MANAGING THE DELUGE: 
Industry Perspective on AFFF Use and Planning

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Introduction to the Deluge

• A need to control and rapidly extinguish flammable liquid fires led to the development and mandated use of Class B firefighting foams.

• Aqueous film-forming foams (AFFFs) are a type of Class B foam that have demonstrated superior performance and have unique film-forming properties that provide shorter extinguishment times and greater after-fire protection.
  • Originally manufactured by 3M beginning in the late 1960s.
  • US Naval Research Laboratory (NRL) development led to the US Military Specification (Mil-Spec) MIL-F-24385F, requiring the use of fluorinated foam at Department of Defense (DoD) facilities.
  • Only products listed on the US DoD Qualified Products Database (QPD) are approved for military applications.
  • The Federal Aviation Administration (FAA) requires all US airports to carry AFFF agents that meet the Mil-Spec and are listed on the QPD.

• Use of AFFF mandated to Protect People and Investments.
A Deluge of Challenges

- Unknown chronic toxicity
- High costs of fluorinated foams (fluorosurfactants represent 40-80% of the foam costs)
- Replacement of concentrates
- Volume of foam wastewater
- Cleanup and removal
- Use of these foams for incidents and exercises can negatively impact the environment
Why Fluorinated Foams?

Aqueous film-forming foam (AFFF) composition:
- Fluorinated surfactants (PFASs)
  - Film-forming
- Hydrocarbon surfactants (also used in Fluorine-free Foams)
  - Foam-forming
- Organic solvents
- Additional modifiers (polymers, salts, chelating agents, buffers, corrosion inhibitors, and biocides)

Foams
- Cool the Fuel
- Exclude Oxygen
- Suppress fuel vapor
- Prevent (re)ignition

(Hinnant et al., 2018)
PFAS in Aqueous Film-Forming Foam (AFFF)

- **Aqueous film-forming foams (AFFFs)** contain fluorinated surfactants belonging to the Per- and Polyfluoroalkyl Substances chemical family (PFAS)
  - *Legacy PFOS AFFF “Lightwater”* – contains PFOS and PFOS-precursors; PFOA; shorter-chain PFSAs (ex. PFHxS)
  - *Legacy Fluorotelomer AFFF* – long and short-chain PFAS; PFOA and PFOA-precursors; other PFCAs
  - *Modern Fluorotelomer AFFF* – short-chain PFAS, do not break down to PFOS; may contain trace quantities (ppb) of PFOA and PFOA-precursors as byproducts

“Long-Chain PFAS”:
- Perfluoroalkyl carboxylates (*PFCAs*) **with eight (8) or more carbons**, including PFOA
- Perfluoroalkane sulfonates (*PFSAs*) **with six (6) or more carbons**, including perfluorohexane sulfonate (PFHxS) and PFOS

“Short-Chain PFAS”:
- *PFCAs with seven (7) or fewer carbons*, such as perfluorohexanoate (PFHxA)
- *PFSAs with five (5) or fewer carbons*, such as perfluorobutane sulfonate (PFBS)
Inventory and Industrial End-Users

• Fluorinated foam concentrates – contain a mixture of PFASs (undefined).
  • Types of PFASs in AFFF vary by year of production and manufacturer.

• Individual fluorinated surfactants in foam concentrates range from low ug/L (parts per billion) levels to g/L (parts per thousand) levels.
  • Current regulatory guideline concentrations are in parts per trillion.

• Large quantities of AFFF concentrate required to be maintained on-site for large facilities.

• Major Industrial End Users and Facilities:
  ❑ Aviation Industry
    • Aviation Rescue and Firefighting
    • Fuel Storage
    • Terminal Buildings
    • Hangars and Maintenance
    • Engine Test Cells
  ❑ Military Defense Facilities
  ❑ Municipal Fire Departments
  ❑ Oil and Gas, Petroleum Refineries,
    Fuel Storage Farms
A Selection of Best Management Practices (BMPs) for Managing AFFF and the Environmental Impacts Related to PFAS
# BMPs - Managing AFFF and the Environmental Impacts Related to PFAS

