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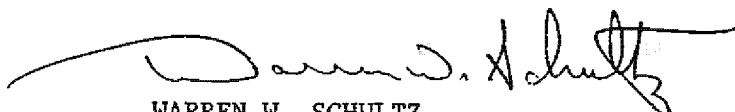
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From: Commanding Officer, Naval Research Laboratory
To: Commanding Officer, Naval Facilities Engineering Service Center, Port Hueneme,
CA (Code ESC421 R. Lee)

Subj: TEST PLAN FOR THE FIRE FIGHTING PERFORMANCE OF A
FLUOROSURFACTANT-FREE ALTERNATIVE TO AQUEOUS FILM FORMING
FOAM (AFFF): INITIAL EVALUATION OF 3M RF3

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2. The Naval Research Laboratory point of contact is Dr. Ronald Sheinson, Code 6185, (202) 404-8101 and email Sheinson@code6185.nrl.navy.mil.


WARREN W. SCHULTZ
By direction

Copy to:
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COMNAVSEASYSCOM (Code 05P4 D. McCrory, D. Baryliski)
OPNAV (Code N762M2 T. Harmon)

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**TEST PLAN FOR THE FIRE FIGHTING PERFORMANCE OF A
FLUOROSURFACTANT-FREE ALTERNATIVE TO AQUEOUS FILM
FORMING FOAM (AFFF): INITIAL EVALUATION OF 3M RF3**

Ronald S Sheinson
Navy Technology Center for Safety and Survivability
Chemistry Division

Scott Ayers
Geo-Centers, Inc., Arlington, VA

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Test Plan for the Fire Fighting Performance of a Fluorosurfactant-Free Alternative To Aqueous Film Forming Foam (AFFF): Initial Evaluation of 3M RF3

Introduction

The discontinuation of perfluoro-octanyl sulfate (PFOS) based chemistry by the 3M Company sent ripples through the fire fighting community. PFOS chemistry was found to be environmentally persistent, bio-accumulative, and toxic. 3M used this technology to produce its Military Specification MIL-F-24385F (MilSpec) [1] certified aqueous film forming foam (AFFF). 3M has been a major supplier of AFFF to the Department of Defense since AFFF's joint development with NRL in the 1960s, but due to environmental concerns 3M has withdrawn their AFFF products. In fact, the Environmental Protection Agency placed PFOS-based chemicals under a Significant New Use Rule and is investigating potential environmental issues for other chemistries used to produce the remaining MilSpec qualified AFFFs. Further, the European Union, United Kingdom, and Australia placed controls on fire-fighting foams, and proposed regulations are increasingly restrictive. These events have led the Naval Facilities Engineering Service Center and the Navy Technology Center for Safety and Survivability of the Naval Research Laboratory (NRL) to study new, less environmentally damaging fire-fighting foam options including fluorosurfactant-free foams.

Fluorosurfactant-free fire fighting foam formulas do not carry the burden of extremely long-lived components and degradation products. Hence, they do not have the same persistence and bioaccumulation concerns, as the current AFFF formulations.

Objective

The objective of this work is to evaluate the fire suppression performance of fluorosurfactant-free foam under MilSpec protocols. This is accomplished by evaluating the time of extinguishment and burn-back protection for both the 28 ft² and 50 ft² fires as specified in MIL-F-24385F. The long-term goal is to find a significantly less environment-damaging, fire-fighting foam that will be able to satisfy the fire suppression performance criteria set forth in the MilSpec. The short term goal is to determine the degree to which a fluorosurfactant free fire fighting foam can approach the fire suppression performance criteria in the MilSpec for a limited specification sub-set of tests.

Technical Approach

The fire tests will be conducted at NRL's Chesapeake Bay Section near Chesapeake Beach, Maryland. A large open space building with an exhaust hood capable venting the products of the fire will be used for the 28 ft² pan fire tests. The 50 ft² pan fires will be conducted outside when atmospheric conditions permit. The tests will follow the MilSpec fire performance tests [1].

Automobile quality unleaded gasoline (87 octane) will be used as the fire fuel for most of the tests. Some tests will use JP-5 as the fire fuel to explore applicability for ground based aircraft support facilities. The 28 ft² tests will use 10 gallons of fuel while the 50 ft² tests will use 15 gallons. The fuel will be poured on top of a thin layer of water approximately ½ inch thick at the shallowest point to create a level surface. A MilSpec-test experienced fire fighter will apply the fluorosurfactant-free foam at a rate of 2 gpm. A foam is successful in meeting the MilSpec performance requirements if the fire can be extinguished in the established time allotted for the test. This test series will evaluate how closely the performance of the foams approach the MilSpec standard requirements.

With successful extinguishment in the 28 ft² tests, the fire fighter continues to apply foam for a total time of 90 seconds (including suppression time) in preparation for the burn-back test. The burn-back test utilizes 1 gallon of gasoline in a 1 ft diameter pan with a 2 inch tall wall. The fuel in this pan is ignited and placed in the center of the foam within 1 minute of ending foam application. The time that the fire needs to reestablish in the larger pan and reach 25 % of the original size is recorded. If the time is 6 minutes or more in the full strength in both the 28 ft² and 50 ft² pans, the foam successfully passes the MilSpec performance requirements. If the time is 5 minutes or more in the 28 ft² pan half strength test, the foam successfully passes the MilSpec performance requirements. These tests are conducted to determine the fire-deterrence of the foam blanket.

