U.S. NAVAL RESEARCH LABORATORY

Fluorine-Free Foam (F3) Military Specification Development

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The FY20 National Defense Authorization Act (NDAA) established the requirement to develop and publish a new military specification for fluorine-free firefighting agents for use at all military installations no later than January 31, 2023.
As a result of this Congressional mandate, NRL initiated an Environmental Security and Technology Certification Program (ESTCP), which resulted in the establishment of the WP20-5373 “Fluorine-Free Foam (F3) Military Specification Development” program. The WP20-5373 program was executed in two phases:

- Collect a comprehensive firefighting performance and chemical/physical properties data set for the selected commercially available F3 products.
- Conduct a detailed analysis of the collected data to determine the parameters that could be used to qualify F3 firefighting agents for DoD landbased military applications.

15. SUBJECT TERMS

Fluorine-Free Foam, F3, Military Specification Development, AFFF, PFAS, PFAS-free alternative

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NRL-CBD 28ft^2 Fire Test

NRL-CBD 50ft^2 Fire Test

PHASE I FIREFIGHTING OBSERVATIONS & FINDINGS: The following list provides a high-level overview of the observations and findings from the Phase I firefighting performance testing:

- The fire extinguishing capabilities of the leading commercially available F3s were less than that of MILSPEC AFFFs. Specifically, none of the F3s could meet the AFFF MILSPEC fire extinguishing performance requirements as currently written. This finding was not surprising since the F3 product surfactants are hydrocarbon-based and not oleophobic, like the fluorocarbon-based surfactants found in AFFF, allowing more vapor transport through the foam blanket to the fire.
- It was determined that the selected F3s had similar fire extinguishment capabilities against the 28 ft^2 fire tests.
- The low viscosity F3s had reduced burnback resistance capability for the gasoline fueled fires in comparison to AFFF and the high viscosity F3s. However, the burnback resistance of the low viscosity F3s products are still considered adequate for DoD land-based applications.
- All five F3s demonstrated consistent fire extinguishing capabilities over the range of concentrations from half strength to quintuple strength solutions.
- All five F3s demonstrated similar fire extinguishing capabilities with reduced aspiration.
- None of the F3s showed any signs of degradation in fire extinguishing capability when the foam concentrate was aged before use.

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LARGE-SCALE F3 VALIDATION TESTS: Large-Scale validation tests were conducted using both handline and foam turret operations at the NAWCWD-China Lake fire test facility:

- ✓ The spill fire tests included aviation Jet A 3,000-6,000 ft^2 fueled fires using either a single 1 ¾ inch handline fitted with a 125 GPM vari-nozzle or a 250 GPM foam turret.
- ✓ The same firefighting delivery hardware was also used for conducting 3-D running fuel fire test scenarios.
- ✓ For both fire test scenarios, the firefighting efforts were conducted with and without a foam tubes.
- ✓ In both test scenarios, the F3 agents were able to complete final extinguishing but took ≈1.5 times longer in comparison to AFFF.

NOTE: The critical application rate for the F3 products has been determined to be 0.07 gpm/ft^2 and the foam application rate for the large-scale validation tests was 0.05 gpm/ft^2.

NAWCWD-China Lake 6,000 ft^2 Uncontained Spill Fire Test

NAWCWD-China Lake 3-D Running Fuel Fire Test

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PHASE II MILITARY SPECIFICATION DEVELOPMENT PROCESS: NRL took the lead in developing the initial draft of the F3 MILSPEC to include the parameters and lessons learned from the Phase I testing. Once the original draft was developed, the specification development team consisting of NRL, NAVSEA and Jensen Hughes met numerous times to prepare a final draft that could be used to start the formal specification project development process led by NAVSEA.

PHASE II MILITARY SPECIFICATION PUBLICATION PROCESS:

- The draft MIL-PRF-XX727 document went through several in-house reviews and was updated and approved by the NAVSEA Technical Warrant Holder (TWH) for Fire Protection Systems – Ships (SEA 05P5) on 17 January 2022.
- As part of the required development process for military specifications, a broad technical review by government and industry, was conducted in July 2022.
- In addition to other federal agencies, reviewers providing comments on the draft specification included state governments, representatives of the firefighting foam manufacturing industry, civil aviation stakeholders, research scientists from industry and academia, private consultants, and professional organizations from the firefighting community.

