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EVALUATION OF THREE PERCENT AQUEOUS FILM FORMING FOAM (AFFF) CO--ETC(U)
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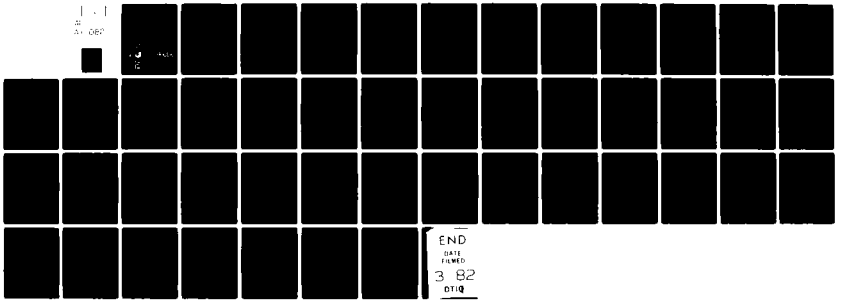

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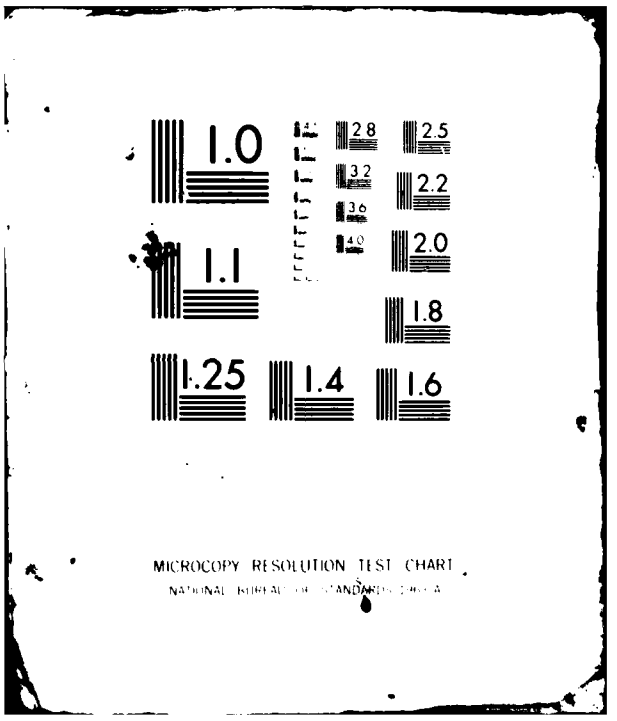
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MICROCOPY RESOLUTION TEST CHART

(12) LEVEL II

ESL-TR-81-18

EVALUATION OF THREE PERCENT AQUEOUS FILM FORMING FOAM (AFFF) CONCENTRATES AS FIRE FIGHTING AGENTS

EDWIN J. JABLONSKI

DEPARTMENT OF THE NAVY
NAVAL RESEARCH LABORATORY
WASHINGTON D. C. 20375

APRIL 1981

FINAL REPORT
SEPTEMBER 1978 - NOVEMBER 1980

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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Fire extinguishing agents
Fire fighting
Nozzles
Fire fighting vehicles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A large-scale fire test program involving 20,000-square foot JP-4 fuel fires was conducted to evaluate the fire suppression effectiveness and compatibility of 3 percent Aqueous Film Forming Foam (AFFF) agents in Air Force fire fighting vehicles. Three commercially available 3 percent AFFF concentrates were tested in accordance with military specification MIL-F-24385B. Test results are summarized in Appendix A. As a result of these tests, an updated Revision C to this MIL SPEC has been accomplished with new requirements for both 3 percent and 6 percent AFFF extinguishing agents.

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PREFACE

This report was prepared by the Fire Suppression Section, Combustion and Fuels Branch, Chemistry Division, Naval Research Laboratory under AFCEC project orders DTC-8-133 and DTC-9-45, Job Order Number 2505-1010 for HQ AFESC/RDCS, Tyndall AFB, Florida.

This report summarizes work done between September 1978 and November 1980.

Appreciation is expressed to Dr Homer W. Carhart, Mr Henry B. Peterson, and Mr Clarence Whitehurst of the Naval Research Laboratory and Mr Robert L. Darwin, Naval Material Command, for their assistance and overall technical support. The excellent cooperation and assistance provided by the members of the Fire Department of the Naval Weapons Center under Fire Chief L. O'Laughlin and Assistant Chief D. Johnson is gratefully acknowledged. Also appreciation is extended to the P-4 crash crew at Edwards AFB for their professionalism and excellent handling of their vehicle.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nationals.

This Technical Report has been reviewed and is approved for publication.

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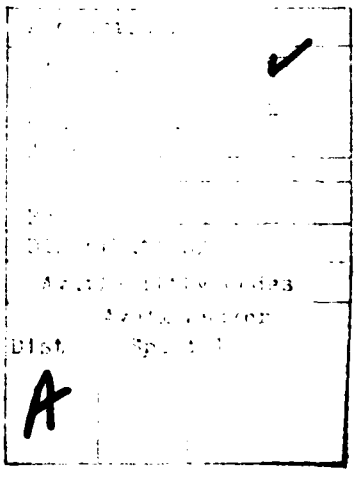
Director, Engineering and Services Laboratory



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TITLE

SECTION I

INTRODUCTION

Aqueous Film Forming Foam (AFFF) is presently purchased by the military services under MIL SPEC MIL-F-24385B (Reference 1) as a 6 percent concentrate and is designed to be mixed at six parts concentrate with 94 parts water. Three percent AFFF concentrates, which are designed to be mixed at three parts concentrate with 97 parts water, are currently manufactured in the United States by The Ansul Company, 3M Company, and National Foam System, Inc., and are used extensively for commercial applications.

The Air Force conjectured that the use of 3 percent AFFF in existing firefighting vehicles would provide twice the agent capability and also result in savings for shipping and storage costs.

