



DEPARTMENT OF THE NAVY
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IN REPLY REFER TO

3905

Ser 6180/0411

10 SEP 2003

From: Commanding Officer, Naval Research Laboratory
To: Commander, Naval Sea Systems Command (Code 05R42 E. Minor)

Subj: RESULTS OF QUALIFICATION TESTING OF 3% BFC-3MS (LOT NUMBER 030403)
AQUEOUS FILM-FORMING FOAM (AFFF) LIQUID CONCENTRATE FIRE
EXTINGUISHING AGENT MANUFACTURED BY THE BUCKEYE FIRE EQUIPMENT
COMPANY.

Ref: (a) NAVSEA ltr 05Q-2001/286 of 15 Nov 01

Encl: (1) Two copies of subject report.

1. In accordance with reference (a), Buckeye Fire Equipment Company's 3% BFC-3MS AFFF (Lot Number 030403) was tested for compliance with Military Specification MIL-F-24385F (SH), Amendment 1, 5 August 1994. The material was received by the Naval Research Laboratory (NRL) from Buckeye Fire Equipment Company in March 2003, with fire performance testing initiated on 31 March 2003. Detailed results of these tests are forwarded for your review as enclosure (1).
2. Buckeye Fire Equipment Company's 3% BFC-3MS (Lot Number 030403) AFFF as supplied by the manufacturer complied with the requirements of the Military Specification MIL-F-24385F (SH), Amendment 1, 5 August 1994, except for the following:
 - Requirement 5.1.1.1e: the color of the container was not green.
 - Requirement 5.1.1.1f: The torque needed to open the 5 gallon containers exceeded 50 inch pounds.
3. Buckeye's 3% BFC-3MS (Lot Number 030403) AFFF is recommended for inclusion in the Qualified Products List, QPL-24385-32, 24 April 2002 when the discrepancies noted in the above paragraph are corrected.
4. The NRL technical point of contact is Dr. Ronald S. Sheinson, Code 6180, (202) 404-8101.


RICHARD J. COLTON
By direction

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6180A:RS
9 September 2003

**RESULTS OF QUALIFICATION TESTING OF 3% BFC-3MS AQUEOUS
FLIM-FORMING FOAM (AFFF) LIQUID CONCENTRATE FIRE
EXTINGUISHING AGENT MANUFACTURED BY THE BUCKEYE FIRE
EQUIPMENT COMPANY**

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Encl (1) to NRL ltr
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References

- (a) NAVSEA ltr 05Q-2001/286 of 15 Nov 01
- (b) Military Specification, "Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Seawater," MIL-F-24385F, (SH) Amend.1, 5 August 1994.
- (c) Qualified Products List, QPL-24385-32, 24 April 2002, which lists products that have been qualified in accordance with reference (b).

Introduction

1. Buckeye Fire Equipment Company submitted the subject 3% Aqueous Film Forming Foam Fire Extinguishing Agent to the Naval Research Laboratory (NRL) for qualification testing (reference (a)) for compliance with the requirements of reference (b). Buckeye's 3% AFFF, BFC-3MS met the criteria for qualification and inclusion in reference (c) required by reference (b), except for the 2 requirements listed below. The material was received by NRL from Buckeye Fire Equipment Company in March 2003, with fire performance testing initiated on 31 March 2003. The results of the qualification testing are presented in Tables 1 through 7.
 - Requirement 5.1.1.1e: the color of the container was not green.
 - Requirement 5.1.1.1f: the torque needed to open the 5 gallon containers exceeded 50 inch pounds.
2. The contents of each table are briefly outlined as follows. Results that did not meet the criteria are in bold and underlined type.
 - a. Table 1: Chemical and Physical requirements.
 - b. Table 2: 28 ft² Fire Performance Test, fresh concentrate.
 - c. Table 3: 50 ft² Fire Performance Test, fresh concentrate.
 - d. Table 4: Concentrate Stability 28 ft² Fire Performance Test, aged concentrate.
 - e. Table 5: Solution Stability 28 ft² Fire Performance Test, aged solution.
 - f. Table 6: AFFF Agents from the Qualified Products List (Reference c) used in the Compatibility Fire Performance Test.
 - g. Table 7: Agent Compatibility 28 ft² Fire Performance Test, aged concentrates.

Table 1. Chemical and Physical Requirements for Buckeye 3% AFFF Concentrates or Solutions.

Requirement	Pass / Fail Criteria	Buckeye BFC-3MS Results
Refractive index, minimum	1.363	1.46
Viscosity (Centistoke) Maximum @ 5°C Minimum @ 25°C	20 2	19.4 11.6
Hydrogen Ion Concentration (pH)	7.0 to 8.5	7.6
Spreading Coefficient, dynes/cm, minimum	3	6
Film Formation and Sealability	No sustained ignition	No ignition
Foamability: Foam Expansion Ratio, minimum Fresh Agent Test: Fresh Water / Sea Water Stability Test, concentrate: Fresh Water / Sea Water Stability Test, solution: Fresh Water / Sea Water Compatibility Tests: Fresh Water / Sea Water Foam 25% Drainage Time, minutes, minimum Fresh Agent Test: Fresh Water / Sea Water Stability Test, concentrate: Fresh Water / Sea Water Stability Test, solution: Fresh Water / Sea Water Compatibility Tests: Fresh Water / Sea Water	5.0:1 2.5	9.4 / 7.7 8.8 / 8.3 8.6 / 9.7 8.7 / 6.9 6:00 / 5:06 6:00 / 5:15 6:15 / 4:25 3:47 / 4:13
Corrosion Rate: General Cold rolled, Low carbon steel (UNS G10100) mili in/yr, maximum Copper-Nickel (90-10) (US C70600) mili in/yr, maximum Nickel-Copper (70-30) (US N04400) mili in/yr, maximum Bronze (UNS C90500), milligrams maximum Localized, corrosion-resistant (CRES) steel, UNS S30400)	1.5 1.0 1.0 100 No pits	0.825 0.024 0.012 0.046 No pits
Total Halides, ppm maximum	500	332
Dry chemical compatibility, burn -back resistance time 360 seconds minimum	360	550
Environmental impact: Toxicity, LC ₅₀ , mg/L, minimum COD, mg/L, maximum BOD ₂₀ minimum COD	500 1,000,000 0.65	1000> 793,900 mg/L 0.85
Fluorine content, mg/L	-----	9,460 mg/L
Stratification: Stability Test Compatibility Test	None None	None None
Precipitation, % by Volume: Stability Test Compatibility Test, 1:1 Ratio Mixes Compatibility Test, All Agent Mix	< 0.05 < 0.05 < 0.05	<0.05 <0.05 < 0.05
Container cap opening torque (average)	50 in/lbs max	<u>54 lbs.</u>

