Fire Fighting Foam – Where are we going and why?

HELICOPTER SAFETY ADVISORY CONFERENCE

May 2023

Edward Hawthorne,
DFW Dynamics

Brief History of Firefighting foams

Aqueous Film Forming Foam (AFFF) has been the industry standard for combatting liquid fuel fires and hazards for almost 50 years. AFFF is a water-based solution that contains a fluorinated, film forming surfactant (per- and poly- fluoroalkyl substances (PFAS)) to seal the fuel surface during suppression/extinguishment.

- **PFAS are a family of human-made chemicals in products used by consumers and through various industries.**
- **Some PFAS are classified as forever chemicals that do not naturally breakdown in the environment and/or in the human body.**
- **Some PFAS have emerged as contaminants of concern.**
- **Some PFAS have been associated with health effects**

Brief History of Firefighting foams

Recently, Federal and State authorities have implemented health and environmental regulatory actions for PFAS and PFAS-containing AFFF.

These regulations will or have impacted, if not eliminated the production, distribution, and use of legacy AFFF in upcoming years.

Finding a suitable, environmentally friendly, non-toxic, and effective AFFF alternative presents one of the greatest challenges the fire protection industry and fire responder community has faced of the past 50 years.

What are the challenges

- Getting a foam which is acceptable to the users' and public from an environmental and health perspective

- Getting a foam which will put out hydrocarbon and polar solvent fires:

  Spill fires and large in-depth storage tank fires

Project Background:
Fire Service Foam Roadmap

- Funding: DHS/FEMA Fire Grant (FP&S)
- Primary Recipient: Fire Protection Research Foundation
  - FPRF Project Manager: Sreeni Ranganathan
- Project Contractors:
  - Jerry Back, Jensen Hughes
  - Ed Hawthorne, DFW Dynamics
  - Casey Grant, DSRAE LLC

Project Background:
Fire Service Foam Roadmap

- Used testing conducted by:
  - Fire Service Research Foundation – Funded by the Petroleum Industry
  - LASTFIRE Consortium – Industry Global Project
  - Dept of Defense – Aircraft fires for Military
  - FAA testing of AFFF and SFFF foams

Premises of the Project

This road map provides the latest renewed guidance in the following areas:

1. Health and Safety precautions to safely work with and use Fluorinated and Fluorine free foams
2. Environmental Best Practices (such as) how to:
   a) Remove AFFF from existing storage containers including storage tanks, on apparatus systems, etc.
   b) How to clean those storage containers
   c) How to dispose of AFFF stocks
   d) How to dispose of AFFF fire water in an emergency situation
3. Latest testing information on fluorine-free / PFAS-free foams (FFF/PFF) in test fire situations
4. Latest information on engineering transition on mobile and fixed foam application equipment
5. Current understanding of change in tactics using FFFs/PFFs to extinguish fires and deal with vapor control on spills to prevent ignition.

Premises of the Project

This road map is based on a transition to a fluorine-free / PFAS-free foam fire fighting environment. Some may not transition that far, but the road map will provide the steps.

This road map is based on three user segments of the fire service community. It is realized that many departments provide more than one of these roles:

1. Airport Crash Rescue departments (both DOD and FAA sites) responding to aircraft spill fires with large life hazards.
2. Industrial and Specialized Fire Departments responding to large fires in depth such as storage tank fires with less life hazards.
3. Fire Departments that respond to a wide variety of mixed hazard fires that are a smaller blend of the two classes above. (in general, small to moderate petrochemical fires with small to moderate life hazard)..

NFPA Fire Protection Research Foundation

2018-2020 Research Program -

High Level Description

165 test parametric assessment (UL listed products)

- Blind study on the capabilities and limitations of fluorine free foams (FFFs) as a “technology” for use as input to NFPA 11 (2020 revision cycle)
- Over 10 UL listed SFFFs (we tested 5 of them) SFFF fall under Syn in UL (16 now listed)
- UL 162 Type II (gentle-fixed) and Type III (forceful – manual) basis of the assessment
- Parameters included; Foam Quality, Fuel Type, Water Type and Fuel Temperature
- Two presentative foam qualities (exp ratios) for testing
  - aspirating nozzle (expansion ratio in the 7-8 range)
  - non-aspirating nozzle (expansion ratio in the 3-4 range)
- This involved over 100 small scale fire tests.

