



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

IN REPLY REFER TO:

6180-1130:JTL:mls
NRL Problem No.
61-0051-B-4
17 November 1983

From: Commanding Officer, Naval Research Laboratory
To: Commander, Naval Sea Systems Command (Code 55Z3)

Subj: Qualification of AFFF Liquid Concentrate Fire
Extinguishing Agents Manufactured by the 3-M Company;
results of

Ref: (a) NAVSEASYS COM ltr "Qualification Testing of Aqueous
Film Forming Foam Liquid Concentrate Fire Extinguishing
Agents Manufactured by 3-M Company, State Docks Road,
Decatur, Alabama 35601 and Chemolite Siding, Chemolite,
Minnesota 55133; Authorization of;" SEA 55Z31/PAP,
4123/24385, Ser 1519, dated 16 June 1983

Encl: (1) Two copies of subject report

1. In accordance with reference (a), the subject products have
been tested in order to determine compliance with the require-
ments of MIL-F-24385C. A report covering the work is forwarded
herewith as enclosure (1).

D. L. VENEZKY
By direction

Copy to: (w/1 copy encl (1))
NAVSEASYS COM (Code 0534)
(Code 996)
(Code 05DC4)
NAVWSUPCEN (Code 304E)
NAVMAT (Code 04F)

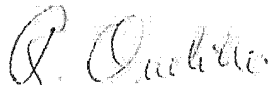
6180-1130A:JTL:mls
16 November 1983

Subj: Qualification Testing of AFFF Liquid Concentrate Fire
Extinguishing Agents Manufactured by the 3-M Company;
results of

Ref: (a) Military Specification MIL-F-24385C with Amendment 2

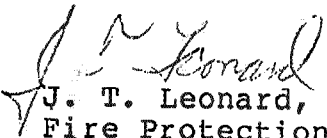
1. AFFF concentrates made by the 3-M Company and designated as FC-203CE (3%-type) and FC-206CE (6%-type) were tested in accordance with the procedures of and compliance with the requirements of reference (a).
2. The test data obtained are summarized in the attached tables.
3. Both candidate AFFF concentrates met the requirements of reference (a).


E. J. Jablonski
Hughes Associates, Inc.
Kensington, Maryland


R. Ouelette
Chesapeake Bay Detachment
NRL Code 2761


R. L. Gipe
Fire Protection Section
Combustion & Fuels Branch
Chemistry Division
NRL Code 6180


C. L. Whitehurst
Fire Protection Section
Combustion & Fuels Branch
Chemistry Division
NRL Code 6180


J. T. Leonard, Head
Fire Protection Section
Combustion & Fuels Branch
Chemistry Division
NRL Code 6180

Attachments
Test Results (11)

Encl (1) to NRL ltr.
6180-1130:JTL:mls
NRL Problem No.
61-0051-B-4

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by: 3M (FC-203CE - FC 206CE)

Para 3.3 Chemical & Physical Requirements for Concentrates

Requirement	Value	Results	
		203CE	206CE
Refractive index, minimum 3% type	1.3630	> 1.3630	X
6% type	1.3580	X	> 1.3580
Viscosity, centistokes			
maximum, 5°C, 3% Type	20	< 20	X
minimum, 25°C, 3% Type	2	> 2.0	X
maximum, 5°C, 6% Type	10	X	< 10
minimum, 25°C, 6% Type	2	X	> 2.0
Hydrogen ion concentration (pH)	7.0-8.5	7.96	7.99
Spreading coefficient, minimum	3	7.0	6.9
Foamability			
fresh water, minimum expansion	6.0	8.6	8.4
minutes, minimum drain time	2.5	4.3	4.6
sea water, minimum expansion	6.0	8.1	8.0
minutes, min drain time	2.5	4.5	4.6
Corrosion rate			
General, maximum			
steel, milli inches/yr	1.5	0.87	0.89
Cu-Ni, milli inches/yr	1.0	0.08	0.10
Ni-Cu, milli inches/yr	1.0	0.01	0.01
Bronze, milligrams	100	56	42
Localized CRES	No pits	No pits	No pits
Total halides, ppm, maximum, 3% type	500	31	X
6% type	250	X	13
Dry chemical compatibility,			
seconds, minimum	360	450	480
Environmental impact			
Toxicity, TC, mg/L, minimum			
50			
3% type	500	> 500	X
6% type	1000	X	> 1000
COD, mg/L, maximum, 3% type	1000K	798	X
6% type	500K	X	383
BOD /COD, minimum	0.9	> 0.9	> 0.9
20			

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by: 3M (FC-203CE - FC 206CE)

Para 3.4 Fire Performance

Requirement	Value	Results	
		203CE	206CE
28 ft ² fire test			
extinguishing time, seconds, maximum			
fresh water, half strength	45	42	37
full strength	30	26	22
sea water, half strength	45	30	33
full strength	30	22	22
quintuple strength	55	37	41
burnback time, seconds, minimum			
fresh water, half strength	300	468	396
full strength	360	420	474
sea water, half strength	300	462	384
full strength	360	528	582
quintuple strength	200	282	246
50 ft ² fire test			
extinguishing time, seconds, maximum	50	45	29
burnback time, sec, minimum	360	426	444
40-sec summation, minimum	320	334	365