Table 1 MilSpec Success Criteria

Fire Area	Foam Strength	Extinguishment time	Burn-back
28 ft ²	Full	≤ 30 seconds	≥ 6 minutes
28 ft ²	Half	≤ 45 seconds	≥ 5 minutes
50 ft ²	Full	≤ 50 seconds	≥ 6 minutes

Test Parameters

The foam solutions and the fire pan size will be the variables in the tests, as given in Table 2. Fluorosurfactant-free concentrate types of 3 % and 6 % will be tested. Foams will be mixed for selected conditions of fresh and salt water at normal and half-strength blends. 3M fire fighting foam product RF3, a concentrate intended to be used at 3 per cent concentration in water, is the primary focus of this task. Some tests will be conducted with a MilSpec certified AFFF for test control purposes. Limited testing of 3M fire fighting foam product RF6, a concentrate intended to be used at 6 per cent concentration in water, will be conducted for comparison. Limited evaluation of performance on JP-5 fuel fires will also be conducted.

Table 2 Test Conditions Matrix

Test Condition	Water Salinity	Foam Strength	Fire Area
1	fresh	full	28 ft ²
2	fresh	half	28 ft ²
3	Salt	full	28 ft ²
4	Salt	half	28 ft ²
5	fresh	full	50 ft ²
6	Salt	full	50 ft ²

Test Procedure

The test team will consist of at least three members. The test director will record the test results and time the suppression and burn-back. This individual will be responsible for ensuring the quality of the results and be responsible for the safety of the test team, observers, and general facility. The fire fighter will apply the foam and conduct the burn-back test. Test team members will pour and ignite the gasoline, mix the foam solutions, and perform any other tasks that the test director or the fire fighter deem necessary to complete the testing. Observers, if any, will be required to follow directions from any member of the test team.

The test procedure will begin with the preparation of the necessary fuel amounts. An approximate ½ inch layer of water will be poured into the test pan. The foam solution for the upcoming test will be prepared as per the instructions of the test director. The foam application nozzle will be calibrated to 2 gpm at the beginning and end of each day. The solution will be poured into the holding tank, and the tank will then be pressurized. The fire fighter will prepare for suppression testing, the fuel will be poured into the pan in less than 30 seconds and then ignited within 30 more seconds. The test director will count down the 10 second pre-burn after which the experiment will begin and the fire fighter will commence to suppress the fire. If the fire is considered successfully extinguished, the burn-back test will be conducted.

The burn-back procedure will have a member of the test team prepare the 1 ft pan with gasoline and ignite it as the fire fighter finishes applying the additional foam to the fire test pan. The fire fighter will use a rod to pick up the smaller pan and place it in the center of the larger pan. At the moment the small burning pan is placed into the foam filled pan the test director will begin timing the burn-back. Once the burn-back evaluation has been completed, the fire fighter will apply foam until the fire is extinguished and the contents of the pan will be removed and flushed out and preparation for the next test will commence.

Following each test the contents of the fire pan, foam, fuel and water, including flush water, will be pumped to the collection pit. Once the foam from accumulated test wastes of each day of testing has sufficiently diminished, the pit contents will be pumped into the holding tank for subsequent collection and environmentally acceptable disposal.

Testing Specifics

This is an initial fire fighting performance evaluation of 3M RF3 fire fighting foam under controlled MilSpec specified test protocols. Evaluation will not include the complete fire performance evaluation matrix. Typically two or three tests each for selected variables will be conducted to obtain reproducibility of results. Burn-back tests will be conducted as judged suitable at the time of testing. The intended test sequence, subject to modification based on results from the prior tests, is given in Table 3.

Table 3 Specific Test Matrix

Testing Sequence	Foam	Water Salinity	Foam Strength	Fire Area	Fuel
1	RF3	Fresh	Full	28 ft ²	Gasoline
2	AFFF	Fresh	Full	28 ft ²	Gasoline
3	RF3	Fresh	Half	28 ft ²	Gasoline
4	RF6	Fresh	Full	28 ft ²	Gasoline
5	RF3	Fresh	Full	28 ft ²	JP-5
6	AFFF	Fresh	Full	28 ft ²	JP-5
7	RF3	Salt	Full	28 ft ²	Gasoline
8	RF3	Salt	Half	28 ft ²	Gasoline
9	RF3	Fresh	Full	50 ft ²	Gasoline
10	AFFF	Fresh	Full	50 ft ²	Gasoline
11	RF3	Fresh	Half	50 ft ²	Gasoline

Safety

The test team and observers will be required to wear long sleeves and pants as well as hard soled shoes. The fire fighter will wear full turnout gear with a specialized helmet when fighting the fire. Two AFFF fire extinguishers will be present as a secondary suppression means. Radiation shield panels will be set up prior to testing so that personnel may be protected from the thermal radiation from the fire. The building doors will be opened and the exhaust hood will be engaged to vent the space following each test. The doors will be closed and the hood disengaged during the test, so as not to cause drafts that could affect test results.

Reference

[1] United States Military Specification "Fire Extinguishment Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water," MILSPEC MIL-F-24385F, 7 January 1992.