In order to evaluate the 3 percent AFFF concentrates for their use, the Air Force tasked the Naval Research Laboratory to test three commercially available 3 percent AFFFs under the requirements of the MIL-F-24385B specification.

The testing program was later expanded to include compatibility testing of 3 percent AFFF in the Air Force AS-32/P-4(P-4) firefighting vehicle. Large-scale fire tests were conducted at the Naval Weapons Center (NWC), China Lake, California, in September 1979.

SECTION II

TEST PHASES AND OBJECTIVES

The test programs were divided into two phases as follows:

1. Phase 1 consisted of objectives to test commercial 3 percent AFFF formulations according to the requirements of MIL-F-24385B and develop a draft specification for these 3 percent AFFF concentrates.

2. Phase 2 objectives consisted of providing compatibility testing of 3 percent AFFF in the P-4 firefighting vehicle, conduct large-scale fire tests, and compare results with similar tests performed with 6 percent AFFF reported in Reference 2.

SECTION III

TEST MATERIALS AND PROCEDURES

1. PHASE 1

a. Materials

The 3 percent AFFF formulations used initially in 1978 were as follows: Ansul Lot 20377001, 3M-FC-203A Lot 3539, and National Lot 12917. However, when the Phase 2 tests were conducted in 1979, new formulations were available from the manufacturers. Testing was subsequently repeated using the following 3 percent AFFF formulations: Ansul Lot 2039027, 3M-FC203A Lot 2507, and National Lot 13193.

b. Procedures

The testing procedures required for Military Specification MIL-F024385B were followed.

2. Phase 2

a. Materials

The 3 percent AFFF formulations mentioned above were used in these tests. Also, experimental 1 percent AFFF formulations obtained from 3M and National were tested. JP-4 was used as the test fuel.

For these tests 2,000 gallons were utilized to prevent premature burnout. The fuel depth above the water substratum was approximately 0.4 inch and provided about 3 minutes of full area burning time.

b. Procedures

In order to verify nozzle flow rates for each test, the water tank of the P-4 vehicle was calibrated and found to be 36.8 gallons per inch.

Analysis of the foam produced by the air-aspirating nozzles with 3 percent AFFF was made in accordance with the procedures of the National Fire Protection Association Pamphlet 412 (Reference 3).

Generally, premix solutions of 1 percent and 3 percent AFFF were used in order to obtain consistent test results. Attempts to set the proportioner for desired concentrations were made in some tests.

The same 8,000 square foot test site at NWC, China Lake, California, that was used in 1977 for the 6 percent AFFF nozzle

tests (Reference 2) were also used for these tests. Duplicate fire tests were run for each of the 3 percent AFFF formulations. One test each for the 1 percent AFFF was conducted. For comparison purposes, the water-barrel nozzle was used with the 3 percent AFFF on one test and nominal 6 percent AFFF in the air-aspirating nozzle in another test.

After a nominal 30 second preburn period, foam was applied downwind from a distance of approximately 15 feet from the leading edge of the 80-foot side of the 80-foot by 100-foot test area. control times (90 percent extinguishment) were recorded and total foam application time was held constant at 80 seconds in order to provide an equal starting point for the burnback evaluation which followed. This is the same test procedure that was used in Reference 2.

SECTION IV

OBSERVATIONS

1. PHASE 1

The results of testing three commercially available 3 percent AFFF formulations in accordance with MIL-F-24385B are summarized in Appendix A.

Changes in the required values for Refractive Index, Total Halides, and Environmental Impact are necessary in order to reflect the differences between 3 percent and 6 percent AFFF formulations.

Problems with respect to extinguishing time, burnback time, film formulation, and compatibility were found with the National 3 percent AFFF Lot 13103 formulation. This was also found to be true for the earlier Lot 12917 formulation where some fires were not extinguished either when used by itself or in combination with other test concentrates.

The proposed Revision C to MIL-F024385 is included as the Appendix. It includes the requirements for both 3 percent and 6 percent AFFF type concentrates. Recent formulation improvements by the manufacturers have been reflected in proposed Revision C by requiring, in some tests, shorter extinguishing times and longer burnback resistance times.

2. PHASE 2

The test results for analysis of foam producing using 3 percent AFFF with the P-4 turret is given in Table 1. These data are similar to those obtained with 6 percent AFFF in the same turret nozzle (Reference 2).

The results of the eleven fire tests conducted are summarized in Table 2. Taking into account the variation in application technique from one test to another, the control times obtained were similar for all three types of 3 percent AFFF. Table 2 indicates the solution flow rate varied from 690 to 760 gpm during these tests. From inside the P-4 truck cab it was observed that although the engine speed remained fairly constant (1,700-1,900 rpm) during these tests, the pump pressure varied from 140 to 285 psi. Comparing application densities, which compensate for differences in flow rates, to achieve control is probably a fairer means of analyzing the data.

Again, similar test results were obtained with 1 percent AFFF, 6 percent AFFF, and the water barrel nozzles using 3 percent AFFF.

The P-4 proportioning system was used in lieu of premixed solutions from Tests 9-11. For Test 9, the proportioner metering

TABLE 1. FOAM ANALYSIS: P-4 TURRET WITH 3% AFFF.

	3% ANSUL PATTERN		3% 3M PATTERN		3% NATIONAL PATTERN	
	Full Spray	Straight Stream	Full Spray	Straight Stream	Full Spray	Straight Stream
Expansion	7.4	9.6	9.3	10.8	9.3	13.5
25% Drainage Time (Min)	2.9	3.1	3.1	2.9	3.5	2.5

valve was set for what was believed to be 3 percent. However, concentration analysis by the refractormeter yielded only 2.5 percent. Again, for Test 11, a 6 percent setting resulted in an 8 percent concentration by refractometer analysis. Obviously, the calibration of the metering valve for use with AFFF needs further refinement.

Test results in Table 2 for control times, application densities, and burnback times were considered essentially equal with those previously obtained for 6 percent AFFF under similar test conditions (Reference 2).

