

NRL RESPONSE TO 19392C4 – FIREFIGHTING FOAM INQUIRY

**John P. Farley (Code 6186)
Naval Research Laboratory
Washington, DC 20375-5342**

INTRODUCTION: This information paper has been prepared by the Naval Research Laboratory (NRL) to discuss the potential problems the U.S. DoD may encounter by substituting military specification (MILSPEC) MIL-F-24385F Aqueous Film Forming Foam (AFFF) products with commercial-off-the-shelf (COTS) fluorine-free foam (F3) products, and to provide specific comment to a list of questions provided by Ms. Whitney Verett (Legislative Director) for Congressman Michael D. Rogers (Third District of Alabama).

QUESTION 1 – RESPONSE: With regard to the suitability of the available COTS F3 products, previous NRL MILSPEC AFFF fire testing has demonstrated that the present F3 formulations do not conform to the MIL-F-24385F standard, and cannot be used as an AFFF substitute in U.S. DoD applications which require MILSPEC AFFF. The principle reasons for this are:

a. MIL-F-24385F explicitly states that AFFF must be able to produce an aqueous film with a positive spreading coefficient on the surface of a burning liquid. In addition, it requires that all qualified products be cross-compatible (two or more products mixed in any proportions must maintain the same firefighting performance). Cross-compatibility with several AFFF formulations already listed on the Qualified Product Database (QPD) would be difficult to achieve for an F3 product.

b. An extinguishment time as short as possible is critical for crew safety, mission restoration, and vital capital asset fire protection, especially considering the hazardous conditions posed when there may be ordnance present. Currently there are no COTS F3 products that can meet the MIL-F-24385F firefighting extinguishment performance standard. Additionally, since the extinguishment time for COTS F3 products are inherently slower in comparison to AFFF, the application rate would have to be increased, which would result in greater system costs and higher weight penalties for ship classes, which tend to be weight critical by design.

c. Beyond firefighting extinguishment performance, MIL-F-24385F additionally mandates specific chemical and physical requirements to ensure the candidate foam products are compatible with existing military foam proportioning systems and firefighting appliances. The current F3 products have demonstrated potential problematic issues with regard to their concentrate viscosity, sea water compatibility, their ability to function with non-aspirating nozzles, and will have increased acute toxicity to aquatic life forms, particularly fish, due to their higher levels of hydrocarbon surfactants in comparison to AFFF.

Question 2 – RESPONSE: Enclosure (1) provides specific comment to the provided Military Specification 24385F Aqueous Film Forming Foam (AFFF) Concentrate questionnaire.

The Naval Research Laboratory's points of contact are John P. Farley, Code 6186, (202) 404-8459, e-mail: john.farley@nrl.navy.mil and Dr. Bradley A. Williams, Code 6185, (202) 767-3583, e-mail: bradley.williams@nrl.navy.mil.

MILITARY SPECIFICATION 24385F
AQUEOUS FILM FORMING FOAM (AFFF) CONCENTRATE – NAVY RESPONSE

ISSUE: The current military specification for firefighting foams mandates the use of fluorinated chemicals that are harmful to military personnel and the environment. New technologies are available that avoid these risks, but the specification has not been updated to allow their use. What must be done to correct this situation?

- Original Military Specification Issued in the 1970's.

COMMENT: Essentially correct; AFFF was first introduced into the Navy in 1970 (original MILSPEC (MIL-F-23905) was published on 01 Nov 1963 and was replaced with MIL-F-24385 on 21 Nov 1969).

- Current Military Specification for firefighting foam dated August, 1994 (F Version)

COMMENT: Correct.

- Requires all Products on the **Qualified Products List (QPL)** to contain fluorinated chemicals, which was the state of the art in the 1960's.

COMMENT: The current AFFF MILSPEC is specific for film forming agents, which provides rapid extinguishment (i.e., creates a vapor barrier at the fuel/foam surface interface and also limits fuel transport through the foam blanket) and explicitly specifies the use of a fluorosurfactant to enable film formation. To date no Fluorine Free Foam (F3) product has demonstrated the ability to extinguish flammable liquid pool fires as quickly as required by the MIL-F-24385F specification for AFFF.