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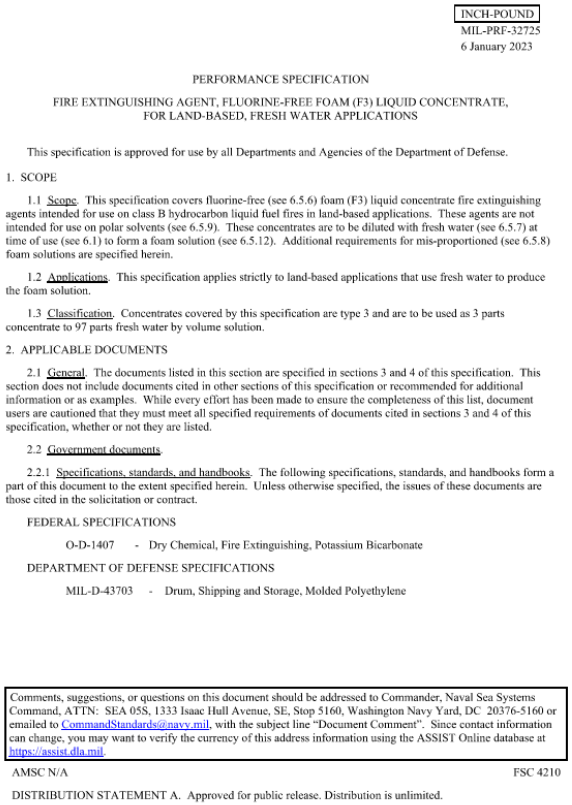
F3 MILITARY SPECIFICATION PUBLICATION:

- After the comments reviewed during this review were adjudicated, the specification was updated then sent to NAVESA (05S) Command Standards for review.
- The Command Standards comments were received and then adjudicated, marking the end of the development and review process.
- The MIL-PRF-32725 serial number was assigned, and the specification was dated 06 January 2023.
- The F3 MILSPEC was made publicly available via the DLA ASSIST (a comprehensive database for military specifications and other technical documents) on 12 January 2023.



INCH-POUND
MIL-PRF-32725
6 January 2023

PERFORMANCE SPECIFICATION

FIRE EXTINGUISHING AGENT, FLUORINE-FREE FOAM (F3) LIQUID CONCENTRATE, FOR LAND-BASED, FRESH WATER APPLICATIONS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers fluorine-free (see 6.5.6) foam (F3) liquid concentrate fire extinguishing agents intended for use on class B hydrocarbon liquid fuel fires in land-based applications. These agents are not intended for use on polar solvents (see 6.5.9). These concentrates are to be diluted with fresh water (see 6.5.7) at time of use (see 6.1) to form a foam solution (see 6.5.12). Additional requirements for mis-proportioned (see 6.5.8) foam solutions are specified herein.

1.2 Applications. This specification applies strictly to land-based applications that use fresh water to produce the foam solution.

1.3 Classification. Concentrates covered by this specification are type 3 and are to be used as 3 parts concentrate to 97 parts fresh water by volume solution.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

O-D-1407 - Dry Chemical, Fire Extinguishing, Potassium Bicarbonate

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-D-43703 - Drum, Shipping and Storage, Molded Polyethylene

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

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MIL-PRF-32725 Title Page

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SUMMARY & CONCLUSIONS:

- The goal of the ESTCP WP20-5373 program was to develop and publish a new F3 MILSPEC applicable for all DoD land-based military installations in accordance with the requirements and timeline established for the FY20 NDAA.
- Although the fire extinguishing capabilities of the existing MILSPEC F3s are somewhat less in comparison to MILSPEC AFFFs, their demonstrated performance capabilities are deemed sufficient to meet all land-based DoD end-user requirements.
- It should be noted that the F3 MILSPEC will be a living document and will be revised and/or amended as F3 technologies continue to improve to ensure that the DoD end-users will be provided with the best available products.

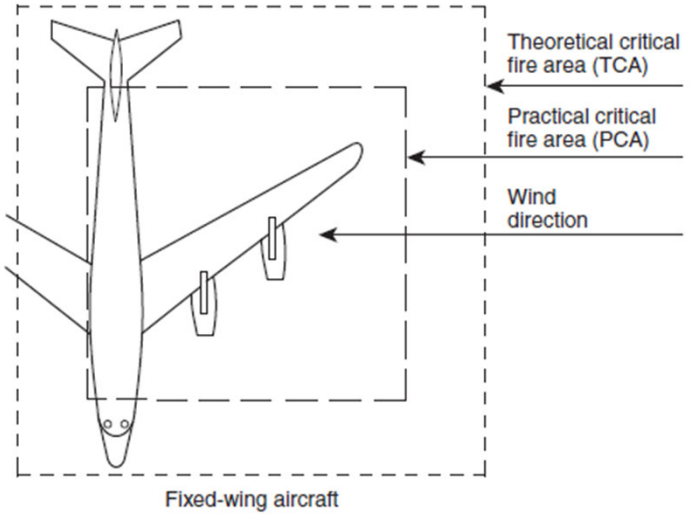

FIGURE B.2.1 Theoretical Critical Fire Area (TCA) Relative to Practical Critical Fire Area (PCA).

NFPA 403 Delivery Rates Based on 0.13 gpm/ft^2 Application Rate (Practical Critical Fire Area (PCA): Control 60 sec & Extinguishment 90 sec)