TABLE 2. SUMMARY OF FIRE TEST DATA FOR APPLYING AFFF FROM 800 GPM TURRET NOZZLES ON 8,000 SQUARE-FOOT JP-4 FUEL FIRES.

Test No.	Type AFFF	Nozzle	AFFF Solution Rate - GPM	FIRE CONTROL (90% Extinguishment) Time (sec)	FIRE CONTROL (90% Extinguishment) Application Density (gal/ft^2)	BURNBACK Time to 25% (min)
1	3% NAT'L	AIR-ASP	690	40	0.058	(1)
2	3% NAT'L	AIR-ASP	755	25	0.039	17
3	3% ANSUL	AIR-ASP	697	34	0.049	(2)
4	3% ANSUL	AIR-ASP	704	25	0.037	15
5	3% 3M	AIR-ASP	760	28	0.044	14
6	3% 3M	AIR-ASP	750	22	0.034	16.5
7	1% NAT'L	AIR-ASP	736	30	0.046	15
8	1% 3M	AIR-ASP	681	19(3)	0.027	(3)
9	3% 3M	Water Barrel	713	26	0.039	No Data
10	6% 3M	AIR-ASP	-	N.G.(4)	-	-
11	6% 3M	AIR-ASP	662	29	0.040	No Data

NOTES:

(1) After 12 minutes Burnback time very little burning outside of pan - lack of fuel near pan.

(2) After 15 minutes Burnback time only 3% fire involvement - again attributed to lack of fuel near pan.

(3) Strong upwind influenced Control time and Burnback test (only 10% after 15 minutes).

(4) P-4 AFFF concentrate valve jammed. No AFFF for 70 seconds.

SECTION V

CONCLUSIONS

Three percent AFFF formulations are currently available to meet the requirements of proposed Revision C to Military Specification MIL-F-24385.

The fire extinguishing capability and burnback resistance of the 3 percent AFFF concentrates tested on large-scale fires are essentially equal in performance to 6 percent AFFF concentrates.

Improved AFFF metering valve calibration for firefighting vehicle proportioning systems is needed.

Since test results in Table 2 for 3 percent and 1 percent AFFF were considered essentially equal with those previously obtained for 6 percent AFFF under similar test conditions, the Air Force conjectured that the use of 3 percent AFFF in existing firefighting vehicles would provide twice the agent capability and also result in savings for shipping and storage costs. Therefore, Appendix B contains proposed Revision C to MIL-F-24385. It includes requirements for both 3 percent and 6 percent AFFF type concentrates. Recent formulation improvements by the manufacturers have also been included in the proposed Revision C by requiring variation in extinguishing times and burnback resistance times.

REFERENCES

1. Military Specification MIL-F-24385B, Fire Extinguishing Agent, Aqueous Film Forming Foam (AFFF) Liquid Concentrate, Six Percent, for Fresh and Sea Water, 25 May 1978.

2. Jablonski, E.J., Comparative Nozzle Study for Applying Aqueous Film Forming Foam on Large-Scale Fires, CEEDO-TR-78-22, April 1978.

3. National Fire Protection Association Pamphlet No. 412, Evaluating Foam Fire Equipment on Aircraft Rescue and Fire Fighting Vehicles, Boston, Massachusetts, 1974.

APPENDIX A

TEST RESULTS FOR MIL-F-24385B QUALIFICATION

Test Results for MIL-F-24385B Qualification.

Para.	Requirement		Value	3% ANSUL Lot 2039027	3% 3M FC 203A Lot 2507	3% NAT'L Lot 13193
3.3	Refractive Index		1.3580	1.3651	1.3700	1.3795
	Viscosity	5°	<30	7.1	7.3	58
		25°	> 2	3.6	3.6	27.5
	pH		7.0-8.5	7.9	7.8	8.0
	Spreading Coefficient		> 3	6.61	5.55	5.70
	Formability					
	fresh water	expansion	>6.0	8.5	8.1	8.6
		drain time	>2.5	3.9	4.4	4.0
	sea water	expansion	>6.0	7.9	7.8	7.4
		drain time	>2.5	3.9	3.3	2.8
	Corrosion Rate					
	general	steel	<1.5	0.085	1.24	1.24
		copper-nickel	<1.0	0.25	0.008	0.57
		bronze	<100	4.1	2.4	46.4
	localized	CRES	no pits	no pits	no pits	no pits
	Total Halides		<100	64	43	60
	Dry Chemical compatibility		>320	336	492	162
	Environmental Impact					
		toxicity	>1500	958	678	1354
		COD				
		BOD/COD	<500K	460	1109	982
3.3.1	Film formation & Sealability		>0.85	0.95	0.96	0.99
	fresh water		no ign	no ign	no ign	no ign
	sea water		no ign	no ign	no ign	no ign
3.3.2	Stability					
	(a) spreading coefficient					
	concentrate		>3	7.77	7.59	6.88
	fresh premix		>3	7.37	7.70	5.64
	sea premix		>3	7.14	8.32	6.37

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	3% ANSUL Lot 2039027	3% 3M FC 203A Lot 2507	3% NAT'L Lot 13193
	(b) fomability					
	fresh water	expansion	>6.0	8.3	8.2	9.0
		drain time	>2.5	4.3	5.3	4.7
	sea water	expansion	>6.0	8.8	8.3	7.9
		drain time	>2.5	4.2	4.2	3.3
	(c) film formation					
	3% fresh water		no ign	no ign	no ign	no ign
	3% sea water		no ign	no ign	no ign	no ign
	1.5% fresh water		no ign	no ign	no ign	no ign
	1.5% sea water		no ign	no ign	no ign	no ign
	3% fresh premix		no ign	no ign	no ign	no ign
	3% sea premix		no ign	no ign	no ign	no ign
	(d) fire performance					
	1.5% fresh water	ext time	<65	54	62	55
		burnback	>240	432	462	378
	3% sea water	ext time	<65	61	65	55
		burnback	>240	376	420	396
	3% fresh premix	ext time	<30	25	27	no ext
		burnback	>320	426	432	-
	3% sea premix	ext time	<30	26	26	90
		burnback	>320	330	420	126
	(e) stratification					
	concentrate		none	none	none	none
	fresh premix		none	none	none	none
	sea premix		none	none	none	none
	(f) precipitation					
	concentrate		<0.05	<0.05	<0.05	<0.05
	fresh premix		<0.05	<0.05	<0.05	<0.05
	sea premix		<0.05	<0.05	<0.05	<0.05

