Aqueous Film Forming Foam (AFFF) ENVIRONMENTAL IMPACT REVIEW

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Background:
AFFF Constituents

- MILSPEC based on Performance, not Constituents
- Must be on Qualified Products List - QPL
- Main Ingredients in Firefighting Strength Foam:
  - WATER = 98%-99%
  - Butyl Carbitol (Glycol Ether) = 0.5%–1.1%
  - Fluorosurfactants & Hydrocarbon Surfactants = 0.03%–0.45%
  - Ethylene Glycol (Not in all formulations) = 0.34%–0.60%
  - Urea (Not in all formulations) = 0.2–0.4%

Background:
AFFF 'Environmental' Properties

- MIL-F-24385F Requirements
  - Chemical Oxygen Demand
    - 3% Concentrate - 1,000,000 mg/L Max
    - 6% Concentrate - 500,000 mg/L Max
    - Calculated Firefighting Strength ~ 30,000 mg/L Max
  - Biochemical Oxygen Demand (20 Day)
    - =(0.65 X COD) or greater
  - Aquatic Toxicity (LC50, Killiefish)
    - 3% Concentrate - 500 mg/L Min
    - 6% Concentrate - 1000 mg/L Min
    - Calculated Firefighting Strength ~ 16,667 mg/L Min
- Persistence and Bioaccumulation
  - Only Fluorosurfactants - Not in other constituents
  - example: Butyl Carbitol log BCF = 0.46
- Foams

Background: AFFF Properties
MILSPEC vs. Typical QPL Product

Property	MIL-F-24385F Requirements			Typical QPL Product		
	3%	6%	FF	3%	6%	FF
Chemical Oxygen Demand (mg/L)	1,000,000 Max	500,000 Max	30,000 Max	750,000	341,000	22,500
Biochemical Oxygen Demand (mg/L)	BOD_{20} > 0.65 x COD			720,000 (0.96*COD)	274,000 (0.80*COD)	21,600
Aquatic Toxicity (Killiefish) (mg/L)	500 Min	1000 Min	16,667	>1000	>1000	>16,777 or >33,333

Codes and Standards Survey
Approach

- Electronic Review
- Federal Environmental Regulations
  - "AFFF"
  - MILSPEC AFFF Constituents (19)
    - Surfactants
    - Fluorosurfactants
    - Glycol Ethers
    - Urea, etc.
  - AFFF "Environmental" Properties
    - Biochemical And Chemical Oxygen Demands
    - Aquatic Toxicity
    - Foaming
- DOD, State And Local Regulations
  - "AFFF"
  - MILSPEC AFFF Constituents

Codes and Standards Survey
Federal Environmental Regulations

- Clean Air Act (CAA)
  - Air Emissions
  - Air Discharge Permits
- Emergency Planning and Community Right-to-Know Act (EPCRA)
  - Toxics Release Inventory (TRI)
  - Chemical Storage and Use
- Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA)
  - Superfund Amendments and Re-authorization Act (SARA)
  - Spills and Clean-up Of Spills
- Resource Conservation and Recovery Act (RCRA)
  - Hazardous Waste
- Safe Drinking Water Act (SDWA)
  - Regulates Contaminants in Treated Drinking Water
- Clean Water Act (CWA)
  - Water Discharges
  - Water Discharge Permits

Federal Environmental Regulations
Results

- Clean Air Act (CAA)
  - Glycol Ethers In AFFF Are Hazardous Air Pollutants (HAPs)
  - HAP Releases Are Regulated by the Installation Air Permit
    - Major Sources for HAPs Might Have Potential Permit Issue
- EPCRA and TRI
  - Glycol Ethers are Covered Because CAA Defines them as HAPs
  - Chemicals Released Above a Reportable Quantity (RQ) Must Be Reported
    - Default RQ was One (1) Pound
    - EPA Established a No RQ
  - AFFF Discharges Do Not Currently Need to Be Reported Under EPCRA and TRI
  - Ethylene Glycol Specifically Listed
  - No Other Constituent is Currently Regulated by EPCRA and TRI