- The Specification does not allow for newer alternative technologies that are safer and less expensive

COMMENT: Alternative Class B (flammable liquid) foaming agent technologies have not been able to provide the requisite safety margins that are inherent to MILSPEC AFFF.

COMMENT (SAFETY): The principle DoD safety concerns relate to limiting personnel exposure to large unconfined fires, which may include ordnance, flight crew rescue, and limiting damage (both primary and secondary) to vital Fleet assets.

COMMENT (COST): The supply system price for MILSPEC AFFF concentrate is approximately \$63.00/5 gallon pail. The cost to DoD is actually less. Additionally, the cost of MILSPEC AFFF concentrate is very low in comparison to the vital assets, which they are expected to protect. Also, the MILSPEC requirement that vendor products be compatible with one another allows for greater competition among the qualified vendors and allows DoD to award contracts for MILSPEC AFFF based on best value. This compatibility is also essential to Fleet logistics.

- Specific problems with current specification:
 - The fluorinated chemicals used in current Military Specification are:
 - Environmentally Persistent
 - Bio accumulative
 - Toxic

COMMENT: All AFFF (both MILSPEC AFFF and UL 162 commercial AFFF) products contain fluorosurfactants, which are environmentally persistent as a class. Perfluorooctane Sulfonate (PFOS) is a specific class used in the original MILSPEC AFFF formulation, but its use was discontinued in the early 2000's by the U.S. EPA due to the PBT combination.

- Fluorinated foams will remain in the environment for centuries, no biodegradation

COMMENT: AFFF "concentrate" typically contains 2% fluorosurfactant, 2-5% hydrocarbon surfactant, and 15-20% solvents. The rest of the formulation is water (78-81%). This means that 98% of AFFF "concentrate" is biodegradable. NOTE: The DoD does not introduce AFFF "concentrate" into the environment. What is introduced into the environment are AFFF "solutions" Type 6 (94% water and 6% AFFF concentrate) and Type 3 (97% water and 3% AFFF concentrate). Therefore, considering the true amount of water and organic material (fluorosurfactant/hydrocarbon surfactant/solvents) present results in a finding that the AFFF solution introduced into the environment is 99.9% biodegradable. That said, considering 50 years of legacy emissions and any additional AFFF introduction there is a valid concern since there is no straightforward treatment approach once fluorosurfactants have been dispersed into the environment. The DoD Strategic Environmental R&D program (SERDP) has funded several research programs to characterize the types and occurrence of fluorosurfactant contamination and to develop remediation technology remedies.

- The 2015 USEPA Voluntary Stewardship Program targets:
 - Elimination (99.9%) of Toxic Fluorosurfactants
 - 2015 Compliance Date
 - All Current QPL Products must be re-qualified to Comply
 - Military Firefighters cannot conduct live training with Fluorinated Foams due to the safety and environmental concerns. The resulting lack of live fire training affects preparedness

COMMENT: Perfluorooctanoic Acid (PFOA), sometimes called "C8", is not present in MILSPEC AFFF's, but in some cases, the fluorochemical surfactants in AFFF can degrade into PFOA in the environment. The key factor for this to occur is the presence of an eight-carbon fluorinated "tail" on the surfactant molecule, which is biologically accumulative. The non-PFOS fluorosurfactants currently used in AFFF have used a fluorosurfactant, synthesized by telomerization (a polymerization process producing extremely short chains) that predominately have a six-carbon tail, which cannot form PFOA. The current U.S. EPA PFOA Stewardship Program has established a goal to eliminate PFOA, PFOA precursors, and related higher homologue chemicals from emissions and products including AFFF by end of 2015. In short, current MILSPEC AFFF products do not contain PFOS, and will not contain significant materials capable of degrading into PFOA, but they do contain fluorochemicals, which are environmentally persistent.

