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Ser 6180/0099

2 MAY 2016

From: Commanding Officer, Naval Research Laboratory  
To: Commander, Naval Sea Systems Command (SEA 05P5 S. Fletcher)

Subj: RESULTS OF MIL-F-24385F QUALIFICATION TESTING OF THE NATIONAL  
FOAM INCORPORATED AER-O-WATER 3EM-C6/TRIDOL-C6 M3 AFFF  
CONCENTRATE

Encl: (1) One copy of subject report

1. Enclosure (1) is forwarded for your information and retention.
2. This report provides results of the qualification testing for the National Foam Inc. Aer-O-Water 3EM-C6/Tridol-C6 M3 AFFF concentrate, which was evaluated against the MIL-F-24385F, "Fire Extinguishing Agent, Aqueous Film Forming Foam (AFFF) Liquid Concentrate for Fresh and Seawater" qualification standard. The Aer-O-Water 3EM-C6/Tridol-C6 M3 AFFF product met all of the fire extinguishment and burn back protection requirements of the MIL-F-24385F test standard. Based on these test results it is recommended that the Aer-O-Water 3EM-C6/Tridol-C6 M3 AFFF product be listed on the AFFF Qualified Products List (QPL).
3. The Naval Research Laboratory's point of contact is John P. Farley Code 6186, (202) 404-8459, e-mail: [john.farley@nrl.navy.mil](mailto:john.farley@nrl.navy.mil).

  
WARREN W. SCHULTZ  
By direction

Copy to:  
COMNAVSEASYSCOM (SEA 05P5 Hunstad)

6180/0099A:JPF  
02 May 2016

# **Results of Mil-F-24385F Qualification Testing of the National Foam Inc. Aer-O-Water 3EM- C6/Tridol-C6 M3 AFFF Concentrate**

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**Test results--Paragraphs denoted below refer to the applicable section  
of MIL-F-24385F**

**Paragraph 3.3 Chemical and Physical Requirements for Concentrates**

| <b>Property:</b>                                                         | <b>Type 3<br/>Criteria</b> | <b>Type 3<br/>Value</b> | <b>Pass/<br/>Fail</b> |
|--------------------------------------------------------------------------|----------------------------|-------------------------|-----------------------|
| Viscosity @25 °C cSt                                                     | ≥2                         | 2.21                    | Pass                  |
| Viscosity @5 °C cSt                                                      | ≤20                        | 4.21                    | Pass                  |
| Hydrogen Ion (pH)                                                        | 7-8.5                      | 8.09                    | Pass                  |
| Spreading Coefficient on<br>cyclohexane (dynes/cm)                       | ≥3.0                       | 6.76                    | Pass                  |
| Index of refraction                                                      | ≥1.3630                    | 1.3737                  | Pass                  |
| <b>Foamability (average of two measurements for each<br/>condition):</b> |                            |                         |                       |
| Fresh Water Expansion Ratio<br>(minutes)                                 | ≥5.0                       | 8.1                     | Pass                  |
| Fresh Water Drain Time<br>(minutes)                                      | ≥2:30                      | 6:37                    | Pass                  |
| Salt Water Expansion Ratio                                               | ≥5.0                       | 7.7                     | Pass                  |
| Salt Water Drain Time<br>(minutes)                                       | ≥2:30                      | 5:57                    | Pass                  |
| <b>Film Formation:</b>                                                   |                            |                         |                       |
| Full Strength Fresh                                                      | No<br>Ignition             | No<br>Ignition          | Pass                  |
| Full Strength Salt                                                       | No<br>Ignition             | No<br>Ignition          | Pass                  |
| <b>Corrosion Rate:</b>                                                   |                            |                         |                       |
| steel (10 <sup>-3</sup> inches/yr)                                       | ≤1.5                       | 0.82                    | Pass                  |
| Cu-Ni (10 <sup>-3</sup> inches/yr)                                       | ≤1.0                       | 0.16                    | Pass                  |
| Ni-Cu (10 <sup>-3</sup> inches/yr)                                       | ≤1.0                       | 0.004                   | Pass                  |
| Bronze (mg)                                                              | ≤100                       | 1.14                    | Pass                  |
| Localized pitting (Corrosion-<br>resistant steel)                        | No Pits                    | No Pits                 | Pass                  |
| Total Halides (ppm)                                                      | ≤500                       | <50                     | Pass                  |
| <b>Dry Chemical Compatibility:</b>                                       |                            |                         |                       |
| Burn Back time (s)                                                       | ≥360                       | 780                     | Pass                  |
| <b>Environmental Impact:</b>                                             |                            |                         |                       |
| Toxicity (LC <sub>50</sub> ) mg/L                                        | ≥500                       | ≤2000*                  | Pass                  |
| COD (g O <sub>2</sub> /L)                                                | ≤1000                      | 599                     | Pass                  |
| BOD <sub>20</sub> /COD                                                   | ≥0.65                      | 0.85                    | Pass                  |

N.O.\* = None Observed

NOTE\* – No fish (killifish (*Fundulus Heteroclitus*) mortality observed at concentrations ≤ 2000 mg/L for the Type 3 concentrate.