3.3.4	Total fluorine, percent		2.1	1.07
5.1.1.1 (f)	Cap removal torque,			
	in-lbs, maximum	50		

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-203CE)

Para 3.33 Compatibility

Mixture 25/25/25/25 FC 203CE/FC-203/NaCl H₂O 3/ANIS AFCE

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.0	7.9	8.1	8.0
drain time, min, minimum	2.5	X	5.1	5.2	4.5	4.1
(b) Film formation	no ignit.	X	NO 1971	NO 1971	NO 1971	NO 1971
(c) Fire performance						
full strength						
ext time, sec, max	30	X	22	25	23	22
burnback, sec, min	360	X	522	504	456	504
(d) Stratification	none	NEVP	X	X	NOTE	NOTE
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-203CE)

Para 3.33 Compatibility

Mixture 50/50 FC-203CE / AMS AFC-5A

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.0	7.2	8.0	7.9
drain time, min, minimum	2.5	X	5.1	5.0	4.4	4.0
(b) Film formation	no ignit.	X	NO IGN	NO IGN	NO IGN	NO IGN
(c) Fire performance						
full strength						
ext time, sec, max	30	X	21	29	26	22
burnback, sec, min	360	X	558	516	456	468
(d) Stratification	none	None	X	X	None	None
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-203 CE)

Para 3.33 Compatibility

Mixture 50/50 FC203 CE / Ngt/ AOW-3

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.6	7.8	8.2	7.9
drain time, min, minimum	2.5	X	5.0	5.8	4.5	4.9
(b) Film formation	no ignit.	X	no ignit	no ignit	no ignit	no ignit
(c) Fire performance						
full strength						
ext time, sec, max	30	X	26	20	23	25
burnback, sec, min	360	X	510	594	486	474
(d) Stratification	none	none	X	X	none	none
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-203CE)

Para 3.33 Compatibility

Mixture 50/50 FC 203 CE / FC 203C

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.5	8.4	8.5	8.1
drain time, min, minimum	2.5	X	5.4	5.6	4.5	5.0
(b) Film formation	no ignit.	X	no ignit	no ignit	no ignit	no ignit
(c) Fire performance						
full strength						
ext time, sec, max	30	X	28	23	22	25
burnback, sec, min	360	X	510	510	468	492
(d) Stratification	none	none	X	X	none	none
(e) Precipitation,						
volume percent, max	<0.05	<0.05	X	X	<0.05	<0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3.11 (FC-206 CE)

Para 3.33 Compatibility

Mixture 25/25/25/2.5 FC 206-CE/FC 206/NaF/AQUO 6110/AN 5 A FC

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.3	7.4	7.5	7.4
drain time, min, minimum	2.5	X	4.8	4.9	4.5	4.8
(b) Film Formation	no ignit.	X	NO 192	NO 192	NO 192	NO 192
(c) Fire performance						
full strength						
ext time, sec, max	30	X	25	28	22	24
burnback, sec, min	360	X	474	540	498	46.8
(d) Stratification	none	none	X	X	NO 710	NO 710
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-206CE)

Para 3.33 Compatibility

Mixture 50/50 FC 206CE/Amsul AFC-5

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.3	7.7	8.0	7.7
drain time, min, minimum	2.5	X	4.9	4.8	4.8	4.6
(b) Film formation	no ignit.	X	no ign	no ign	no ign	no ign
(c) Fire performance						
full strength						
ext time, sec, max	30	X	23	21	22	23
burnback, sec, min	360	X	510	474	528	498
(d) Stratification	none	none	X	X	none	none
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-206CE)

Para 3.33 Compatibility

Mixture 50/50 FC 206 CE / Nat'l AOW 6 MD

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.2	7.8	8.0	6.9
drain time, min, minimum	2.5	X	4.5	4.5	4.1	4.1
(b) Film formation	no ignit.	X	no ign	no ign	no ign	no ign
(c) Fire performance						
full strength						
ext time, sec, max	30	X	25	26	25	24
burnback, sec, min	360	X	450	378	444	426
(d) Stratification	none	none	X	X	none	none
(e) Precipitation,						
volume percent, max	<0.05	<0.05	X	X	<0.05	<0.05

NAVAL RESEARCH LABORATORY
FIRE SUPPRESSION SECTION
 WASHINGTON, D.C. 20375

MIL-F-24385C Qualification Test Results

Submitted by 3M (FC-206 CE)

Para 3.33 Compatibility

Mixture 50/FC-206CE - 50/FC-206C

Requirement	Value	Liquid				
		Conc	Conc/ Fresh	Conc/ Sea	Fresh Premix	Sea Premix
(a) Foamability						
expansion, minimum	6.0	X	8.6	10.1	8.1	7.9
drain time, min, minimum	2.5	X	5.1	5.4	5.2	5.1
(b) Film formation	no ignit.	X	no ignit	no ignit	no ignit	no ignit
(c) Fire performance						
full strength						
ext time, sec, max	30	X	27	21	24	21
burnback, sec, min	360	X	444	480	570	468
(d) Stratification	none	none	X	X	none	none
(e) Precipitation,						
volume percent, max	< 0.05	< 0.05	X	X	< 0.05	< 0.05