination of filled
4.4.2	4.5.1	containers paragraph to give the section a more logical and coherent structure.
4.4.2	4.5.1	- Change in order of paragraphs to give section a
4.4.1	4.6	more logical and coherent structure.
---	4.7.1	- Addition of paragraph on test materials including three paragraphs on substitute ocean water (4.7.1.1), n-heptane for fire performance tests (4.7.1.2) and n-heptane for laboratory tests (4.7.1.3).
4.7.4	4.7.5	- Change in hydrocarbon fuel to n-heptane to determine the spreading coefficient.
4.7.5	4.7.6	- Change in foamability testing procedure to include a nozzle stand for fixed point application of AFFF solutions.
---	4.7.6.1	- Addition of paragraph in foamability on the nozzle design.
4.7.6	4.7.7	- Change in procedure in determining the film formation and sealability by applying a AFFF solution to the top of a screw and allowing the solution to flow down to the surface of hydrocarbon fuel (n-heptane). A flame is passed over the surface of the fuel to check proper AFFF film formation. This test allows for film formation and sealability to be observed plus limits the amount of AFFF solution needed to obtain these characteristics.
4.7.7	4.7.8.1.1	- Change in paragraph numbering on test medium used in corrosion studies.
4.7.7.1.1	4.7.8.1.2	- Change in metal coupons to have a 1/16 inch hole centered from top of metal coupon. This allows the coupons to be suspended to prevent interaction from occurring between metal coupons.
---	4.7.8.1.3	- Addition of paragraph in preparing and cleaning of metal coupons conforming with ASTM G 1.
---	4.7.8.1.4	- Addition of paragraph in preparing and cleaning of glassware to be made of borosilicated glass and be rinsed with 1:1 nitric acid then with water.

4.7.7.1.2	4.7.8.1.5	- Change in corrosion test procedure to increasing the temperature of testing to 35°C, which will reduce the time of testing to 28 days.
---	4.7.8.1.6	- Addition of paragraph of analyzing metal ion in the AFFF solution at the end of the corrosion test period. Metal ions within solution can decrease the fire performance of AFFF. A test method has been developed to analyze AFFF solution for metal ions. The low metal ion content within solution can be maintained by the addition of a corrosion inhibitor.
---	4.7.8.1.7	- Change in calculating corrosion rate of test metal coupons to conform to ASTM G 1.
4.7.12.3	4.7.13.3	- Change in the wording of paragraph to prevent confusion on calculating the BOD. The BOD test is performed for 20 days using the 5 day BOD procedure outlined in the "Standard Methods for the Examination of Water and Wastewater Handbook" published by the American Public Health Association.
4.7.13	4.7.14	- Change in the fire test procedure which will consist of two phases. The first phase is to determine the agent's extinguishing abilities and the second phase the agent resistance to burnback. Passing criteria is listed for both phases in this paragraph. Fire performance paragraphs were changed to eliminate the environmental and human factors.
---	4.7.14.1	- Addition of paragraph that all tests will be conducted inside to ensure reliability and reproducible test results.
---	4.7.14.2	- Addition of paragraph on the retention of test results for two years on all data collection instrumentation.
---	4.7.14.3	- Addition of paragraph and drawings on the test pan and AFFF delivery system.
4.7.13.1.1	4.7.14.3.1	- Change in the construction material used for the test pan to stainless steel.
---	4.7.14.3.2 4.7.14.3.2.1 4.7.14.3.2.2	- Addition of AFFF delivery paragraphs and drawings on the nozzle system including flow control/aspirating device, system piping and nozzle type.

- | | | |
|------------|----------------------------|--|
| 4.7.13.1.4 | 4.7.14.3.3 | - Change in burnback pan material construction to stainless steel. |
| --- | 4.7.14.2.4
4.7.14.2.4.1 | - Addition of paragraphs on the instrumentation of burnback times with radiometers. |
| 4.7.13.1.2 | 4.7.14.4 | - Change in test material used for fire performance testing. AFFF solutions shall be mixed with ocean water. The fuel used for fire testing shall be at least 95 percent purity n-heptane and the fuel used in the burnback pan shall be motor gasoline. |
| | | - Change in table IV on the AFFF test solution values for double and quintupled strength. |
| --- | 4.7.14.5 | - Addition of paragraph on the extinguishment phase test procedures for half, full and double strength AFFF solutions. |
| --- | 4.7.14.6 | - Addition of paragraph on the extinguishment phase test procedure for quintuple strength solutions. |
| 4.7.13.1.4 | 4.7.14.7 | - Changes in paragraph on burnback phase test procedure for all tests which include: 30 seconds after foam application, burnback pan shall be placed in the center of the 28 square foot pan and burnback pan shall remain in the center of the 28 square-foot pan for the entire burnback phase of testing. |
| | | - Additions to paragraph include the collection of flux level data during the entire burnback phase and extinguishment of fire once the fire has involved 50 percent of the test pan area. |
| --- | 4.7.14.8 | - Addition of paragraph on the determination of 15 percent burnback time. |
| --- | 4.7.14.8.1 | - Addition of paragraph on calculating the average background flux. |
| --- | 4.7.14.8.2 | - Addition of paragraph on calculating the percent increase above two minute background interval. |
| 4.7.13.2 | 4.7.15 | - Change in 50 square-foot fire test paragraph in which the fire test procedure consist of two phases; the agent's extinguishing ability and its burnback resistance. |
| 4.7.16 | 4.7.18 | - Change in the test procedure and method in determining the fluorine content of AFFF |

concentrates. The previous specification allowed for manufacturers to choose a test method to determine the fluorine content which leads to inconsistencies in results between different manufacturers products.

- | | | |
|-----------|--|---|
| --- | 4.7.18.1
4.7.18.2
4.7.18.3
4.7.18.3.1
4.7.18.4 | - Addition of paragraphs outlining the test apparatus, test reagents, calibration of equipment, test procedure and calculation of the fluoride ion content. |
| 4.7.17.2 | 4.7.19.2 | - Addition to the torque test paragraph that the torque test shall be conducted 48 hours after initial installation of cap. |
| --- | 5.1.1 | - Addition of paragraph for lumber and plywood to meet the Navy fire-retardant requirements as specified in MIL-L-19140. |
| 5.1.1.1.1 | 5.2.1.1 | - Addition to paragraph on specification for 5 gallon container to include a tamper-proof seal. |
| --- | 5.5 | - Addition of paragraph that material safety data sheets be attached to shipping document for each destination. |
| --- | 6.2.1 | - Addition to paragraph on acquisition requirements on when fire retardant packaging material is not required. |
| 6.2.2.1 | --- | - Deletion of optional maiver of data requirements from the old specification. |
| 6.4 | --- | - Deletion in old specification of subcontracted material and parts because all materials acquired would come from a single given manufacturer. |