### Paragraph 3.3.2 Stability

| Property                                                                | Type 3<br>Criteria | Type 3<br>Value | Pass/<br>Fail |
|-------------------------------------------------------------------------|--------------------|-----------------|---------------|
| <b>Spreading Coefficient on cyclohexane (dynes/cm):</b>                 |                    |                 |               |
| using aged concentrate mixed with fresh water                           | $\geq 3.0$         | 4.12            | Pass          |
| using aged premix with fresh water                                      | $\geq 3.0$         | 5.92            | Pass          |
| using aged premix with salt water                                       | $\geq 3.0$         | 5.38            | Pass          |
| <b>Foamability using aged concentrate(average of two measurements):</b> |                    |                 |               |
| Fresh Water Expansion Ratio                                             | $\geq 5.0$         | 7.9             | Pass          |
| Fresh Water Drain Time (minutes)                                        | $\geq 2:30$        | 5:40            | Pass          |
| Salt Water Expansion Ratio                                              | $\geq 5.0$         | 7.7             | Pass          |
| Salt Water Drain Time (minutes)                                         | $\geq 2:30$        | 6:08            | Pass          |
| <b>Foamability using aged premix (average of two measurements):</b>     |                    |                 |               |
| Fresh Water Expansion Ratio                                             | $\geq 5.0$         | 8.8             | Pass          |
| Fresh Water Drain Time (minutes)                                        | $\geq 2:30$        | 4:57            | Pass          |
| Salt Water Expansion Ratio                                              | $\geq 5.0$         | 7.9             | Pass          |
| Salt Water Drain Time (minutes)                                         | $\geq 2:30$        | 5:45            | Pass          |
| <b>Film Formation:</b>                                                  |                    |                 |               |
| from aged concentrate, full strength, fresh water                       | no ignition        | no ignition     | Pass          |
| from aged concentrate, full strength, salt water                        | no ignition        | no ignition     | Pass          |
| from aged premix, full strength, fresh water                            | no ignition        | no ignition     | Pass          |
| from aged premix, full strength, salt water                             | no ignition        | no ignition     | Pass          |
| <b>Fire Performance:</b>                                                |                    |                 |               |
| Aged Concentrate, ½ strength, Fresh                                     |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 45$          | 45              | Pass          |
| Burn back time (s)                                                      | $\geq 300$         | 458             | Pass          |
| Aged Concentrate, ½ strength, Salt                                      |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 45$          | 35              | Pass          |
| Burn back time (s)                                                      | $\geq 300$         | 420             | Pass          |
| Aged Concentrate, full strength, Fresh                                  |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 30$          | 25              | Pass          |
| Burn back time (s)                                                      | $\geq 360$         | 574             | Pass          |
| Aged Concentrate, full strength, Salt                                   |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 30$          | 30              | Pass          |
| Burn back time (s)                                                      | $\geq 360$         | 590             | Pass          |
| Aged Premix, ½ strength, Fresh                                          |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 45$          | 45              | Pass          |
| Burn back time (s)                                                      | $\geq 300$         | 473             | Pass          |
| Aged Premix, ½ strength Salt                                            |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 45$          | 39              | Pass          |
| Burn back time (s)                                                      | $\geq 300$         | 577             | Pass          |
| Aged Premix, full strength, Fresh                                       |                    |                 |               |
| Extinguishment time (s)                                                 | $\leq 30$          | 27              | Pass          |
| Burn back time (s)                                                      | $\geq 360$         | 596             | Pass          |
| Aged Premix, full strength, Salt                                        |                    |                 |               |

|                         |      |     |      |
|-------------------------|------|-----|------|
| Extinguishment time (s) | ≤30  | 27  | Pass |
| Burn back time (s)      | ≥360 | 590 | Pass |

| Property                                      | Type 3 Criteria | Type 3 Value | Pass/Fail |
|-----------------------------------------------|-----------------|--------------|-----------|
| <b>Stratification:</b>                        |                 |              |           |
| using aged concentrate mixed with fresh water | N.O.*           | N.O.*        | Pass      |
| using aged premix with fresh water            | N.O.*           | N.O.*        | Pass      |
| using aged premix with salt water             | N.O.*           | N.O.*        | Pass      |
| <b>Precipitation (vol%):</b>                  |                 |              |           |
| using aged concentrate mixed with fresh water | ≤0.05           | N.O.*        | Pass      |
| using aged premix with fresh water            | ≤0.05           | N.O.*        | Pass      |
| using aged premix with salt water             | ≤0.05           | N.O.*        | Pass      |

N.O.\* = None Observed.

