

Ignitable Liquids and AFFF: What's an FPE to do?

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Terminology

- AFFF
 - Aqueous Film-Forming Foam
- PFOS
 - Perfluorooctanesulfonic Acid
- PFOA
 - Perfluorooctanoic Acid
- PFAS
 - Per- and Polyfluoroalkyl Substances
 - Includes PFOS AND PFOA



What Are We Talking About Today?

- History of AFFF
- How Does AFFF Work?
- Environmental Concerns
- Alternatives
- Things to Watch Out For
- Where Do We Go From Here?



History of Foam

- Protein Foam Developed in Early 1940s
 - Effective but not Efficient
- High-Expansion Foam Developed in Early 1950s
 - Started in Mining Industry
 - Kidde Bought Patents in 1964ish
- Neither Were Effective for Shipboard / Aircraft Uses



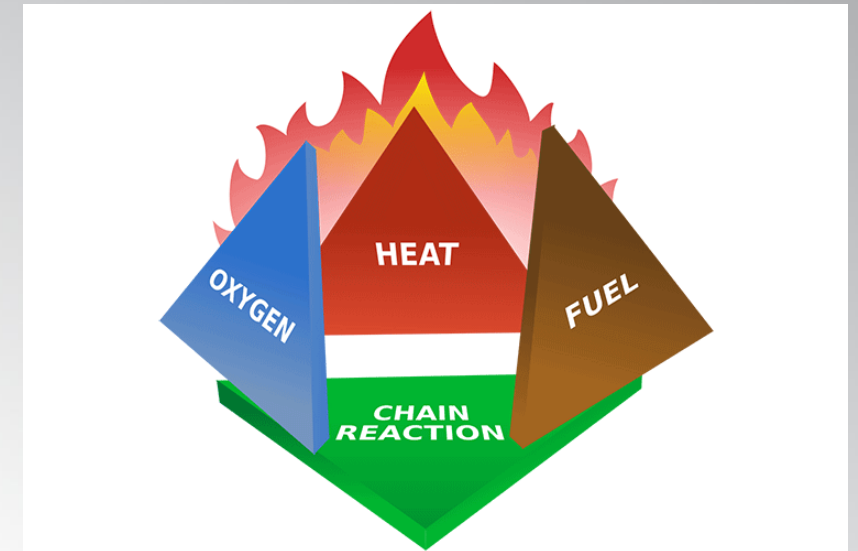
History of AFFF

- Naval Research Lab & 3M Collaborated in Early 1960's
 - PFOA (Teflon) also Called C8
 - PFOS (Scotch Guard)
- Chemical Makeup Allowed for a Film to Develop
 - Separated the Ignitable Liquids from Air
- National Foam Developed First ARC 1970s
 - Effective on Polar Solvents
- 3M Used PFOA and PFOS
- Other Manufacturers Used Other PFAS



How Does AFFF Work

- Aqueous *Film-Forming* Foam
- Fluorochemicals Reduce Water Surface Tension
- Allows a “Film” to Form on Top of Ignitable Liquids
 - Reduces/Prohibits Vapor Production
 - Limits O₂ in Contact with Fuel
 - Film Seals Surface
- Water Component Provides Cooling



AFFF Timeline

- 1960s: Developed by NRL/3M
- 1966: NRL Receives Patent for AFFF
- 1970s: National Foam Develops ARC
- 1974: Navy Questions Environmental Impact of AFFF
- 1976: Concerns About Bioaccumulation in Humans
- 1980 – 1990: Multiple Studies by 3M and DoD Related to Health Effects



AFFF Timeline

- 2000: EPA & 3M Agree to “Voluntarily Phase out PFOS”
 - 3M Drops Entire AFFF Line
 - Also Dropped Teflon/Scotch Guard Products
 - Belief was only 3M AFFF at Issue Due to PFOS
- 2002: USAF Switches to Hi-Ex (ETL 02-15)
- 2016 – 2017: DoD Starts to Change out C8 to C6 AFFF
 - C8 had PFOS
 - C6 had no PFOS but still had PFAS



AFFF Timeline

- 2014 – 2019: DoD Looking Further into PFAS
 - Approximately 1,000 Active/Former Installations/Training Sites
 - Contaminated with PFAS Chemicals
- 2016 – 2017: Whidbey Island (NAS), WA
 - Biannual Testing of Well Water
 - More than 5% Levels Higher than EPA Advisory
 - One Location was 36x Health Advisory Level
 - Navy Spent \$24MM for Testing/Correction
 - Not Remediation
 - Navy Providing Water or Connecting to City Water



AFFF Timeline

- 2020: National Defense Authorization Act
 - Jan 31, 2023: MIL-SPEC for Fluorine Free Foam Published
 - Draft Published May 26, 2022
 - October 1, 2023
 - No Funds May be Used to Purchase PFAS Containing Foam
 - Oct 1, 2024: Fluorinated AFFF Not Permitted
 - Except Ships...or... if a Waiver is Granted...or...