  http://www.nfpa.org/News-and-Research/Resources/Fire-Protection-Research-Foundation

Fire Research Foundation Testing – Over 100 test burns

Heptane and Gas (MILSPEC and E(10)) manual application

DoD/ARFF Program(s)

Systematic Approach

WP19-5324

- Literature search, small-scale screening tests, foam selection, real-scale confirmation tests

WP21-3561
WP21-3565

- Large scale validation tests

WP20-5373

- MilSpec testing of selected products to define specification requirements – EcoTox Testing

www.serdp-estcp.org

Fire Test Descriptions

Approval-Scale Testing
28 ft^2 pan fire (MilSpec)
2 & 3 gpm - Ext. & Burnback
Gasoline and Jet A
Aspirating nozzle
(MilSpec - gasoline - 2 gpm - 30 sec)

Real-Scale Testing
400 ft^2 pan fire
30 gpm nozzle – Ext only
w & w/o foam tube
mostly Jet A (some gasoline)

Both conducted at 0.07 gpm/ft^2

ARFF Type Fire Scenarios

Spill Fire Scenario

400 gallons F-24 (Jet A)
2400-2800 ft^2
~0.05 gpm/ft^2 application rate

Debris Pile Fire Scenario

Steel enclosure, fuel cascade, cinder blocks
45 gpm F-24 (Jet A)
Spill fire, 3D running fuel, highly obstructed

Airport Crash Rescue (3-5 minutes Response Time)

	ARFF Needs	AFFF Foam	SFFF
Fast Knock Down	High	Fast	Moderate
Resealing of foam to protect FF's when entered	High	Yes	No
Can be applied with non-air aspirating nozzle with increased reach	Moderate	Yes	No with 1st tests, later testing maybe yes
Aspiration Rate - Foam on the fire per gallon of concentrate (Tank size limited)	Moderate	3-5 X	10 X with 1st tests, later testing 3-5 X
Foam drain time	Minor	No	3 X (CAF 10 X)

Research Work – Rational Progression more than 200 tests

Small scale
Simulated tank fire
Critical application rates

Phases have included
- Different foams
- Different nozzles
- Different application methods
- Different rates
- Different fuels (including crude)
- Different preburns
- Fresh/Salt water

Subsurface tests

Spill fire
Critical application rates

Larger scale
"Real life" Application
NFPA rates

Longer flow
"Real life" Application
NFPA rates

Self expanding foam

Vapour suppression

Hybrid Medium Expansion

LASTFIRE
Large Atmospheric Storage Tank Fires

LASTFIRE
Large Atmospheric Storage Tank Fires

Overall Achievements/Conclusions

- Carried out over 200 tests
- Validated extrapolation of test data from small scale LASTFIRE testing to large scale
- No direct drop-in – performance plus suitability for system
  - Really has always been the case when changing foam
- Cannot be generic!
- Combination of foam/foam properties/application rate/application technique is critical
  - (Currently not fully reflected in standards)

Other techniques give the potential for more efficient extinguishing of large tank/bund fires

Important not to draw generic conclusions!

info@lastfire.org
www.lastfire.org.uk

LASTFIRE
Large Atmospheric Storage Tank Fires

Overall Achievements/Conclusions

- Proved that some Fluorine Free foams can provide equivalent performance to C6 foams and provide appropriate performance for hydrocarbons:
  - When used with NFPA application rates for following applications:
    - Tank fires ~15m+ diameter (No reason to doubt >25m+)
      - Conventional pourer standard application rates
      - Aspirating monitor
      - “Non aspirating” monitor with appropriate foam characteristics
    - Tank fires ~60m+ diameter (No reason to doubt >80m +) or bund fires
      - Foam pourer
  - When used at lower rates than NFPA using CAF application:
    - Tank fires ~15m+ diameter (No reason to doubt >25m+)
      - Monitor application
    - Tank fires ~80m+ diameter (No reason to doubt >100m +) or bund fires
      - Foam pourer

Important not to draw generic conclusions!