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	3% ANSUL Lot 2039027	3% 3M FC 203A Lot 2507	3% NAT'L Lot 13193
3.3.3	Compatibility (see attached sheets)					
3.3.4	Total fluorine content		report	1.28%	1.73%	0.75%
3.4	Fire performance					
	28 ft^2					
	1.5% fresh water	ext time	<65	41	59	84
		burnback	>240	46.5	426	192
	1.5% sea water	ext time	<65	47	63	60
		burnback	>240	260	400	200
	3% fresh water	ext time	<30	28	30	30
		burnback	>320	396	362	264
	3% sea water	ext time	<30	28	25	38
		burnback	>320	372	444	174
	25% sea water	ext time	<55	31	82	-
		burnback	>150	190	108	-
	50 ft^2					
	3% sea water	ext time	<50	50	49	57-95
		burnback	>300	324	390	-
		40 S	>300	305	304	275-325
	1260 ft^2					
	1.5% sea water	85% ext	<40	35	30	25
		40 S	>285	285	287	295
	3% fresh water	85% ext	<30	30	20	25
		40 S	>300	310	344	310
	3% sea water	85% ext	<30	25	18	30
		40 S	>300	308	334	310

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	Conc	33% Nat'L Conc/ Fresh	33% Ansul Conc/ Sea	33% Fresh Premix	3M Sea Premix
3.3.3	Compatibility							
	(a) foamability	expansion	>6.0		8.2	8.9	7.7	4.3
		drain	>2.5		5.3	4.5	3.9	5.3
	(b) film formation		no ign		no ign	no ign	ign	no ign
	(c) fire performance	ext time	<30		38	52	no ign	45
		burnback	>320		378	378	-	420
	(d) stratification		none				none	none
	(e) precipitation		<0.05				<0.05	<0.05

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	Conc	50% Ansul Conc/ Fresh	50% 3M Conc/ Sea	Fresh Premix	Sea Premix
3.3.3	Compatibility							
	(a) foamability							
		expansion	>6.0		10.7	7.1	10.3	8.0
		drain	>2.5		3.7	4.4	4.0	3.9
	(b) film formation		no ign		no ign	no ign	no ign	no ign
	(c) fire performance							
		ext time	<30		26	28	30	26
		burnback	>320		390	408	480	390
	(d) stratification		none				none	none
	(e) precipitation		<0.05				<0.05	<0.05

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	Conc	50% Nat'l Conc/ Fresh	50% 3M Conc/ Sea	Fresh Premix	Sea Premix
3.3.3	Compatibility							
	(a) foamability							
		expansion	>6.0		9.6	7.9	7.3	8.1
		drain	>2.5		4.9	4.2	3.8	5.5
	(b) film formation		no ign		no ign	no ign	ign	no ign
	(c) fire performance							
		ext time	<30		45	62	No ext	52
		burnback	>320		504	348	-	324
	(d) stratification		none				none	none
	(e) precipitation		<0.05				<0.05	<0.05

Test Results for MIL-F-24385B Qualification (Continued).

Para.	Requirement		Value	Conc	50% Nat'l Conc/ Fresh	50% Ansul Conc/ Sea	Fresh Premix	Sea Premix
3.3.3	Compatibility							
	(a) foamability							
		expansion	>6.0		8.7	7.2	7.2	2.2
		drain	>2.5		4.7	3.9	4.7	2.3
	(b) film formation		no ign		no ign	no ign	no ign	no ign
	(c) fire performance							
		ext time	<30		45	53	45	71
		burnback	>320		420	384	420	230
	(d) stratification		none				none	none
	(e) precipitation		<0.05				<0.05	<0.05

APPENDIX B

PROPOSED REVISION

MIL-F-24385C

MIL-F-24385C
12 March 1981
SUPERSEDING
MIL-F-24385B
25 May 1978
(See 6.5)

MILITARY SPECIFICATION

FIRE EXTINGUISHING AGENT, AQUEOUS FILM-FORMING

FOAM (AFFF) LIQUID CONCENTRATE

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 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 they shall be diluted with fresh or sea water to form a fire-extinguishing solution. Certain proportioning equipment may produce AFFF solutions of extreme concentrations; requirements for 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 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4210

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

MILITARY

MIL-G-5572 - Gasoline, Aviation, Grades 80/87, 100/130, 115/145.
MIL-I-17214 - Indicator, Permeability; Low-Mu (GO-NO-GO).

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.

PUBLICATIONS

MILITARY

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER (DTNSRDC)
Standard Marine Bioassay Procedure for Shipboard Chemicals.

(Application for copies should be addressed to Commander, David W. Taylor Naval Ship Research and Development Center, (Code 2865), Annapolis, MD 21402.)

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

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 Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
D96-73 - Water and Sediment in Crude Oils.
D445-74 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).
D1141 - Substitute Ocean Water.
D1331 - Surface and Interfacial Tension of Solutions of Surface-Active Agents.
D1821 - Inorganic Chlorides in Askarels.
E527 - Numbering Metals and Alloys (UNS).
E729 - Standard Practice for Conducting Acute Toxicity Tests with Fish, Macroinvertebrates and Amphibians.

(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 - 18th Street, N.W., Washington, DC 20036.)