Federal Environmental Regulations
Results

- CERCLA and SARA
  - Glycol Ethers are Covered Because CAA Defines them as HAPs
  - Glycol Ethers May Need to Be “Cleaned Up” After a Spill
    - Air Pollutants So Expected to be Volatile
      - Are not volatile when mixed with water
    - Biodegradable So Might Be “Cleaned Up” Naturally
- Resource Conservation And Recovery Act (RCRA)
  - AFFF and Its Constituents are Not Classified as Hazardous Waste
  - RCRA Does Not Apply
- Safe Drinking Water Act:
  - Primary Drinking Water Regulations (Health Properties)
    - Does not regulate AFFF or its constituents
  - Secondary Drinking Water Regulations (Aesthetic Properties):
    - Foaming Agents <0.5 mg/L in drinking water
    - Do not regulate foaming agents in source water
    - Guideline for State Regulations Only (Not Federally Enforceable)

Federal Environmental Regulations
Results (Continued)

- Clean Water Act (CWA)
  - Installations Require Discharge Permits
    - Storm Water
    - Treated Sewage from Installation Wastewater Treatment Plant
    - Raw Sewage to Public Wastewater Treatment Plant (Locale Specific)
  - Regulates Wastewater that:
    - Foam
    - Remove Oxygen From Water
    - Disrupt Wastewater Treatment Plants, etc.
  - AFFF
    - Persistent Foam
    - Removes High Amounts of Oxygen From Water (High BOD and/or COD)
    - Untreated, Undiluted AFFF Will Disrupt Wastewater Treatment Plant
    - (Even Diluted AFFF Can Disrupt Wastewater Treatment Plant) SDWA

Codes and Standards Survey

State/Local Environmental Regulations

- State Regulations Can be More Strict Than Federal
  - No Specific Instances Found for AFFF
  - Storm Sewer Regulations Emphasized
- Nothing Additional in County and City Regulations
- Representative Jurisdictions
  - Telephone Surveys
  - Focused on Jurisdictions In:
    - Virginia
    - Hawaii
    - Florida
    - California
- Local Anecdotal AFFF ‘Problems’
  - Sewage Treatment Plants Becoming ‘Bubble Baths’
  - Pump Stations ‘Burned-up’
  - Storm Sewer Overflowing With Foam

State/Local Environmental Regulations
(Continued)

- Foaming the Greatest Concern
- Perception:
  - Foam Is Highly Toxic to Everything
  - No Concentration is Okay for a WWTP
- Results
  - Local Jurisdictions **CAN** and **DO** Regulate AFFF by Name
  - Have Water Discharge Permit Authority
  - Local Waste Water Treatment Plants Often Ban AFFF
    - Based on Direct Experience with a Disruption
    - High Oxygen Demand
    - Foaming

Environmental Consequences

- Media Considered
  - Air
  - Groundwater
  - Soil
  - Surface Water
    - Via storm water
    - Via wastewater treatment plant
- Both Constituent Characteristics and AFFF Solution Properties

Environmental Consequences
Media: Air

- HAPS: Butyl Carbitol, Ethylene Glycol
- Low Migration Potential (All Constituents)
  - Highly Soluble in Water
    - Tends to stay with liquid water
    - Not very volatile
  - If Volatilized, Half-lives in Air 4 Hr - 3.5 Days

Environmental Consequences
Media: Groundwater

- Consequence Varies Depending on Subsurface Conditions
- Fluorosurfactants: Not Mobile
- All Other Constituents:
  - Highly Soluble, Highly Mobile
  - Degrades Rapidly in Soil
    - 30% Degradation Over 24 Hour Period
- Drinking Water Wells ‘Under the Influence of Surface Water’ Could Receive Undegraded AFFF Constituents

Environmental Consequences
Media: Soil

- Consequence varies depending on soil type
- Fluorosurfactants and break-down products
  - Persistent in soil
  - No quantified environmental impact
  - EPA will discuss further tomorrow
- Other constituents highly mobile in water, will not adsorb to soil

