



NAVAL RESEARCH LABORATORY

WASHINGTON, D.C. 20375

IN REPLY REFER TO:

6180-16:HBP:bh

NRL Prob C05-19D

24 Jan 77

From: Commanding Officer, Naval Research Laboratory, Washington, D. C. 20375
To: Director of Operations, Air Force Civil Engineering Center, Tyndall
Air Force Base, FL 32401 (Major B. Pease)

Subj: Improved Environmental Effect Properties for AFFF Materials; forwarding
of progress report on

Encl: (1) Two copies of subject report

1. Enclosure (1) is forwarded for your information and retention.

6180-16A:HBP:bh
10 January 1977

Subj: Improved Environmental Effect Properties for AFFF Materials; progress report on

Encl: (1) 1 Jan 77 Draft of Proposed Revision of MIL-F-24385

1. A new draft of the proposed revision of MIL-F-24385 for the procurement of AFFF materials has been prepared by NRL. It includes requirements for toxicity towards marine organisms and Biochemical Oxygen Demand (BOD)/Chemical Oxygen Demand (COD) ratio. The current specification contains no environmentally-related requirements. A copy of the draft is forwarded as enclosure (1). The draft has been forwarded to the Naval Ship Engineering Center who in turn will send it out for comments prior to coordination and adoption.

2. Equipment and facility improvements for the testing of the new materials to be supplied under the Ansul contract have been made. An infra-red gas detector has been obtained to be used in connection with the study of the formation and stability of AFFF films on fuel surfaces.

3. Investigations have been initiated into doing further studies on the treatment of AFFF wastes.

4. Delivery of the new Ansul AFFF material has been delayed beyond the original 31 December date. This is due primarily because of Ansul's difficulty in getting the necessary fish toxicity studies completed at outside laboratories who are overloaded with environmental work.

5. The 20K funds received for the T76 have been expended as of 31 December 1976. The expenditure of 77 funds have been minimal, 2-3K, pending the arrival of new experimental concentrates.



H. B. Peterson, Head
Fire Suppression
Combustion and Fuels Branch
Code 6180, Chemistry Division

Encl (1) to NRL ltr
6180-16:HBP:bh
NRL Prob C05-19D

MIL-F-24385A

SUPERSEDING
MIL-F-24385(NAVY)
21 November 1969

MILITARY SPECIFICATION

FIRE EXTINGUISHING AGENT, AQUEOUS FILM FORMING
FOAM (AFFF) LIQUID CONCENTRATE, SIX PERCENT,
FOR FRESH AND SEA WATER

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

1. SCOPE

1.1 This specification covers the requirements for aqueous film forming foam (AFFF) liquid concentrate fire extinguishing agent, consisting of fluorocarbon surfactants and foam stabilizers. The liquid concentrate will be diluted for use in concentrations of six parts concentrate to ninety-four parts fresh or sea water by volume.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

O-D-1407 - Dry Chemical, Fire Extinguishing, Potassium Bicarbonate.
RR-S-366 - Sieve, Test.

VV-G-76 - Gasoline, Automotive.

PPP-C-1337 - Containers, Metal, With Polyethylene Inserts.

MILITARY

Packaging,

MIL-P-116 - Preservation Methods of.

MIL-G-5572 - Gasoline, Aviation, Grades 80/87, 100/130, 115/145.

STANDARDS

FEDERAL

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 for 40" x 48" Pallets.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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171-1-24385-17

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA No. 412 - Evaluating Foam Fire Equipment on Aircraft Rescue and Fire Fighting Vehicles

(Application for copies should be addressed to National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D96-73 - Water and Sediments in Crude Oils.

D445-74 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)

D1141-52 - Substitute Ocean Water

D1331-56 - Surface and Interfacial Tension of Solutions of Surface-Active Agents

D1821-63 - Inorganic Chlorides in Askerels

D5-56 Unified Numbering System for Metals and Alloys

(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 - 16th Street, N. W., Washington, D. C. 20036.)

DAVID M. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

DTNSRDC Standard Marine Bioassay Procedure for Shipboard Chemicals

(Application for copies should be addressed to Commander, Naval Ship Research and Development Center, Annapolis, MD 21402 Attn: Cole 2853)

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UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, Room 110c, 222 South Riverside Plaza, Chicago, IL)

DEPARTMENT OF TRANSPORTATION

49 CFR 171-1770 - Department of Transportation Rules and Regulations for Transportation of Explosives and Other Dangerous Articles.