UNIFORM CALSSIFICATION 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 TRANSPORTATION
Code of Federal Regulations, Title 49.

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

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.)

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 Materials. Concentrates 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 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 publication	Test paragraph
	Type 3	Type 6		
Refractive index, minimum	1.3630	1.3580	----------	4.7.1
Viscosity, centistokes			ASTM D445-74	4.7.2
Maximum at 5°C	20	10		
Minimum at 25°C	2	2		
Hydrogen ion concentration (pH)	7.0 to 8.5	7.0 to 8.5	----------	4.7.3
Spreading coefficient, minimum	3	3	----------	4.7.4
Foamability:				
Foam expansion, minimum	6.0	6.0	NFPA STD 412	4.7.5
Foam 25% drainage time, minutes, minimum	2.5	2.5	NFPA STD 412	4.7.5
Corrosion rate:				
General				
Cold rolled, low carbon steel (UNS G10100), milli in/yr, maximum	1.5	1.5	ASTM E527	4.7.7
Copper-nickel (90-10) (UNS C70600), m in/yr, maximum	1.0	1.0	ASTM E527	4.7.7
Nickel-copper (70-30) (UNS N04400), m in/yr, maximum	1.0	1.0	ASTM E527	4.7.7
Bronze (UNS C90500), milligrams, maximum	100	100	ASTM E527	4.7.7
Localized, corrosion-resistant (CRES) steel, (UNS S30400)	No pits	No pits	-- -------	4.7.7
Total halides, p/m, maximum	500	250	ASTM D1821	4.7.8

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

Requirements	Values		Applicable publication	Test paragraph
	Type 3	Type 6		
Dry chemical compatibility, burn-back resistance time, seconds, minimum	360	360	----------	4.7.9
Environmental impact:				
Toxicity, LC_{50}, mg/L, min	500	1000	----------	4.7.12.1
COD, mg/L, maximum	1000K	500K	----------	4.7.12.2
$\frac{BOD_{20}}{COD}$, minimum	.9	.9	----------	4.7.12.3

3.3.1 Film formation and sealability. The foam produced film shall spread over the fuel surface and seal off vapor production to prevent sustained ignition (see 4.7.6).

3.3.2 Stability. The concentrate (Type 3 or Type 6) and a 3 percent premix solution of Type 3 or a 6 percent premix solution of Type 6 as applicable shall conform to the following requirements after 10 days storage at 65°C ± 2.0°C (see 4.7.10):

(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 ft^2 fire, 1.5 and 3 percent of Type 3 and 3 and 6 percent of Type 6 fresh and sea water solutions: As specified in 3.4.
(e) Stratification: No visible evidence following test (see 4.7.14).
(f) Precipitation: 0.05 percent by volume (see 4.7.15).

3.3.3 Compatibility. The concentrates of one manufacturer shall be compatible in all proportions with concentrate furnished by other manufacturers 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 known to be still in use in significant quantities. Information regarding these materials may be obtained from NAVSEA. The concentrate shall conform to the following requirements after 10 days storage at 65°C ± 2.0°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 ft^2, 3 percent of Type 3 and 6 percent of Type 6 fresh and sea water solution: As specified in 3.4.
(d) Stratification: No visible evidence following test (see 4.7.14).
(e) Precipitation: 0.05 percent by volume (see 4.7.15).

3.3.4 Total fluorine content. The total fluorine content of the AFFF shall be determined and shall not deviate more than 1.5 percent of the value determined and reported at time of qualification report (see 4.7.16.1).

3.4 Fire performance. The foam shall conform to the fire performance requirements shown in table II.

TABLE II. Fire performance.

	AFFF Solutions, percent		
	1.5% of Type 3 3.0% of Type 6	3% of Type 3 6% of Type 6	15% of Type 3 30% of Type 6
	(Fresh and sea)	(Fresh and sea)	(Sea)
28 ft ^{2} fire (see 4.7.13.1):			
Foam application time to extinguish, seconds, maximum	45	30	55
Burnback time of resulting foam cover, seconds, minimum	300	360	200
50 ft ^{2} fire (see 4.7.13.2):		(Sea)	
Foam application time to extinguish, seconds, maximum		50	
Burnback time of resulting foam cover, seconds, minimum		360	
40-second summation, minimum		320	

3.5 Marking.

3.5.1 Identification marking shall be in accordance with MIL-STD-130. In addition, the marking on the containers (see 5.3) shall be in white characters against a green background for Type 3, a blue background for the Type 6.

3.5.2 Two identical markings conforming to 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 will 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, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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.

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

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.5).
    (1) Examination of filled containers.
    (2) Quality conformance inspection.

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 III.

TABLE III. Qualification and quality conformance inspections.

Examination or test	Reference paragraph		Qualification	Quality conformance
	Requirement	Test		
Refractive index	3.3	4.7.1	X	X
Viscosity	3.3	4.7.2	X	X
pH value	3.3	4.7.3	X	X
Spreading coefficient	3.3	4.7.4	X	X
Foamability	3.3	4.7.5	X	X
Film formation and sealability	3.3.1	4.7.6	X	X
General corrosion	3.3	4.7.7	X	
Localized corrosion	3.3	4.7.7	X	
Total halides	3.3	4.7.8	X	X
Fluorine content	3.3.4	4.7.16	X	X
Dry chemical compatibility	3.3	4.7.9	X	
Stability	3.3.2	4.7.10	X	
Compatibility	3.3.3	4.7.11	X	
Environmental impact	3.3	4.7.12	X	
28 ft^2 fire test	3.4	4.7.13	X	
50 ft^2 fire test	3.4	4.7.19	X	X
Examination of filled containers		4.6		X
Torque to remove cap[1/]	5.1.1.1.1(f)	4.7.17.2	X	X

1/ Torque test to be performed a minimum of 48 hours after initial closure.

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 Sampling for quality conformance inspection.