Table 2. 28 ft² Fire Performance Test Results: Buckeye 3% fresh concentrate.

PROPERTY MEASURED	EXTINGUISH TIME CRITERIA	ACTUAL TIMES	BURNBACK TIME CRITERIA	ACTUAL TIMES
Fresh Water Full Strength	30 Sec (Max)	30	360 Sec (Min)	500
Fresh Water Half Strength	45 Sec (Max)	41	300 Sec (Min)	390
Sea Water Full Strength	30 Sec (Max)	28	360 Sec (Min)	515
Sea Water Half Strength	45 Sec (Max)	44	300 Sec (Min)	450
Quintuple Strength (15%) Sea Water	55 Sec (Max)	43	200 Sec (Min)	420

Table 3. 50 ft² Fire Performance Test Results: Buckeye 3% AFFF.

PROPERTY MEASURED	EXTINGUISHMENT TIME CRITERIA	ACTUAL TIMES	BURNBACK TIME CRITERIA	ACTUAL TIMES	40 SECOND SUMMATION	ACTUAL TOTAL
Sea Water Full Strength	50 Sec (Max)	43	360 Sec (Min)	400	320 (Min)	329

Table 4. 28 ft² Fire Performance Concentrate Stability Test Results: Buckeye 3% AFFF.

PROPERTY MEASURED	EXTINGUISHMENT TIME CRITERIA	ACTUAL TIMES	BURNBACK TIME CRITERIA	ACTUAL TIMES
Fresh Water Full Strength	30 Sec (Max)	30	360 Sec (Min)	460
Fresh Water Half Strength	45 Sec (Max)	41	300 Sec (Min)	460
Sea Water Full Strength	30 Sec (Max)	30	360 Sec (Min)	541
Sea Water Half Strength	45 Sec (Max)	43	300 Sec (Min)	390

Table 5. 28 ft² Fire Performance Solution Stability Test Results: Buckeye 3% AFFF.

PROPERTY MEASURED	EXTINGUISHMENT TIME CRITERIA	ACTUAL TIMES	BURNBACK TIME CRITERIA	ACTUAL TIMES
Fresh Water Full Strength	30 Sec (Max)	30	360 Sec (Min)	480
Sea Water Full Strength	30 Sec (Max)	28	360 Sec (Min)	425

3. The AFFF agents from the QPL, reference (c), used for the Compatibility Tests were from NRL stock, and are listed in Table 6. The Buckeye 3% was mixed individually with each of the 4 concentrates in a 1:1 volume ratio, and with all the 4 concentrates in a 1:1:1:1 volume ratio. These concentrate mixtures were aged in accordance with reference (b) and then used to prepare the solutions used for fire performance testing.

Table 6. 3% AFFF Agents from the Qualified Products List used in the Compatibility Fire Performance Test.

QUALIFIED AGENT	MANUFACTURER	LOT / BATCH	DATE OF MANUFACTURE
C-301 MS	Chemguard		
3EM	Chubb National Foam (CNF)	91175	May 1991
Ansul	Ansulite AFC-5A		
FC-203CE	Minnesota, Mining & Manufacturing, Co., (3M)		

Table 7. 28 ft² Fire Performance Concentrate Compatibility Test Results: 3% Aged Concentrates.

QUALIFIED AGENT	PROPERTY MEASURED	EXTINGUISH TIME CRITERIA	ACTUAL TIMES	BURNBACK TIME CRITERIA	ACTUAL TIMES
C-301 MS	Fresh Water	30 Sec (Max)	25	360 Sec (Min)	490
C-301 MS	Sea Water	30 Sec (Max)	25	360 Sec (Min)	535
3EM	Fresh Water	30 Sec (Max)	28	360 Sec (Min)	510
3EM	Sea Water	30 Sec (Max)	26	360 Sec (Min)	560
AFC-5A	Fresh Water	30 Sec (Max)	25	360 Sec (Min)	485
AFC-5A	Sea Water	30 Sec (Max)	27	360 Sec (Min)	530
FC203CE	Fresh Water	30 Sec (Max)	24	360 Sec (Min)	600
FC203CE	Sea Water	30 Sec (Max)	28	360 Sec (Min)	600
All of the Above	Fresh Water	30 Sec (Max)	25	360 Sec (Min)	505
All of the Above	Sea Water	30 Sec (Max)	35	360 Sec (Min)	570

4. Buckeye 3% BFC-3MS AFFF, 030403 is recommended for inclusion in the Qualified Products List (reference (c)) when the two (2) discrepancies listed in Paragraph 1 have been corrected.