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

3. REQUIREMENTS

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

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

3.3 Refractive index. When tested in accordance with 4.7.1, the concentrate shall have a minimum refractive index of 1.3700

3.4 Viscosity. When tested in accordance with 4.7.2, the concentrate shall have a maximum viscosity of 30 centistokes (cs) and a minimum viscosity of 2 cs.

3.5 Hydrogen ion concentration (pH). When tested in accordance with 4.7.3, the concentrate shall have a pH value of between 7.0 and 8.5.

3.6 Spreading coefficient. When tested in accordance with 4.7.4, a 6-percent water solution shall have a minimum spreading coefficient of plus 3.0.

3.7 Foamability. When tested in accordance with 4.7.5, 6-percent by volume solutions of fresh water and sea water shall produce foams with a minimum expansion of 6.0 and a minimum drainage time of 2.5 minutes.

3.8 File formation and sealability. When tested in accordance with 4.7.6, the foam-produced film shall spread over the fuel surface and prevent sustained ignition.

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3.9 Fire performance.

3.9.1 General. Fire performance shall be determined by extinguishing fires on three different sized areas: 28, 50, and 1260 square feet. Extinguishment shall be by application of foams made from solutions prepared from the concentrate and fresh water or sea water as specified herein.

3.9.2 28 square-foot fire test. When tested in accordance with 4.7.7, the specified performance levels shall be met.

3.9.2.1 2-percent solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. The fire shall be extinguished within a foam application time of 65 seconds and the resulting foam cover shall exhibit a burnback time of at least 240 seconds.

3.9.2.2 6-percent solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. The fire shall be extinguished within a foam application time of 45 seconds and the resulting foam cover shall exhibit a burnback time of at least 320 seconds.

3.9.2.3 35-percent solution. A minimum of one fire test with sea water shall be conducted. The fire shall be extinguished within a foam application time of 55 seconds and the resulting foam cover shall exhibit a burnback time of at least 150 seconds.

3.9.3 50 square-foot fire test. When tested in accordance with 4.7.8, the fire shall be extinguished within a foam application time of 50 seconds and the resulting foam cover shall exhibit a burnback time of at least 240 seconds. The 40-second summation shall be a minimum of 300. A minimum of one fire test with a 6-percent sea water solution shall be conducted.

3.9.4 1260 square-foot fire test. When tested in accordance with 4.7.9, the specified performance levels shall be met.

3.9.4.1 2-percent solution. A minimum of one fire test with sea water shall be conducted. 85 percent of the fire area shall be extinguished within a foam application time of 40 seconds and the 40-second summation shall be a minimum of 285.

3.9.4.2 6-percent solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. 85 percent of the fire area shall be extinguished within a foam application time of 30 seconds and the 40-second summation shall be a minimum of 300.

3.9.4.3 35-percent solution. A minimum of one fire test with sea water shall be conducted. 85 percent of the fire area shall be extinguished within a foam application time of 45 seconds and the 40-second summation shall be a minimum of 225.

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3.10 General corrosion. When tested in accordance with 4.7.10, the corrosion rate shall not exceed 5.0 milli-inches per year (mpy) for cold rolled, low carbon steel (UNS G10100); 3.0 mpy for 90-10 copper-nickel (UNS C70600); 1.5 mpy for 70-30 nickel-copper (UNS N04400); and 300 milligrams (mg) for cast fine bronze (UNS C90500). (The nominal compositions of Unified Numbering System (UNS) metals and alloys are given in ASTM B5-56.)

3.11 Localized corrosion. When tested in accordance with 4.7.11, corrosion resistant steel (UNS S30400) specimens shall show no evidence of pitting.

3.12 Total halides. When tested in accordance with 4.7.12, the total halides content of the concentrate shall not exceed 100 parts per million (ppm).

3.13 Dry chemical compatibility. When tested in accordance with 4.7.13, the foam cover shall exhibit a burnback resistance time of at least 320 seconds.

3.14 Stability. Stability shall be determined by testing the concentrate, fresh water premix solution, and sea water premix solution, as specified, after a high temperature holding period in accordance with 4.7.14.

3.14.1 Spreading coefficient. When tested in accordance with 4.7.14.2, all samples shall still meet the requirement of 3.6.