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

4.4.2 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 (AQL) of 2.5 percent defective shall be used to verify compliance with all requirements regarding fill, closure, marking, and other requirements not requiring tests (see 4.6, 5.1.1.1, and 5.1.1.2).

4.4.3 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 4.6, 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 4.5 shall be submitted to NAVSEA or the designated laboratory.

4.5 Quality conformance inspection. The samples selected in accordance with 4.4.3 shall be subjected to the quality conformance inspection of table III. If the sample tested is found to be not in conformance with any of the quality conformance tests, the lot represented by the sample shall be rejected.

4.5.1 Quality conformance inspection report. The contractor shall prepare test reports in accordance with the data ordering document included in the contract (see 6.2.2).

4.6 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 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.

4.7 Test procedure.[1/]

4.7.1 Refractive index. The refractive index shall be determined at 25°C ± 0.1°C, using sodium vapor source lamp illumination.

4.7.2 Viscosity. The viscosity shall be determined at temperatures of 5°C ± 0.1°C and 25°C ± 0.1°C in accordance with ASTM D445-74, using capillary viscosimeters in 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°C ± 1.0°C.

1/ Where sea water is required for tests, synthetic sea water in accordance with ASTM D1141 shall be used. A sea salt mixture conforming to this standard may be purchased from Lake Products Company, Inc., St. Louis, Missouri 63125.

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

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

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_i = interfacial tension between liquids as determined in 4.7.4.2.

4.7.4.1 Surface tension. The surface tension of 3 ± 0.05 percent of type 3 or 6 ± 0.1 percent of type 6 by volume in distilled water, as appropriate, and of reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at 23°C ± 2.0°C in accordance with ASTM D1331.

4.7.4.2 Interfacial tension. The interfacial tension between 3 ± 0.05 percent of type 3 or 6 ± 0.1 percent of Type 6 by volume in distilled water, as appropriate, and reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at 23°C ± 2.0°C until the readings come to equilibrium and in accordance with ASTM D1331.

4.7.5 Foamability. The foam shall be generated by means of a special 2 gallons per minute (gal/min) test nozzle. The basic nozzle as made by National Foam System, Inc., Lionville, Pennsylvania, (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. The spreader shall have a 1/8 inch wide, circular orifice, 1-7/8 inches long. (It may be made by slightly compressing a Bernz-o-matic TX-1527, or equal, 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 inlet pressure shall be maintained at a gage pressure of 100 pounds per square inch (lb/in^2), and the solution temperature at 23°C ± 5.0°C. The nozzle shall be held at hip height and directed onto the backboard from a distance of 4 to 6 feet. The method and procedure shall be in accordance with NFPA Standard No. 412. Foamability shall be run on 6 percent fresh and sea water solutions of the type 6 concentrate and 3 percent fresh and sea water solutions of the type 3 concentrate.

4.7.6 Film formation and sealability.

4.7.6.1 Test equipment. A CRES graduated measure of 1000 milliliter (mL) capacity (4-1/2 inches in diameter, 5 inches deep; Cole-Parmer Co., Chicago, Illinois, or equal) may be fitted with two retaining clips at the top edge. The clips serve to restrain a cone 5 inches in height and

4-3/4 inches in diameter, made of 80-mesh perforated CRES in an inverted position inside the measure. The 2 gal/min nozzle specified in 4.7.5 shall be used for foam production.

4.7.6.2 Test procedure. After placing 400 mL of water and 200 mL of 98-percent cyclohexane in the measure, 200 mL of freshly-made foam shall be poured onto the fuel. The inverted cone shall be pushed down into the measure, thereby pushing most of the foam aside but allowing the film-producing liquid to creep in through the mesh openings. A foam-free surface shall be created by manually scooping out most of the residual foam from the center of the cone. 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 shall be provided with a hand-held propane cylinder fitted with a capillary tubing outlet.

4.7.7 Corrosion. The liquid for immersion of the metal specimens for general corrosion and localized corrosion tests shall consist of the concentrate diluted by 10 percent by volume with sea water.

4.7.7.1 General corrosion.

4.7.7.1.1 Test specimens. The test specimens shall consist of the following metals, in accordance with UNS designations (see ASTM E527): G10100 steel, C70600 copper-nickel alloy, N04400 nickel-copper 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 Company, Box 6715, San Antonio, Texas 78209.)

4.7.7.1.2 Test procedures. Five weighed specimens of each metal shall be fully immersed in the test medium in a separate 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.

4.7.7.2 Localized corrosion.

4.7.7.2.1 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. 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 a period of 5 minutes.

4.7.7.2.2 Procedure. Ten specimens shall be girdled lengthwise with a clean 1/16 to 1/8 inch wide band of a good grade 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, Pure Gum, Gooch type, 1/32-inch thin wall, pure gum amber tubing, very elastic, especially made for Gooch crucibles, Stock No. 139080, or equal). This tubing is most easily cut into uniform strips with a blade-type papercutter, but can 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 specimens. A 1/4-inch layer of glass beads shall be introduced into the beaker to aid in stabilizing specimen position. Enough liquid shall be added to completely immerse 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.

4.7.7.2.3 Results. The specimens shall be monitored daily over the 60-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, 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 areas of the specimens under, or adjacent to the rubber bands. 10X magnification shall be used, if necessary.

4.7.8 Total halides. The halide content shall be determined to be in accordance with ASTM D1821, except for the following modifications:

(a) Procedure:
  (1) Weight 2 ± 0.1 g 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 (one volume of concentrated acid to 60 volumes of water).

(b) The calculation shall be modified as follows:

$$\text{halide content, p/m} = 44.4(A-B)$$

4.7.9 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 dry chemical.

4.7.9.1 Test materials. The fuel shall be gasoline conforming to VV-G-1690. The dry chemical agent shall conform to O-D-1407. The sieve shall be an 8-inch diameter, 40 mesh sieve conforming to type I, style A of RR-S-366.