### Paragraph 3.3.3 Compatibility

#### Mixture: Aer-O-Water 3EM-C6/ National<sup>1</sup> (50/50) (Type 3)

| Requirement                                                             | Criteria    | Value       | Pass/Fail |
|-------------------------------------------------------------------------|-------------|-------------|-----------|
| <b>Stratification:</b>                                                  |             |             |           |
| using aged concentrate                                                  | N.O.*       | N.O.*       | Pass      |
| <b>Precipitation (vol%):</b>                                            |             |             |           |
| using aged concentrate                                                  | ≤0.05       | N.O.*       | Pass      |
| <b>Foamability using aged concentrate(average of two measurements):</b> |             |             |           |
| Fresh Water Expansion Ratio                                             | ≥5.0        | 8.4         | Pass      |
| Fresh Water Drain Time (minutes)                                        | ≥2:30       | 5:50        | Pass      |
| Salt Water Expansion Ratio                                              | ≥5.0        | 7.4         | Pass      |
| Salt Water Drain Time (minutes)                                         | ≥2:30       | 5:46        | Pass      |
| <b>Film Formation:</b>                                                  |             |             |           |
| from aged concentrate, ½ strength, fresh water                          | no ignition | no ignition | Pass      |
| from aged concentrate, ½ strength, salt water                           | no ignition | no ignition | Pass      |
| <b>Fire Performance:</b>                                                |             |             |           |
| Aged Concentrate, fresh water                                           |             |             |           |
| Extinguishment time (s)                                                 | ≤30         | 27          | Pass      |
| Burn back time (s)                                                      | ≥360        | 570         | Pass      |
| Aged Concentrate, salt water                                            |             |             |           |
| Extinguishment time (s)                                                 | ≤30         | 29          | Pass      |
| Burn back time (s)                                                      | ≥360        | 548         | Pass      |

\*N.O. = None Observed.

<sup>1</sup> National 3%-3EM Lot L11360, 10/11

**Mixture: Aer-O-Water 3EM-C6 / Chemguard<sup>2</sup> (50/50) (Type 3)**

| Requirement                                                             | Criteria       | Value          | Pass/<br>Fail |
|-------------------------------------------------------------------------|----------------|----------------|---------------|
| <b>Stratification:</b>                                                  |                |                |               |
| using aged concentrate                                                  | N.O.*          | N.O.*          | Pass          |
| <b>Precipitation (vol%):</b>                                            |                |                |               |
| using aged concentrate                                                  | ≤0.05          | N.O.*          | Pass          |
| <b>Foamability using aged concentrate(average of two measurements):</b> |                |                |               |
| Fresh Water Expansion Ratio                                             | ≥5.0           | 7.8            | Pass          |
| Fresh Water Drain Time (minutes)                                        | ≥2:30          | 5:55           | Pass          |
| Salt Water Expansion Ratio                                              | ≥5.0           | 7.55           | Pass          |
| Salt Water Drain Time (minutes)                                         | ≥2:30          | 5:33           | Pass          |
| <b>Film Formation:</b>                                                  |                |                |               |
| from aged concentrate, ½ strength, fresh water                          | no<br>ignition | no<br>ignition | Pass          |
| from aged concentrate, ½ strength, salt water                           | no<br>ignition | no<br>ignition | Pass          |
| <b>Fire Performance:</b>                                                |                |                |               |
| Aged Concentrate, fresh water                                           |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 28             | Pass          |
| Burn back time (s)                                                      | ≥360           | 498            | Pass          |
| Aged Concentrate, salt water                                            |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 26             | Pass          |
| Burn back time (s)                                                      | ≥360           | 580            | Pass          |

\*N.O. = None Observed.