3.14.2 Foamability. When tested in accordance with 4.7.14.3, all samples shall still meet the requirements of 3.7.

3.14.3 Film formation and sealability. When tested in accordance with 4.7.14.4, all samples shall still meet the requirement of 3.8.

3.14.4 Fire performance.

3.14.4.1 2-percent solutions. When tested in accordance with 4.7.14.5, 2-percent fresh water and sea water solutions freshly prepared from aged concentrate shall still meet the requirements of 3.9.2.1.

3.14.4.2 6-percent solutions. When tested in accordance with 4.7.14.5, 6-percent fresh water and sea water solutions aged as premix solutions shall still meet the requirements of 3.9.2.2.

3.14.5 Stratification. When tested in accordance with 4.7.14.6, there shall be no visual evidence of stratification.

3.14.6 Precipitation. When tested in accordance with 4.7.14.7, any precipitation shall not exceed 0.05 percent by volume.

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3.15 Compatibility. The material shall be compatible in all proportions with other materials previously approved under this specification, as defined by Commander, Naval Ship Engineering Center at the time of sample submission. Compatibility shall be determined in accordance with 4.7.15.

3.15.1 Viscosity. When tested in accordance with 4.7.15.2, the viscosity of the mixtures of the concentrates shall not be greater than the more/most viscous of the constituents or less than the lesser/least viscous of the constituents.

3.15.2 Spreading coefficient. When tested in accordance with 4.7.15.3, all samples shall meet the requirements of 3.6.

3.15.3 Foamability. When tested in accordance with 4.7.15.4, all samples shall meet the requirements of 3.7.

3.15.4 Film formation and sealability. When tested in accordance with 4.7.15.5, all samples shall meet the requirements of 3.8.

3.15.5 Fire performance. When tested in accordance with 4.7.15.6, all samples shall meet the requirements of 3.9.2.2.

3.15.6 Stratification. When tested in accordance with 4.7.15.7, all samples shall meet the requirements of 3.14.5.

3.15.7 Precipitation. When tested in accordance with 4.7.15.8, all samples shall meet the requirements of 3.14.6.

3.16 Environmental effect.

3.16.1 Toxicity to marine organisms. When tested in accordance with 4.7.16.1, the concentrate shall have a 96-hour LC_{50} of not less than 1500 ppm.

3.16.2 Biodegradability. When tested in accordance with 4.7.16.2, the biodegradability shall not be less than 80 percent.

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5.1.1. Identification marking shall be in accordance with MIL-STD-130. In addition, the marking on the container (see 5.1.3) shall be in white characters against a blue background (see 5.1.1.3).

5.1.2. The identical markings conforming to Figure 1 shall be applied to containers so that the markings are readily discriminately specified. The markings shall be applied on the containers in such a manner that water-resistant, contact with the contents of the containers, or normal handling will not impair the legibility of the marking. No paper labels shall be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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.

4.2 Classification of tests. The inspection of the fire extinguishing agent shall be classified as follows:

- (a) Qualification tests.
- (b) Quality conformance inspection.
 - (1) Examination of filled containers.
 - (2) Quality conformance tests.

4.2.1 Test reports. The supplier shall prepare test reports in accordance with the data ordering document included in the contract or order (see 6.2.2).

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of examination and tests shown in table I.

4.3.1 Samples for qualification tests. Forty five gallon-containers (210 gallons) are required for the qualification tests.

4.4 The tests and examination applicable to each classification shall be as shown in table I:

Table I - Categories of Inspection

Reference		Qualification	Quality conformance
5.3, 4.7.1	Refractive index	X	X
5.4, 4.7.2	Viscosity	X	X
5.5, 4.7.3	pH value	X	X
5.6, 4.7.4	Spreading coefficient	X	X
5.7, 4.7.5	Foamability	X	X
5.8, 4.7.6	Film formation and seal	X	X
5.9.2, 4.7.7	28 ft ² fire test	X	
5.9.3, 4.7.8	50 ft ² fire test	X	X
5.9.4, 4.7.9	1260 ft ² fire test	X	
5.10, 4.7.10	General corrosion	X	
5.11, 4.7.11	Localized corrosion	X	
5.12, 4.7.12	Total halides	X	
5.13, 4.7.13	Dry chemical compatibility	X	
5.14, 4.7.14	Stability	X	
5.15, 4.7.15	Compatibility	X	
5.16, 4.7.16	Environmental effect	X	X
4.5.2	Form of filled containers		
5.1.1.1.1.	Torque to remove cap	X	

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4.5.1 Sampling lot. For purposes of sampling, a lot shall consist of all material manufactured as one batch and transferred from one mixing tank to the shipping container.