COMMENT (RECENTLY QUALIFIED MILSPEC AFFF): The most recent MILSPEC AFFF product approved by NAVSEA has been the first MILSPEC AFFF product to meet both the U.S. EPA PFOA Stewardship Program requirements and all of the requirements stipulated within the MIL-F-24385F specification.

COMMENT (MILITARY TRAINING): Due to environmental concerns, military firefighting training facilities use propane fires, which eliminates the use of Class A (combustible solid), pooled Class B (flammable liquid), and Class C (electrical) fuel sources. As a result, there is no need to use AFFF during firefighting training evolutions, water only or water with a foam simulant is used. This does not impact

firefighting training effectiveness since the goal is to provide the students with firefighting equipment familiarization and to focus on proper firefighting doctrine (tactics & procedures). Additionally, all foam manufacturers market a foam simulant that is recommended for training. This helps to limit the induction of foaming agents into municipal water treatment plants, which can affect their operation.

- Military Specification foam is the most expensive of all firefighting foams
 - Fluorine is the most expensive ingredient
 - Military Specification foam requires the greatest level of fluorine
 - Military Specification foam is the most environmentally persistent of all foams

COMMENT (COST): The cost of MILSPEC AFFF has been previously addressed.

I understand that there are newer technologies available that avoid these problems, but those products are not allowed under the outdated specification:

COMMENT: Though the specification has not been updated since 1994, the performance requirements within are not outdated. The inherent risk, especially on Flight Decks, where aircraft movement, fueling, and weapons loading all occur in very close proximity, warrants the rapid extinguishment times that the MILSPEC requires.

- Re-Healing Fluorine Free Firefighting Foam
 - 100% Biodegradable
 - More effective in fighting fires, extinguishes more rapidly and requires less reapplication than fluorinated foams
 - Globally Approved to all current International Standards
 - UL, FM, ICAO, EN, ULC, SSL, Among others
- Fluorine Free foam does not expose Military Personnel to dangerous PBT Chemicals
- Lack of fluorine allows live exercises that improve readiness
- Because of lack of fluorine, cost is significantly less
- Sample list of Current Customers:
 - Statoil Norway
 - ConocoPhillips
 - British Petroleum
 - All Australian Airports
 - Copenhagen, Frankfurt, Dubai, Manchester Airports
 - a. Enbridge
 - b. Flint Hills Refinery
 - c. Alert Disaster Control

COMMENT: NRL is well aware of the Solberg® (formerly 3-M Australia) Re-Healing™ foam products, which are non-fluorinated foam with polysaccharide thickeners, which are designed to have mechanical properties to compensate for the lack of film formation. Under a previous Cooperative Agreement with 3-M Australia and with the current Non-Disclosure Agreement between NRL and Amerex Corporation, NRL has been conducting fire testing and laboratory studies to help further investigate the potential possibilities for developing a fluorine-free product that could meet the MILSPEC AFFF fire performance requirements. Although the Solberg® products are superior to other F3 foams tested at NRL, they still fail to meet the MIL-F-24385F 28 ft² fire performance test at full strength. Since the products have not been successful at the 28 ft² fire performance test at full strength, NRL has not pursued additional test

requirements that include the 28 ft² ½ strength testing, 28 ft² testing (full and ½ strength) with aged concentrate, 28 ft² testing (full and ½ strength) with aged solutions, 28 ft² testing for cross-compatibility, 28 ft² quintuple test or the requisite 50 ft² fire performance test. In addition, the AFFF MILSPEC has several other key requirements that must be considered, including compatibility among vendors, dry chemical compatibility, burn back, and viscosity. Integration and compatibility with existing installed AFFF systems and equipment will also be a factor.

COMMENT: Although Solberg® has been somewhat successful in the commercial market, the western foreign Navies, USCG military vessels, and the FAA still relies on MILSPEC AFFF and requires their use for Class B (flammable liquid) fire applications where rapid extinguishing performance is mandated.

What can be done to modify the specification to allow fluorine alternatives?

COMMENT: The DON research community will continue to investigate the potential options to include Fluorinated AFFF, Fluorine-Free Foams or a Fluorine-Free AFFF that may include the development of a new class of silicone-based surfactants.