**Mixture: Aer-O-Water 3EM-C6 / Ansul<sup>3</sup> (50/50) (Type 3)**

| Requirement                                                             | Criteria       | Value          | Pass/<br>Fail |
|-------------------------------------------------------------------------|----------------|----------------|---------------|
| <b>Stratification:</b>                                                  |                |                |               |
| using aged concentrate                                                  | N.O.*          | N.O.*          | Pass          |
| <b>Precipitation (vol%):</b>                                            |                |                |               |
| using aged concentrate                                                  | ≤0.05          | N.O.*          | Pass          |
| <b>Foamability using aged concentrate(average of two measurements):</b> |                |                |               |
| Fresh Water Expansion Ratio                                             | ≥5.0           | 8.2            | Pass          |
| Fresh Water Drain Time (minutes)                                        | ≥2:30          | 5:11           | Pass          |
| Salt Water Expansion Ratio                                              | ≥5.0           | 7.3            | Pass          |
| Salt Water Drain Time (minutes)                                         | ≥2:30          | 5:10           | Pass          |
| <b>Film Formation:</b>                                                  |                |                |               |
| from aged concentrate, ½ strength, fresh water                          | no<br>ignition | no<br>ignition | Pass          |
| from aged concentrate, ½ strength, salt water                           | no<br>ignition | no<br>ignition | Pass          |
| <b>Fire Performance:</b>                                                |                |                |               |
| Aged Concentrate, fresh water                                           |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 30             | Pass          |
| Burn back time (s)                                                      | ≥360           | 416            | Pass          |
| Aged Concentrate, salt water                                            |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 27             | Pass          |
| Burn back time (s)                                                      | ≥360           | 510            | Pass          |

<sup>2</sup> Chemguard 3%-C301 MS, 9/23/11

<sup>3</sup> Ansul 3% AFC5A, Lot 4212, 8/14

**Mixture: ¼ Aer-O-Water 3EM-C6 /National /Ansul/ Chemguard (Type 3)**

| Requirement                                                             | Criteria       | Value          | Pass/<br>Fail |
|-------------------------------------------------------------------------|----------------|----------------|---------------|
| <b>Stratification:</b>                                                  |                |                |               |
| using aged concentrate                                                  | N.O.*          | N.O.*          | Pass          |
| <b>Precipitation (vol%):</b>                                            |                |                |               |
| using aged concentrate                                                  | ≤0.05          | N.O.*          | Pass          |
| <b>Foamability using aged concentrate(average of two measurements):</b> |                |                |               |
| Fresh Water Expansion Ratio                                             | ≥5.0           | 8.4            | Pass          |
| Fresh Water Drain Time (minutes)                                        | ≥2:30          | 5:09           | Pass          |
| Salt Water Expansion Ratio                                              | ≥5.0           | 7.6            | Pass          |
| Salt Water Drain Time (minutes)                                         | ≥2:30          | 5:57           | Pass          |
| <b>Film Formation:</b>                                                  |                |                |               |
| from aged concentrate, ½ strength, fresh water                          | no<br>ignition | no<br>ignition | Pass          |
| from aged concentrate, ½ strength, salt water                           | no<br>ignition | no<br>ignition | Pass          |
| <b>Fire Performance:</b>                                                |                |                |               |
| Aged Concentrate, fresh water                                           |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 29             | Pass          |
| Burn back time (s)                                                      | ≥360           | 517            | Pass          |
| Aged Concentrate, salt water                                            |                |                |               |
| Extinguishment time (s)                                                 | ≤30            | 30             | Pass          |
| Burn back time (s)                                                      | ≥360           | 584            | Pass          |

\*N.O. = None Observed

**Paragraph 3.4 Fire Performance**

|                                       | Type 3<br>requirement | Type 3<br>Value | Pass/<br>Fail |
|---------------------------------------|-----------------------|-----------------|---------------|
| <b>28 ft² Extinguishment Time (s)</b> |                       |                 |               |
| Fresh Water ½ strength                | ≤45                   | 31              | Pass          |
| Fresh Water full strength             | ≤30                   | 27              | Pass          |
| Salt Water ½ strength                 | ≤45                   | 30              | Pass          |
| Salt Water full strength              | ≤30                   | 29              | Pass          |
| Salt Water Quintuple Strength         | ≤55                   | 34              | Pass          |
| <b>Burn Back Time (s)</b>             |                       |                 |               |
| Fresh Water ½ strength                | ≥300                  | 481             | Pass          |
| Fresh Water full strength             | ≥360                  | 624             | Pass          |
| Salt Water ½ strength                 | ≥300                  | 625             | Pass          |
| Salt Water full strength              | ≥360                  | 694             | Pass          |
| Salt Water Quintuple Strength         | ≥200                  | 388             | Pass          |
| <b>50 ft² Fire Test (Salt Water)</b>  |                       |                 |               |
| Extinguishment time (s)               | ≤50                   | 42*             | Pass          |
| Burn back time (s)                    | ≥360                  | 443             | Pass          |
| 40 second summation                   | ≥320                  | 324*            | Pass          |

NOTE\*: Type 3 extinguishment time and summation figures were slightly impacted by ignition of the firefighter's Flash Hood due to thermal radiation, which affected firefighting actions.

Additional Measurements:

- (1) – Container cap torque test results: Type 3 container 32 in/lbs.
- (2) – Total Fluorine: Aero-O-Water C6 3EM; 0.898% (GLI Procedure E9-3).