4.5.2 Sampling for examination of filled containers. 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 = 2.5 percent defective shall be used to verify compliance with all requirements regarding fill, closure, marking, and other requirements not requiring tests, as specified in 4.6.1, 5.1.1.1, and 5.1.1.2.

4.5.3 Sampling for quality assurance tests. Three filled 5-gallon containers shall be selected at random from each lot and used as one composite sample for the tests specified in 4.6.2, or three 5-gallon containers of the product shall be withdrawn from an agitated mixing tank prior to packaging. The results of the tests required by 4.6.2 shall be submitted to the Naval Ship Engineering Center or the designated laboratory.

4.6 Quality assurance inspection

4.6.1 Examination of filled containers. Each sample filled container shall be examined for defects of operation of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each filled container shall also be weighed to determine 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 of MIL-STD-105, this shall be cause for rejection of the lot represented by the sample.

4.6.2 Quality assurance tests. The samples selected in accordance with 4.5.3 shall be subjected to the tests of table 1, as applicable.

4.6.2.1 Action in case of failure. If the sample tested is found to be not in conformance with any requirement of this specification, the lot represented by the sample shall be rejected.

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THIS END UP

U.S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

MILITARY SPECIFICATION MIL-F-24385

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 SEA WATER OR FRESH WATER AT VOLUME PROPORTIONS OF SIX GALLONS CONCENTRATE TO 94 GALLONS WATER. IT MAY ALSO BE DILUTED FOR READY-USE STORAGE AS A SIX-PERCENT PREMIX SOLUTION WITH FRESH WATER ONLY.

FOR READY USE DO NOT STORE BELOW 32°F. AVOID PROLONGED STORAGE ABOVE 120°F. DO NOT MIX WITH OTHER THAN LIQUID CONCENTRATE APPROVED UNDER SPECIFICATION MIL-F-24385 OR WATER.

MANUFACTURER'S NAME
ADDRESS
BATCH NO.
DATE OF MANUFACTURE.

Figure 1 - Container markings.

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4.7 Test procedures.

NOTE: Where sea water is required for tests synthetic sea water in accordance with ASTM D-1141 shall be used. A sea salt mixture conforming to this standard may be purchased from Lake Products Co Inc, St Louis, MO 63125.

4.7.1 Refractive index. The refractive index shall be determined at $25 \pm 0.1^\circ\text{C}$, using sodium vapor source lamp illumination.

4.7.2 Viscosity. The viscosity shall be determined at temperatures of $5 \pm 0.1^\circ\text{C}$ and $25 \pm 0.1^\circ\text{C}$ in accordance with ASTM D-445-74, using capillary viscometers of the appropriate size.

4.7.3 pH value. The pH value shall be determined potentiometrically, using a pH meter with a glass electrode and a reference electrode, at $25 \pm 0.1^\circ\text{C}$.

4.7.4 Spreading coefficient. The spreading coefficient shall be determined with reference to cyclohexane in accordance with the following relationship:

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

where $S_{a/b}$ = spreading coefficient

γ_b = surface tension of cyclohexane as determined in 4.7.4.1

γ_a = surface tension of AFFF solution as determined in 4.7.4.1

γ_c = interfacial tension between liquids as determined in 4.7.4.2

4.7.4.1 Surface tension. The surface tension of a 6 ± 0.1 percent by volume of the concentrate in distilled water and of reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at $25 \pm 0.1^\circ\text{C}$ in accordance with ASTM D1331-56.

4.7.4.2 Interfacial tension. The interfacial tension between reagent grade cyclohexane and a 6 ± 0.1 percent by volume of the concentrate in distilled water shall be determined in a DuNoy tensiometer, or equal, at $25 \pm 0.1^\circ\text{C}$ until the readings come to equilibrium and in accordance with ASTM D1331-56.