4.7.9.2 Test procedure. A 28-square-foot fire test shall be conducted in accordance with 4.7.7.1 using type 3 or 6 AFFF sea water solution, as required. Before placing the burning pan, one pound of dry chemical agent shall be evenly distributed over the foam blanket with the aid of a sieve 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 burning pan will be not longer than 90 seconds. The burnback time shall be determined as in 4.7.13.1.4.

4.7.10 Stability.

4.7.10.1 Sample preparation. Samples of concentrate, and type 3 and type 6 AFFF fresh water and sea water solution, as appropriate, shall be prepared in sufficient quantity to perform the required tests. One liter (L) of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at 65°C ± 2.0°C for a period of 10 days. The samples shall then be subjected to the following tests:

(a)	Spreading coefficient	4.7.4
(b)	Foamability	4.7.5
(c)	Film formation and sealability	4.7.6
(d)	Fire performance (28 ft^2)	4.7.13.1
(e)	Stratification	4.7.14
(f)	Precipitation	1/ 4.7.15

1/ In the preparation of the samples to be used for the precipitation test, the synthetic sea water shall be filtered prior to use.

4.7.11 Compatibility.

4.7.11.1 Sample preparation. The Government will provide samples of appropriate qualified product 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, the testing activity will determine the number of product mixtures to be evaluated and the ratio of products comprising these mixtures.) Additionally, 3 percent of type 3 or 6 percent of type 6 AFFF fresh water and sea water solutions shall be prepared from each concentrate mixture. One L of each shall be placed in lightly stoppered glass cylinders. The samples shall be stored at 65°C ± 2.0°C for a period of 10 days. The samples shall then be subjected to the following tests:

(a)	Foamability	4.7.5
(b)	Film formation and sealability	4.7.6
(c)	Fire performance (28 ft^2)	4.7.13.1
(d)	Stratification	4.7.14
(e)	Precipitation	4.7.15

4.7.12 Environmental impact.

4.7.12.1 Toxicity. Toxicity test shall be performed on the Killiefish (Fundulus nerteroclitus) in accordance with ASTM E729, using dynamic procedures. The minimum acceptable dissolved oxygen content of water used in this procedure shall be 5 p/m.

4.7.12.2 COD shall be determined in accordance with procedures in Standard Method for the Examination of Water and Waste Water (latest applicable Edition).

4.7.12.3 Biodegradability. Biodegradability shall be determined by dividing the value expressed in mg/L for the 20-day biological oxygen demand (BOD20) determined from 5-day BOD test in accordance with the

procedure specified in Standard Methods for the Examination of Water and Waste Water (latest applicable Edition) by the value expressed in mg/L for chemical oxygen demand (COD) determined as specified in 4.7.12.2. (This method is approved by EPA at this time although EPA has a proposed Carbonaceous method in the Federal Register of 3 December 1979 (page 69594) which may also be used when adopted.)

4.7.13 Fire test.[1/] No fire test shall be conducted when the wind speed is above 10 miles per hour (mi/hr).

4.7.13.1 Twenty-eight-square-foot fire test.

4.7.13.1.1 Test equipment. The fire test shall be conducted in a level, circular pan 6 feet in diameter, fabricated from 1/4-inch thick steel with a 4-inch high side. A shallow water layer shall be 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 gal/min device specified in 4.7.5.

4.7.13.1.2 Test materials. Foam shall be generated at 23°C ± 5.0°C from AFFF solutions made with fresh or sea water, as required, at concentration values shown in table IV. The fuel shall be 10 gallons of motor gasoline conforming to VV-G-1690.

TABLE IV. AFFF test concentration values.

Solutions	Type 3	Type 6
Lean[1/]	1.5 ± .03	3.5 ± 0.1
Normal strength	3 ± .05	6 ± 0.1
Rich[2/]	15 ± 0.2	30 ± 0.2

1/ One test with fresh water and one with sea water.
2/ One test with sea water.

4.7.13.1.3 Test procedure. 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 for a total of 90 seconds. The fire test required shall be as follows:

4.7.13.1.4 Burnback procedure. Within 60 seconds of the completion of foam application, a burning pan (1-foot in diameter with 2-inch side) shall be placed in the center of the 28-square-foot pan and a timer

1/ These tests are normally conducted indoors to avoid adverse weather conditions.

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 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 a part of the burnback area unless sustained burning occurs. All isolated, sustained burning areas shall be included in arriving at the 7-square-foot total area.

4.7.13.2 Fifty-square-foot fire test.

4.7.13.2.1 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 the fuel.

4.7.13.2.2 Test equipment. The nozzle used for foam application shall be the 2 gal/min device specified in 4.7.5, operated at a gage pressure of 100 lb/in^2.

4.7.13.2.3 Test materials. The foam shall be generated at 20°C ± 5.0°C from 3 ± 0.05 percent of Type 3 or 6 ± 0.1 percent of Type 6 AFFF solutions made with sea water. The fuel shall be 15 gallons of gasoline conforming to MIL-G-5572 or VV-G-1690.

4.7.13.2.4 Test procedure. 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 total of 90 seconds.

4.7.13.2.5 Burnback procedure. Within 60 seconds of the completion of foam application, a burnback test shall be conducted as specified in 4.7.13.1.4, except that the burnback area shall be 12.5 square feet (25 percent).

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

4.7.15 Precipitation. The amount of precipitation shall be determined by centrifuging the 100 mL sample withdrawn from the 1-L sample after thorough agitation in accordance with the primary method of ASTM D96-73.

4.7.16 Fluorine content.

4.7.16.1 Qualification. The total fluorine content shall be determined. The total fluorine content and the test procedure used to determine the content shall be furnished as part of the qualification inspection report.

4.7.16.2 Quality conformance inspection. The total fluorine content shall be determined in accordance with the test procedure furnished with the qualification inspection report (see 4.7.16.1). The total fluorine content shall be included in the quality conformance inspection report.