AFFF ISSUE

- DoD Estimates 3MM Gallons of AFFF in Use
- US Airports Estimated to Have 20x DoD Supply
- Municipal FD Has How Much?
 - What if You “Need” AFFF for Active Hazard?
- Who Is Going to Pay to:
 - Swap?
 - Retrofit?
 - Decon?
 - Dispose?



PFAS – The Next Asbestos?

- PFAS – per- and polyfluoroalkyl substances
 - Group of chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water
 - Fluoropolymer coatings can be in a variety of products
 - Clothing, furniture, adhesives, food packaging, heat-resistant non-stick cooking surfaces, and the insulation of electrical wire
- “Forever Chemical”



PFAS - Concerns

- Issues
 - Does not break down in the environment
 - Can move through soil and contaminate drinking water sources
 - Can build up (bioaccumulate) in fish and wildlife
 - Has been found in rivers and lakes and in many types of animals
- EPA “Non-Enforceable” Health Advisory (2016)
 - 70 Parts Per Trillion (ppt)
 - 12 oz Can of Coke in 1.3 Billion Gallons of Water



PFAS - Concerns

- EPA “Non-Enforceable” Health Advisory (Jun 15, 2022)
 - **1 Part Per Trillion (ppt)**
 - 1 ppt is 12 oz Coke in 93 Billion Gallons Water
 - +/- 1 Drop of Water in 13.2 Million Gallons!
- PFAS in Fire Protection Piping?
 - Can it be Decontaminated?
 - Can it be Cleaned?



PFAS – What to Do?

- Currently Not Labelled as Haz Waste
 - Haz Waste Disposal Sites Do Not Want It
 - Unlined Landfills Do No Want It
 - Can it be Burned?
- Sep 6, 2022 EPA Proposed Rulemaking
 - PFOS/PFOA To Be Hazardous Substance Under CERCLA (Superfund)
 - Holds Manufacturers, Sellers and *USERS* Accountable



Class Action Lawsuits

- Multiple States Filed Legal Action
 - NY, NH, VT, NJ, OH, NM, CO, NC, FL, MA, MI, WI, MN (3M)
 - Not Just Related Foam Fire Suppression Systems
 - Foam Manufacturers Included
 - More States Waiting “in the wings” – Difficult to Track
- Multiple Individual and Class Action Suits in Process or Pending
 - In the Thousands
- Forever Chemical = Forever Litigation



State Legislation/Regulation

- Most States Looking at PFAS/PFOS Legislation
- 30 States with Current/Proposed Legislation Related to Foam (as of 08/22)
- Some Address only Training
- Others Address Use in General
 - Typically, Ban on Sale
- Nevada (AB97, May 2021)
 - No discharge for testing or training
 - No prohibition on sale of PFAS containing foam
 - Prohibitions relate to textiles and similar products



CA Regulation – The Law

- SB 1044 (HSC 13061) – Enacted September 29, 2020
- January 2022 – No Foam with PFAS Permitted to be Sold or Used in CA (Unless Federally Required)
 - Exemption for Fixed Systems with 100% Containment
- January 2024 – Applies to Fixed Fire Suppression Systems
- January 2028 – Applies to Tank Farms



CA Regulation – Aircraft Hangars

- January 2022
 - PFAS Containing Foam can Continue to be Used if Fixed System and 110% Containment
 - Must File for Exemption with State FM Office
- January 2024
 - PFAS Containing Foam No Longer Permitted to Be Used
 - No Definition of “Use”
- Is State FM’s Office Prepared?
 - Anyone File for Exemption?



What Do We Do?

- NFPA 11, 2021 edition
 - Still Provides Criteria for AFFF
 - Provides No Specific Criteria for SFFF
- NFPA 30, 2021 edition
 - Still Provides Criteria for AFFF
 - Provides No Specific Criteria for SFFF
- NFPA 409, 2022 edition
 - Specifically States AFFF
 - Can I Use SFFF Prescriptively?



Alternatives?