4.7.5 Foamability. The foam shall be generated by means of a special, 2 gallons per minute (GPM) test nozzle. The basic nozzle as made by National Foam System, Inc., Lionville, PA shall be modified by shortening the length of the foam barrel from $2\frac{1}{2}$ to $1\frac{1}{2}$ inches and by adding a "wing-tip" spreader on the outlet. The spreader shall have a $1/8$ inch wide, circular orifice, $1-7/8$ inches long. (It may be made by slightly squashing a "Bernz-o-matic TX-1527" flame spreader.) A print of the nozzle construction is available from the Naval Research Laboratory, Code 6180, Washington, DC 20375. During foam sample collection, the nozzle butt pressure shall be maintained at 100 psi and the solution temperature at $25 \pm 2^\circ\text{C}$. The nozzle shall be held at hip height and directed onto the backboard from a distance of 4-6 feet. The method and procedure shall be in accordance with NFPA Standard No. 412.

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4.7.6 Film formation and sealability. The purpose of the test is to determine the ability of the foam to generate a film over the fuel surface capable of sealing-off vapor production.

4.7.6.1 Test equipment. A stainless steel graduated measure of 1000 milliliter (ml) capacity (4 1/2 inches in diameter, 5 inches deep; Cole-Parmer Co., Chicago, IL or similar) shall be fitted with two retaining clips at the top edge. The clips shall serve to restrain a cone 5 inches in height and 4-3/4 inches in diameter made of 80-mesh perforated stainless steel in an inverted position inside the measure. The 2 gpm nozzle described in 4.7.5 shall be used for foam production.

4.7.6.2 Test procedure. After placing 600 ml of 98-percent cyclohexane in the measure, 200 ml of freshly-made foam shall be poured onto the fuel. The inverted cone is pushed down into the measure creating a foam-free fuel surface but allowing the film-producing liquid to creep in thru the mesh openings. After a 1 minute waiting period, a pilot flame shall be passed over the fuel surface at a height of about 1/2 inch. A small flash is permitted but no sustained ignition shall result, if an effective vapor-seal is present. A 1-inch long pilot flame can be provided with a hand-held propane cylinder fitted with a capillary tubing outlet.

4.7.7 28 square-foot fire test.

4.7.7.1 Test equipment. The fire test shall be conducted in a circular pan 6 feet in diameter fabricated from 1/2-inch thick steel with a 4-inch high side. A shallow water layer is used to protect the pan bottom and to ensure complete coverage of the area with fuel. The nozzle used for foam application shall be the 2 gpm device described in 4.7.5.

4.7.7.2 Test materials. Foams shall be generated from 3±0.05, 6±0.1, and 35±1 percent solutions made with fresh water and sea water at 20±5°C. The fuel shall be 10 gallons of motor gasoline conforming to VV-G-76.

4.7.7.3 Test procedure. No tests shall be conducted when the wind speed is above 10 miles per hour (mph). The fuel shall be dumped within a 30 second period. The fuel shall be ignited within 30 seconds of fueling and allowed to burn freely for 10 seconds. After the preburn period the fire shall be attacked and extinguished as expeditiously as possible and the fire extinguishing time shall be recorded at the exact cessation of all flame but foam application shall continue until 90 seconds have elapsed.

4.7.7.4 Burnback procedure. Within 60 seconds of the completion of foam application a burning pan (4-foot diameter, 2-inch side) shall be placed in the center of the 28 square-foot pan and a timer started. When it appears that the fire has spread outside the pan so that burning will continue after pan removal, the pan shall be removed. The burnback time is taken to be that time at which it is estimated that 7 square feet (25 percent) of the total area is involved in flames.

NOTE: Intermittent "flash-overs" may occur. They are characterized by creeping faint blue or invisible flames over the foam surface which usually self-extinguish. They are not considered as a part of the burnback area unless sustained burning occurs. All isolated, sustained burning areas should be included in arriving at the 7 square foot total area.

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4.7.8 50 square-foot fire test.

4.7.8.1 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 with the fuel.

4.7.8.2 Test equipment. The nozzle used for foam application shall be the 2 gpm device described in 4.7.5 operated at 100 psi.

4.7.8.3 Test materials. The foam shall be generated from a 6 ± 0.1 percent, 2015°C solution made with sea water. The fuel shall be 15 gallons of gasoline meeting MIL-G-5572 or VV-G-76.

4.7.8.4 Test procedure. No tests shall be conducted when the wind speed is above 10 mph. The fuel shall be dumped into the area within 60 seconds and ignited within 30 seconds of dumping. After allowing a preburn period of 10 seconds, the fire shall be attacked and extinguished in an expeditious manner. At 10 second intervals after the start of foam application observers shall estimate the percentage of fire area extinguished. The percentages at 10, 20, 30, and 40 seconds shall 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 full 90 seconds.