4.7.17 Packaging inspection. Sample packages and packs and the inspection of preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of 4.6, section 5 and the documents specified therein. The magnetic permeability test (for metal handles of 5-gallon containers) of 4.7.17.1 and the torque test (for the pour cap of 5-gallon containers) of 4.7.17.2 shall be included.

4.7.17.1 Magnetic permeability (metal handles of 5-gallon containers). The metal handles of the 5-gallon containers shall be checked to determine conformance with the magnetic requirements of 5.1.1.1.1(d) using a permeability indicator, low-mu (GO-NO-GO) in accordance with MIL-I-17214.

4.7.17.2 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 with 5.1.1.1.1(f).

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation-packaging. Preservation-packaging for level A shall be as specified hereinafter.

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

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

(a)	Capacity	5-gallon (min.)
(b)	Height, body (overall)	15-inches (max.)
(c)	Diameter, body (overall)	11-3/4 inches (max.)
(d)	Pour opening (inside dim.)	1-1/2 inches (min.)

5.1.1.1.1 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, and as follows:

(a) Shall be stackable and self-supporting.

(b) Shall be provided with a 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 a threaded type plastic cap.
(d) Shall be provided with an integrally molded or recessible plastic or metal handle. Metal handles shall not exceed a magnetic permeability of 2.0.
(e) Shall have colors conforming to 5.1.1.3, Type 3 green, Type 6 blue.
(f) The torque required to remove the pour opening cap shall not exceed 50 inch pounds.

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-1337, and the following:

(a) Insert. The insert shall contain two protruding openings in the top head - one 3/4-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.
(b) Covers. The steel drum cover shall be provided with two openings to accommodate the protruding insert openings. Covers shall be fully removable. Cover gaskets are not required. Covers shall be secured to the steel drum with minimum 16-gage bolt or lever lock type locking rings.

5.1.1.3 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 TT-E-489.

5.2 Packing. For level A no further packing is required.

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

5.2.2 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 NN-P-71, type V, class 1, wood group optional, size 2, are acceptable. Containers shall be properly and firmly nested and arranged to insure a snug, non-shifting load. Pallet dimensions may be adjusted to assure a snug, non-shifting load, but shall not exceed 43 x 52 inches.

5.3 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.

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) Size of container required (see 5.1.1).
(d) Special marking, if required (see 5.3).

6.2.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirement	Applicable DID
4.5.1	Test reports	DI-T-2072

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 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 the applicable 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 orders for the products covered by this specification. The activity responsible for the Qualified Products List is Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362, 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" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material is acquired by the contractor for incoporation into the concentrate and lose separate identity when the concentrate is shipped.

6.5 Changes from previous issue. The symbol "#" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 4210-0339)

Custodians:
Navy - SH
Air Force - 99
Review activities:
Navy - YD
Air Force - 04
DSA - CS
User activities:
Army - CE
Navy - AS, MC, OS, CG

THIS END UP

U.S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

MILITARY SPECIFICATION MIL-F-24385C

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 SEA WATER OR FRESH WATER AT VOLUME PROPORTIONS OF THREE GALLONS CONCENTRATE TO 97 GALLONS WATER. IT MAY ALSO BE DILUTED FOR READY-USE STORAGE AT A THREE 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-24385C (AND PREVIOUS ISSUES) AND WATER.

MANUFACTURER'S NAME
ADDRESS
BATCH NO.
DATE OF MANUFACTURE

FIGURE 1. Type 3 container markings.

THIS END UP

U.S.

AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE

In accordance with

MILITARY SPECIFICATION MIL-F-24385C

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 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.

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-24385C (AND PREVIOUS ISSUES) AND WATER.

MANUFACTURER'S NAME
ADDRESS
BATCH NO.
DATE OF MANUFACTURE

FIGURE 2. Type 6 container markings.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS. This form is provided to solicit beneficial comments which may improve this document and enhance its use. DoD contractors, government activities, manufacturers, vendors, or other prospective users of the document are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity. A response will be provided to the submitter, when name and address is provided, within 30 days indicating that the 1426 was received and when any appropriate action on it will be completed.

NOTE: This form shall not be used to submit requests for waivers, deviations or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

DOCUMENT IDENTIFIER (Number) AND TITLE

MIL-F-24385C

NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER

☐ VENDOR ☐ USER ☐ MANUFACTURER

1. ☐ HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? ☐ IS ANY PART OF IT TOO RIGID, RESTRICTIVE, LOOSE OR AMBIGUOUS? PLEASE EXPLAIN BELOW.

A. GIVE PARAGRAPH NUMBER AND WORDING

B. RECOMMENDED WORDING CHANGE

C. REASON FOR RECOMMENDED CHANGE(S)

2. REMARKS

SUBMITTED BY (Printed or typed name and address — Optional)

TELEPHONE NO.

DATE

DD FORM 1 OCT 78 1426 EDITION OF 1 JAN 72 WILL BE USED UNTIL EXHAUSTED.

MIL-F-24385C
AMENDMENT 1
5 June 81

MILITARY SPECIFICATION

FIRE EXTINGUISHING AGENT, AQUEOUS FILM-FORMING

FOAM, (AFFF) LIQUID CONCENTRATE,

FOR FRESH AND SEA WATER

This amendment forms a part of Military Specification MIL-F-24385C, dated 12 March 1981, and is approved for use by all Departments and Agencies of the Department of Defense.

PAGE 6

3.3.4, line 2: Delete "1.5 percent" and substitute "15 percent".

PAGE 13

TABLE IV, line 1, under Type 6: Delete "3.5 $\pm$ 0.1" and substitute "3 $\pm$ 0.1".

PAGE 14

4.7.13.2.3, line 1: Delete "20°C" and substitute "23°C".

Preparing activity:
Navy - SH
(Project 4210-0344)

Custodians:
Navy - SH
Air Force - 99
Review activities:
Navy - YD
Air Force - 04
DSA - CS
User activities:
Army - CE
Navy - AS, MC, OS, CG

FSC 4210

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