We can overcome performance issues but …

info@lastfire.org
www.lastfire.org.uk

What is happening internationally – Airports

- Many airports globally have gained significant confidence in the fire extinguishment performance of F3 foams such they have transitioned away from AFFF containing PFASs over the last decades.
- Major international airports using F3 foams include London Heathrow, Gatwick, Stansted and City, Manchester, Paris Charles De Gaulle, Paris Orly, Lyon, Helsinki, Lisbon, Dubai, Brussels, Copenhagen, Oslo, Stockholm, Stuttgart, Dortmund, Sydney, Melbourne and Brisbane.

SFFF Summary

- **Performance testing of synthetic fluorine free foams (SFFF) continues via DoD, LASTFIRE and member companies**
- **SFFF have proven they can extinguish flammable liquid spill and in-depth fires, but they react differently. The present SFFF's do not appear to need a higher application rate than AFFF**

SFFF Summary

- New SFFF Mil Spec issued January 6th, 2023. USN is presently testing first batch of foams from suppliers to provide them with a Mil-Spec listing. Expect first listing of foam in Sept/October 2023.
- Foam manufacturers are now submitting MILSPEC SFFF agents for qualification by DoD. Once DoD certifies that a foam meets the new specification, it will be added to the Qualified Product List.
- FAA considers foams on the Qualified Product List as acceptable to use to satisfy the regulatory requirements of Part 139 at all airports in the United States.

Current Regulations

Federal Use Regulations Associated with AFFF

1. **Federal Aviation Administration (FAA)**
   a. Oct 2021 mandate to allow non-Mil Spec / non-fluorinated foams.
2. **National Defense Authorization Act (NDAA)**
   a. Federal legislation that requires the DoD to phase out its use of AFFF at all military installations by 1 October 2024 (requiring the development of a new Mil Spec). This Act also mandated that military training with AFFF be stopped.

Federal Environmental Regulations EPA - https://www.epa.gov/pfas/pfas-laws-and-regulations

1. **Safe Drinking Water Act (SDWA)**
   a. Authorizes the US EPA to establish national limits on drinking water contaminants.
2. **Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)**
   a. Authorizes the US EPA to investigate suspected contamination sites and establish liabilities for hazardous chemical release but main focus is cleanup of hazardous substances releases.
3. **Toxic Substances Control Act (TSCA)**
   a. US EPA federal act that requires the reporting of chemicals manufactured, imported, or processed in the US for review and risk evaluation.

State and Local Regulations – Interstate Technology Regulatory Council (ITRC)

ITRC publishes and produces guidance/training documents to inform state environmental agencies to assist in developing consistent regulatory approaches for reviewing and approving specific technologies. Includes up to date state information and state regulations.

https://pfas-1.itrcweb.org/8-basis-of-regulations/ https://pfas-1.itrcweb.org/

State EPAs are also a good source of information

Post Fire & Post Discharge Cleanup and Documentation

Emergency Planning and Community Right-to-Know Act (EPCRA) guidance on emergency planning requires industry to report on the storage, use and releases of hazardous substances to federal, state, and local governments.

2020 National Defense Authorization Act (NDAA) added certain PFAS to the Toxics Release Inventory (TRI) list including framework for adding PFAS substances. Safe to assume all AFFFs are on this list.

Going forward, all releases will need to be contained including:

(1) Manual firefighting or fuel-blanketing operations
(2) Training
(3) Foam equipment system and foam fire apparatus tests
(4) Fixed system releases

First Responders should contain the flow of foam water solution when conditions and manpower permit including; blocking sewer drains and through the use of portable dikes where applicable.

Trends suggest that **ALL** foams/agents (**not just AFFF**) will need to be contained, collected and disposed of in the future.

Who's responsible and what's the cost?