<table>
<thead>
<tr>
<th>FOAM CONCENTRATE</th>
<th>Best Management Practice (BMP)</th>
<th>Description</th>
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| **Current Inventory** | Use firefighting foam that meets requirements for safety/use. | Meet requirements of  
• Applicable NFPA standard for industry users  
• Underwriters Laboratories Inc., UL-162: Foam Equipment and Liquid Concentrates  
• For Department of Defense (DoD) and US Federal Aviation Authority (FAA) certified facilities:  
  • United States Military Specification (MIL-SPEC), MIL-PRF-24385F (2017), Qualified Product Listing (QPL)  
  • 14 CFR Part 139  
  • NFPA 403 |

| Identify chemical composition | Fluorinated component(s) may be provided on manufacturer’s  
• SDS*  
• Certificates of Composition** |

| Purchasing Records | • Keep records of Manufacturer-Type, Quantity, and Purchase Date |

| Historical Inventory | Identify & Record Historical AFFFs | • Keep records of historical AFFFs used at facility |

* Information provided in SDS usually insufficient for determining fluorinated composition of AFFF.  
** Certificate of Composition – available by request from manufacturer.
BMPs - Managing AFFF and the Environmental Impacts Related to PFAS

<table>
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<th>FOAM CONCENTRATE (continued)</th>
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</table>
| Replacement Inventory        | Search for alternative AFFFs with low environmental impact | • *FAA Reauthorization Act of 2018* (HR 302) – allows use of Fluorine Free Foam (F3) within 3 yrs  
  • SERDP-ESTCP, evaluating F3 against MIL-SPEC; developing a new MIL-SPEC  
  • DoD, 2016 policy for replacement of long-chain AFFFs to short-chain (C6) AFFF and disposal of legacy foams  
  • *USEPA 2010/2015 PFOA Stewardship Program*  
  • USEPA Significant New Use Rules (40 CFR 721.9582)  
  • Take-Back Programs  
  • Consider two-foam approach with F3 used to respond to small incidents  
  • Monitor developments in new foam technologies |
# BMPs - Managing AFFF and the Environmental Impacts Related to PFAS

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<th>STORAGE</th>
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| Compatibility | Do not mix different types or brands of foam | • Do not mix newer AFFF formulations with legacy types  
• Triple rinse or replace tank bladders |
| Containment | Store fluorinated foam concentrate tanks/containers in a covered area with secondary containment | • Designate transfer areas  
• Ensure adequate containment volume  
• Reduce environmental exposure |
| Labelling | Clearly label each AFFF container | • Type of AFFF concentrate  
• Intended concentration in solution  
• Temperature requirements  
• Date of Fill |
| Inspection | Inspect areas containing AFFF concentrate or solutions | • Monitor condition of tanks, containers, equipment  
• Ensure that leaks are addressed promptly  
• Record foam incidents and usages |
# BMPs - Managing AFFF and the Environmental Impacts Related to PFAS

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<th>USE</th>
<th>Best Management Practice (BMP)</th>
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| Foam Solution/Wastewater | Collect, Treat, and Properly Dispose of Foam Solution and Runoff/Wastewater | • Collect foam solution and produced wastewater for treatment and disposal  
• Avoid direct release to the environment to the greatest extent possible |
| Planning | Document safe handling and environmentally-effective mitigation plans to reduce exposure and minimize environmental impacts | • Develop and communicate documented processes for a facility or installation  
• Consider employee, firefighter and public safety first  
• Use appropriate PPE  
• Record of previous foam usages |

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<tr>
<th>TRAINING &amp; TESTING</th>
<th>Best Management Practice (BMP)</th>
<th>Description</th>
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<tr>
<td>Preplanning</td>
<td>Prioritize proper education and training</td>
<td>• Document methods and training, with schedule for review</td>
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<td>Testing of Equipment and Training</td>
<td>Eliminate fluorinated Class B foams for testing and training</td>
<td>• FAA Part 139 CertAlert No. 19-01, January 2019, for ARFF vehicles</td>
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Summary

• **Plan Early:**
  - Monitor developments in new foam technologies and requirements
  - Evaluate and project future foam needs in advance of (re-)purchase
  - More effective to dispose of concentrates than foam wastewaters

• "**Find your Fluorinated**" – identify what types of fluorinated surfactants are in your emergency response foams.

• Consider additional ingredients in fluorinated foams, mitigation chemicals (anti-foams) and flammable liquids when determining **handling and disposal procedures**.
Thank You!

Additional questions may be sent to: Audra.Liggenstoffer@aa.com
References


References