4.7.8.5 Burnback procedure. Within 60 seconds of the completion of foam application a burnback test shall be conducted as described in 4.7.7.4, except that the burnback area be 12.5 square feet (25 percent).

4.7.9 1260 square-foot fire test.

4.7.9.1 Test site. The fire test shall be conducted on a level, circular area 40 feet in diameter. The base and surrounding wall shall be suitable for the 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.

4.7.9.2 Test equipment. The nozzle used for foam application shall be Elkhart Brass Mfg., Co., Inc., Elkhart, IN 46514 Model "SFL" set to discharge at a rate of 60 gpm at a pressure of 100 psi.

4.7.9.3 Test materials. Foams shall be generated from 3 ± 0.05 , 6 ± 0.1 and 35 ± 1 percent solutions made from fresh water and sea water at $20 \pm 5^\circ\text{C}$. The fuel shall be 300 gallons of gasoline conforming to MIL-G-5572.

4.7.9.4 Test procedure. No tests shall be conducted when the wind speed is above 10 mph. The fuel shall be dumped and ignited with a minimum of delay. After allowing a preburn period of 10 seconds, the fire shall be attacked and extinguished in an expeditious manner. At 10 second intervals after the start of foam application observers shall estimate the percentage of fire area extinguished. The percentages at 10, 20, 30, and 40 seconds shall be totaled to give the "40 second summation" value. The time of foam application required to achieve extinguishment of 85 percent of the area shall also be recorded.

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4.7.10 General corrosion.

4.7.10.1 Test medium. The liquid for immersion of the metal specimens shall consist of the concentrate diluted by 10 percent by volume with sea water.

4.7.10.2 Test specimens. The test specimens shall consist of the following metals, according to Unified Numbering System (UNS) designations: A1100 steel, C70600 copper-nickel, N14400 Monel, and C90500 bronze. All specimens, except the bronze, shall be milled to finished dimensions of approximately 1/16 inch thick, 1/2 inch wide, and 3 inches long. The bronze shall have sand cast faces and be approximately 3/16 inch thick, 1/2 inch wide and 3 inches long. All specimens shall be degreased in acetone, rinsed with distilled water and air dried before exposure. (Prepared metal specimens may be obtained from the Metaspec Co., Box 28125, San Antonio, TX 78228)

4.7.10.3 Test procedure. Five weighed specimens of each metal shall be fully immersed in the test medium in a 600 ml beaker and held at room temperature for a period of 60 days. A watch-glass cover shall be used to retard evaporation. At the end of the exposure period the weight-loss shall be determined and the corrosion rate calculated as required.

4.7.11 Localized corrosion.

4.7.11.1 Test medium. Same as 4.7.10.1

4.7.11.2 Test specimens. The test specimens shall consist of UNS A16600 stainless steel milled to finished dimensions of approximately 1/16 inch thick, 1/2 inch wide, and 3 inches long. After degreasing with acetone and rinsing with water, the specimens shall be pretreated by immersion in a 1:9 concentrated nitric acid-water solution for a period of 5 minutes.

4.7.11.3 Test procedure. Ten specimens shall be girdled lengthwise with a clean 1/16 to 1/8 inch wide band of a grid grade of gum rubber of a size such that the band is just 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 (Prestar Scientific Rubber tubing, Pure Gum, Gooch Type, 1/32-inch thin wall, pure gum amber tubing, very elastic, specially made for Gooch crucibles, Stock No. 139090 or equivalent). This tubing is then easily cut into uniform strips with a blade-type papercutter, but can also be cut with sharp shears. The specimens with their rubber bands shall be placed in a beaker so that no contact is made between individual specimens. A 1/4-inch layer of glass beads shall be introduced into the beaker to aid in stabilizing specimen position. The test liquid shall be allowed to completely submerge the specimens, and a watch glass shall be placed over the beaker to retard evaporation (but allow air access) and act as a dust cover, and the assemblies allowed to stand at room temperature for 60 days.

4.7.11.4 Results. The specimens shall be monitored daily over the 60-day period to determine 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 underneath what is readily recognizable as a corrosion pit. If the suspected area cannot be visually identified by the naked eye, it can be at a magnification of 10X. 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 ends of the specimens under, or adjacent to the rubber bands. 10 X magnification shall be used, if necessary.