Summary – Fire Performance

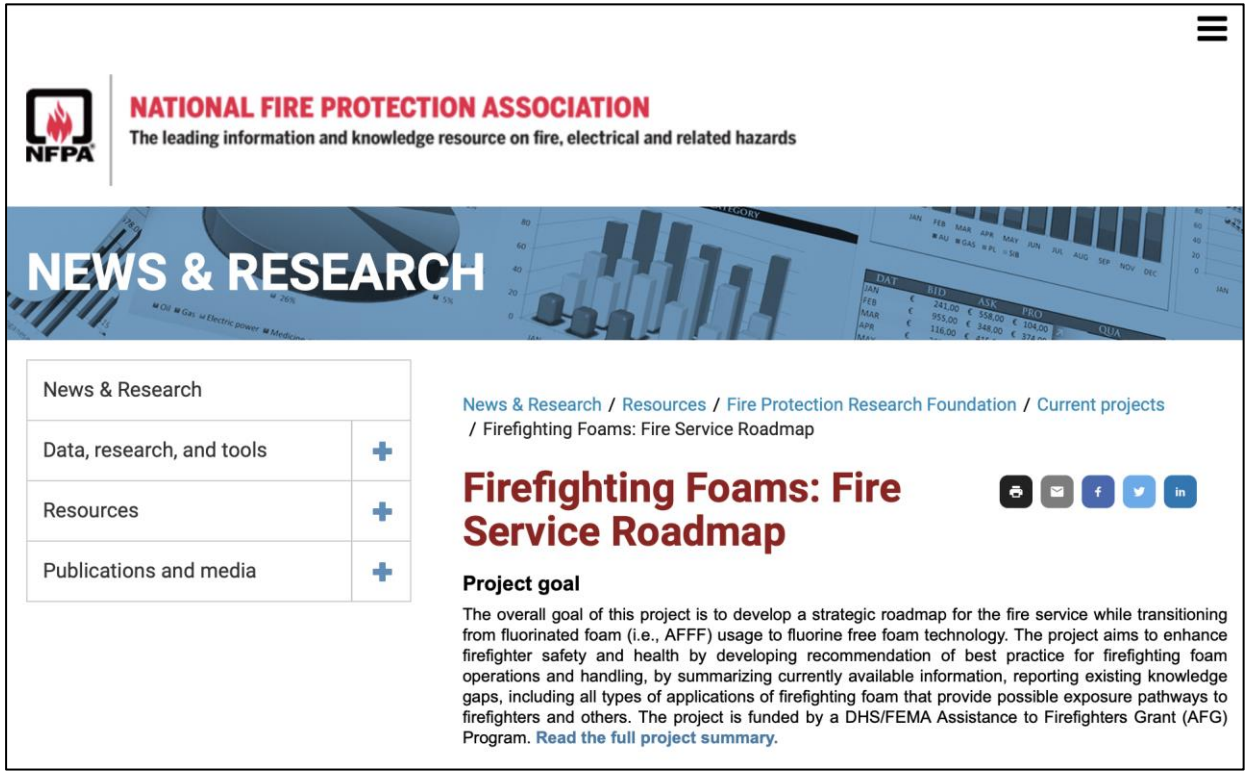
- SFFFs are not a “drop in” replacement for AFFF and are not as good as AFFF but can be made to work well with the right design parameters and is getting better.
- The firefighting capabilities of the SFFFs varied from manufacturer to manufacturer (but appear to be related to the listing/approval).
- In general , extinguishment times were 1.5 to 2 times longer than AFFF for the best SFFFs but continue to get shorter
- Foam Quality will be key to success but non-air aspirated equipment is working
- Fuel type is a major variable with increased challenge for higher vapor pressure fuels and longer preburn times in general
- Implementation Issues
  - Foam quality (exp ratio) / non-aspirating discharge devices
  - Viscosity needs to be considered (proportioning)
  - New firefighting techniques and tactics are required
- We can/will make these work (no other choice)

Transition Guidance

1. **Understanding current regulations and knowing when to make the transition**
   a. Pre-emptive transition /Required transition
2. **Cleaning of equipment and definition of acceptable levels**
   a. Disposal of cleaning effluents
3. **Disposal of current AFFF products**
4. **Selection of an acceptable AFFF alternative**
   a. Hardware compatibility
   b. Firefighting capabilities and limitations
5. **Implementation of the selected alternative**
   a. Proportioning issues and concerns (adjustments)
   b. Discharge devices (potential replacement and/or modifications)
   c. Techniques and tactics (training?)
6. **Firefighter exposures**
   a. Eyes and skin (rinsing and cleaning)
   b. Clothing and equipment (cleaning)
7. **Post fire / post discharge cleanup and documentation**

DO YOUR HOMEWORK

Workshop Proceedings



www.nfpa.org/FoamRoadmap