- High-Expansion Foam
 - “Prove to Me it Won’t be a Problem in Five Years”
- Sprinklers Only?
- Fluorine Free Foam
 - Re-healing and non re-healing
 - NFPA 11 Synthetic Fluorine-Free Foam (SFFF)
 - Will This be a Problem in Five Years?
 - Is it Listed/Approved (Approx ½ on Market Not Listed or Approved)



High-Expansion Foam

- Ignitable Liquids Storage and/or Use
 - Limited Design Criteria
 - What About Openings?
 - Safety Concerns?
 - Fire Department Operations?
- Tank Storage
- Aircraft Hangars
 - 2021 Symposium Discussion



Synthetic Fluorine Free Foam

- Fluorine-Free Foam
 - FPRF Report January 2020
 - “Evaluation of the Fire Protection Effectiveness of Fluorine-Free Firefighting Foams”
 - Full-Scale Testing?
- High Viscosity
 - Similar/Higher than ARC



Back and Farley, FPRF report, January 2020

Synthetic Fluorine Free Foam

- MUST be Listed or Approved
 - Ansul: NFF 3x3 (UL 162)
 - Chemguard: NFF 3x3 (UL 162)
 - Williams: T-Storm NFF 3x3 & Thunderstorm High Performance 3x3 (UL 162)
 - National Foam: Universal F3 Green 3% (UL 162)
 - Perimeter Solutions: Phos-Check 1%, 3%, 6% Fluorine Free
 - Perimeter Solutions: Solberg Re-healing 3x3
 - Viking: ARK 3x3 (FM)
- What Do They All Have in Common?



Synthetic Fluorine Free Foam

- UL 162 Test
 - Pass/Fail Criteria “lessened” for SFFF
 - AFFF Gold Standard
 - CANNOT be Used with Salt Water
 - Has no Bearing on Applicable Design Density
- “I’ll Just Wait for MIL-SPEC, DoD Knows What They Are Doing Right?”



MIL-SPEC SFFF

- MIL-SPEC (Draft May 2022)
 - Pass/Fail Criteria “lessened” for SFFF
 - NOT intended for Polar Solvents
 - CANNOT be Used with Salt Water
 - Tested to Jet A (Kerosene) and Gasoline (AvGas)
- No Testing for Other Ignitable Liquids
- Does Not Provide any Design Density for Ignitable Liquids
- Purpose is Aircraft Hangars



MIL-SPEC SFFF

- NRL Testing
 - Not All Products Perform the Same
 - Some Work Well on Gasoline but Poor on Kerosene
 - Working With Foam Manufacturers Towards June 2023 Target
- Salt Water
 - Some Gel Up, Some Develop an Emulsion on Top
- Viscosity Different Between Foams
 - How Does this Affect Proportioning?



Listed/Approved AFFF

- Tested for Certain Ignitable Liquids
 - Hydrocarbons
 - 15% Ethanol Gasoline
 - Alcohols
 - Ketones
 - Denatured Ethyl Alcohol
 - Methyl Alcohol
 - 85% Ethanol Gasoline



Application Rates

Fuel Group	Concentration	Minimum Recommended Application Rate	
		gpm/ft ²	(Lpm/m ²)
Type III Application¹ – UL Listed			
Hydrocarbons	3%	0.16	(6.5)
E15	3%	0.17	(6.9)
Type III Application² – Third Party Witnessed			
Hydrocarbons	3%	0.10	(4.1)
Premium Gasoline	3%	0.16	(6.5)
Type II Application³ – UL Listed			
Hydrocarbons	3%	0.10	(4.1)
Alcohols	3%	0.17	(6.9)
Ethanol (EtOH)	3%	0.10	(4.1)
Ketones	3%	0.17	(6.9)
E85	3%	0.15	(6.1)

(1) TYPE III DISCHARGE OUTLET – A device that delivers the foam directly onto the burning liquid as described in UL-162.

(2) NFPA 11 allows a design rate of 0.10 gpm/ft² (4.1 Lpm/m²) for spill fire applications. This product has been tested in accordance with UL 162 for use at this application rate.

(3) TYPE II DISCHARGE OUTLET – A device that delivers foam onto the burning liquid and partially submerges the foam or produces restricted agitation of the surface as described in UL-162.

Listed/Approved AFFF

- Listed/Approved Discharge Devices (All in State of Flux)
 - JCI Products: Only Listed with Tyco B1
 - NF Products: Only Listed with Tyco B1 or HD Fire Protect Model F1
 - Solberg: Listed with Multiple Reliable and Viking Sprinklers
 - Viking: Listed with Multiple Viking Sprinklers
- Foam/Discharge Device Determines Design Density!!!!
 - NFPA 11 Standard Densities Do Not Apply!