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4.7.12 Total halides. The halide content shall be determined in accordance with ASTM 14321, except for the following modifications:

(a) Procedure

(1) Weigh 2 ± 0.1 grams or add 2 ± 0.1 ml of concentrate into a 250 ml beaker.

(2) Add 75 ml of acetone. Add 2 ml of dilute nitric acid (1 volume of conc acid to 60 volumes of water).

(b) The calculation shall be modified as follows:

$$\text{halide content, ppm} = 44.4(A - B)$$

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

4.7.13.1 Test materials. The fuel shall be gasoline conforming to WV-3-76. The dry chemical agent shall conform to Federal Specification O-S-1407. The sieve shall be an 8-inch diameter, 40 mesh conforming to Type I, style A of RR-S-336.

4.7.13.2 Test procedure. A 28 square-foot fire test is conducted in accordance with 4.7.7, using a 6-percent sea water solution. Before placing the burning pan one pound of dry chemical agent shall be evenly distributed over the foam blanket with the aid of the sieve on a handle. This shall be accomplished within a 30 second period so that the total time from end of foam application to placement of the burning pan will be no longer than 90 seconds. The burnback time is determined as in 4.7.7.4.

4.7.14 Stability.

4.7.14.1 Sample preparation. Samples of concentrate, 6-percent fresh water solution, and 6-percent sea water solution shall be prepared in sufficient quantity to perform the required tests. One liter of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at $65 \pm 5^\circ\text{C}$ for a period of 10 days prior to testing.

NOTE: In the preparation of the samples to be used for the precipitation test the synthetic sea water shall be filtered prior to use.

4.7.14.2 Spreading coefficient. The spreading coefficient shall be determined in accordance with the procedure in 4.7.4, except that the 6 percent solutions shall not be further diluted.

4.7.14.3 Foamability. Foamability shall be determined in accordance with 4.7.5.

4.7.14.4 Film formation and sealability. The film formation and sealability shall be determined in accordance with 4.7.6.

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4.7.14.5 Fire performance. The fire performance shall be determined by the 23 square-foot fire test in accordance with 4.7.7.

4.7.14.6 Stratification. The presence of stratification shall be determined by visual examination of the samples contained in the glass cylinders.

4.7.14.7 Precipitation. The amount of precipitation shall be determined by centrifuging the one liter samples in accordance with ASTM D96 (Method 4) using cone-shaped tubes, except that benzene shall not be used. The samples shall be thoroughly agitated before transferring to the centrifuge tubes.

4.7.15 Compatibility.

4.7.15.1 Sample preparation. Mixtures of the concentrates to be tested shall be prepared in sufficient quantities to perform the required tests. (For qualification testing the testing activity will determine the number and compositions of the mixtures.) Additionally, 6-percent fresh water and sea water solutions shall be prepared from each concentrate mixture. One liter of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at $35 \pm 5^{\circ}\text{C}$ for a period of 10 days prior to testing.

4.7.15.2 Viscosity. The viscosities of all of the mixtures of concentrates shall be determined in accordance with 4.7.2 at 25°C .

4.7.15.3 Spreading coefficient. The spreading coefficient of all samples shall be determined in accordance with 4.7.4, except that the 6-percent solutions shall not be further diluted.

4.7.15.4 Foamability. The foamability of all samples shall be determined in accordance with 4.7.5.

4.7.15.5 Film formation and sealability. The film formation of all samples shall be determined in accordance with 4.7.6.

4.7.15.6 Fire performance. The fire performance of all samples shall be determined in accordance with the 23 square-foot fire test in 4.7.7.

4.7.15.7 Stratification. The stratification of all samples shall be determined in accordance with 4.7.14.6.

4.7.15.8 Precipitation. The precipitation shall be determined in accordance with 4.7.14.7.

4.7.16 Environmental effect.

4.7.16.1 Toxicity to marine organisms. The toxicity to marine organisms shall be determined in accordance with the procedures cited in ASTM D3820 Standard Marine Bioassay Procedure for Shipboard Chemicals for static bioassay of fish.

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4.7.16.2 Biodegradability. The biodegradability shall be defined as the ratio of the 20-day biochemical oxygen demand (20-day BOD) to the chemical oxygen demand (COD) expressed as a percentage. The result shall be reported as an average of three tests each of BOD and COD. Tests for BOD and COD shall be made in accordance with the procedures cited in Standard Methods for the Examination of Water and Waste Water. Seed material for BOD shall be unacclimated sewage or sewage sludge with fresh water as a dilution medium.