Solberg Re-Healing SP-100

- UL 162 Listed (As of Oct 2022)
- FM Approval Expected Q1 2023
- “Industry’s First UL-Listed Fluorine-Free 3x3 Foam Concentrate With the Full Complement of Hardware and Sprinkler Listings, Including Non-Aspirated, Standard Sprinkler Heads”
 - Per Perimeter Solutions Press Release
- ‘Re-Healing’ Which is “Similar” to AFFF Properties
 - Not a Property of All SFFF



Solberg Re-Healing

Solberg Re-Healing 3x3 SP-100 AR-SRFF, 3%				
Sprinkler	Fuel	Style	Application Rate (Min)	Min Inlet Pressure
Reliable, SIN RA6212 K-Factor 8.0	Hydrocarbons	Pendent	0.22	7.0
Reliable, SIN R1017 K-Factor 8.0	Hydrocarbons	Pendent	0.22	7.0
Reliable, SIN RA6222 K-Factor 8.0	Hydrocarbons	Upright	0.22	7.0
Reliable, SIN R1027 K-Factor 8.0	Hydrocarbons	Upright	0.22	7.0
Viking, SIN VK536 K-Factor 11.2	Hydrocarbons	Pendent	0.32	7.0
Reliable, SIN RA6212 K-Factor 8.0	Alcohols	Pendent	0.37	19.1
Reliable, SIN RA6222 K-Factor 8.0	Alcohols	Upright	0.37	19.1
Reliable, SIN R1017 K-Factor 8.0	Alcohols	Pendent	0.40	22.0
Reliable, SIN R1027 K-Factor 8.0	Alcohols	Upright	0.40	22.0
Viking, SIN VK536 K-Factor 11.2	Alcohols	Pendent	0.48	16.1



What to Watch Out For

- Listed/Approved Compatibility
 - Concentrate
 - Proportioner
 - Discharge Device (Sprinkler, Foam Chamber, Nozzle)
- Don't Cross The Streams!
 - Cannot Mix Different Concentrates
 - Even MIL-SPEC Will Not Permit Mixing



What to Watch Out For

- Concentrate Selection May Depend On:
 - Hazard
 - Discharge Device
 - Design Density
- Water Source
 - May Not Be Able to Use With Salt Water
 - Pier Protection May Require Separate Water Supply
 - Check the Data Sheet



What to Watch Out For

- Shelf Life
 - May Be As Little As 10 Years
- Proportioning/Tank Size
 - Almost All Are 3x3
 - What About 1%?



Where Do We Go From Here?

- New/Revised Products Will Be Coming Out
 - JCI Expected to Release A331 SFFF Before Year's End
 - Will be Listed for Use with Non-Aspirating Sprinklers
 - Hydrocarbons: 0.16 gpm/sf
 - Alcohols: 0.32 gpm/sf
 - Ethanol: 0.18 gpm sf
 - Testing Being Performed with Additional Fuels
 - AFFF Took Many Years to Refine



Where Do We Go From Here?

- AFFF is Still Available
 - Only Certain States Have Banned Sale
 - MIL-SPEC (for now) Does Not Apply to Shipboard
 - Can't Use SFFF with Salt Water



Summary

- AFFF is the New PCB/Halon/Asbestos
- AFFF Will be Around for a Number of Years
 - Even With MIL-SPEC Foam on Market in June 2023
 - How Long Will it Take to Replace?
- Be Careful of Pipe/Tank Decon
 - 1 ppt EPA Health Advisory
- Test Your Water Supply for PFAS, You Might be Surprised....



Summary

- SFFF Is Not a Drop In Panacea
 - Be Very Careful with Listings/Approval
- Select Concentrate Based on Hazard and Protection
- SFFF Needs More Time (And a Different Name.....)
 - 50+ Years of AFFF
 - 2+ Years of SFFF?



Additional Resources

- UL 162 Foam Equipment and Liquid Concentrates (Free Digital View)
 - <https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=34019>
- FPRF Report *Evaluation of the fire protection effectiveness of firefighting foams*
 - <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Suppression/Appendix-Comparative-Characterization-of-Gasoline-Samples.ashx>
- FAA Fluorine-Free Foam Testing Report (July 28, 2022)
 - <https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/fluorine-free-foam-testing>



Questions?

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Photo courtesy of Willis Towers Watson