4.8 Inspection For acceptance for delivery, samples from and packages shall be selected in accordance with MIL-PRC-16 and inspected to verify conformance with the requirements of section 5.

"5. PREPARATION FOR DELIVERY

"(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in Section 2, see 6.4).

"5.1 Preservation packaging. Preservation packaging for levels A and C shall be as specified hereinafter.

"5.1.1 The APFF liquid concentrate shall be furnished in a 5-gallon plastic or in a 55-gallon composite container as specified (see 6.2).

"5.1.1.1 Five-gallon plastic container. The container shall be ~~polyethylene~~ polyethylene as specified herein. The container shall be as follows:

Capacity	5-gallon (min.)
Height, body (overall)	14-1/4 inches (approximate)
Diameter, body (overall)	11 inches (approximate)
Pour opening (inside diam.)	1-1/2 inches (min.)

"5.1.1.1.1 The container shall meet the requirements of Department of Transportation Specification Number 34. Containers shall be:

- (a) Stackable and self-supporting.
- (b) Provided with a ~~locking~~ lock or seal and an NPT threaded-type plastic cap fitted with a gasket for the pour opening.
- (c) May be provided with a vent opening having an easily punctured membrane. When furnished, vent opening shall be provided with an NPT threaded type plastic cap. ~~Accessible~~ Accessible
- (d) ~~As specified in the following~~ As specified in the following handle.
- (e) A blue color conforming to 5.1.1.3.
- (f) The torque required to remove the cap shall not exceed 50 inch-lbs.
- (g) The magnetic permeability shall not exceed 2.0.

"5.1.1.2 Fifty-five gallon container. The 55-gallon container shall be a composite comprised of a plastic insert and a steel drum overpack. The composite container shall conform to the requirements of type II, class 4 of PPP-C-1357, and the following:

- (a) Insert. The insert shall contain two protruding openings in the top head - one 1/4-inch and one 2-inch. Openings shall be so designed that when positioned in the steel drum cover there will be no strain on the protruding openings. The protruding plastic openings shall be secured to the drum cover by means of lock or retaining rings and gaskets. Openings shall be closed by use of NPT threaded plastic plugs and gaskets.
- (b) Covers. The steel drum cover shall be provided with two openings to accommodate the protruding insert openings. Covers shall be fully removable and provided with gaskets. Covers shall be secured to the steel drum with minimum 16 gage bolt or lever lock type locking rings.

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"5.1.1.3 Exterior color and markings. Colors shall be blue and shall be an approximate match to color number 3511 of Munsell 1955. Exterior coating for fiber and steel drums overpacks shall conform to T144-409. In case of question or dispute, a color chip shall be submitted to NAWSEC for resolution.

"5.2 Packing. For levels A, B, and C, no further packing is required.

"5.2.1 Method of shipment shall comply with Uniform Freight Classification Rules or other carrier rules as applicable to the mode of transportation.

"5.2.2 Palletization. When specified (see 6.2), 5-gallon plastic containers shall be palletized for shipment in accordance with MIL-STD-147.

"5.3 Marking. In addition to the marking specified in 3.14 and any special marking required (see 6.2), containers and palletized unit loads shall be marked in accordance with MIL-STD-129."

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.

"6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Size of container required (see 5.1.1).
- (c) Whether palletizing is required (see 5.2.2).
- (d) Special marking required (see 5.3)."

6.3 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List. Whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement. 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 orders for the products covered by this specification. The activity responsible for the qualified products list is the Naval Ship Engineering Center, Department of the Navy, Center Building, Prince Georges County, Maryland, 20782 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-c" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 3333 River Avenue, Philadelphia, Pennsylvania 19120.

6.4 Subcontracting material and parts. The preparation for delivery requirements of referenced documents listed in section 3 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

Basic activities:

Major activities:
OS, VC, MO

Preparing activity:
Navy - 2K
(Project 4410-0051)

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SPECIFICATION ANALYSIS SHEET		Form Approved Subject Bureau No. 110-8114
This sheet is to be filled in by personnel of the Government or contractor, involved in the use of the specification in procurement of products for military use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be produced with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).		
DESCRIPTION (of material)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
MATERIAL PROCURED UNDER A ☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE? ☐ YES ☐ NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
FILLED BY (Printed or typed name and activity)		DATE

DD FORM 1426

REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE

GPO: 1967-2000

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