Environmental Consequences

Media: Surface Water Via Storm Water

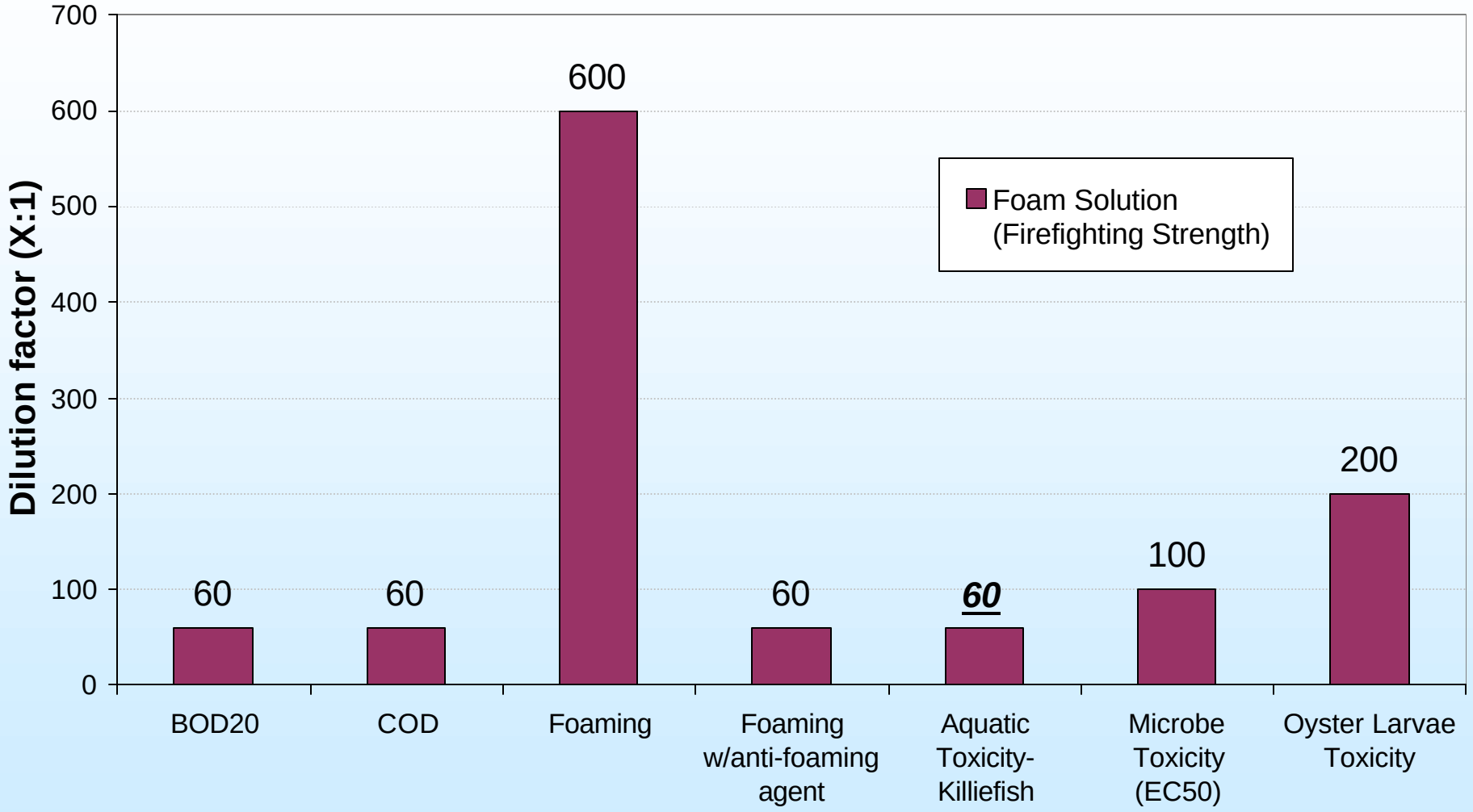
- Foaming:
  - Aesthetic Concern
- Oxygen Demand
  - Robs Oxygen from Water
  - Usually near water's surface
- Aquatic Toxicity
  - Considered 'Practically Nontoxic' by the US Fish and Wildlife Service.
  - Lowest toxicity value in 40 CFR 300
    - LC50 > 1000 mg/L in concentrate
    - ~160 mg/L in most sensitive species
    - Much Lower Toxicity in Firefighting Strength
  - Anecdotal Reports of Higher Toxicity
- Surface Water May influence Groundwater
- 'Environmental' Threat
  - Depends on Sensitivity of Receiving Water: Worst Cases
    - Kaneohe Bay, HI Risk Analysis - "Potential for significant ecological damage … relatively small"
    - Wetlands
      - Waterfowl-Fluorosurfactant Interaction being studied in St. Johns River Basin in Florida.

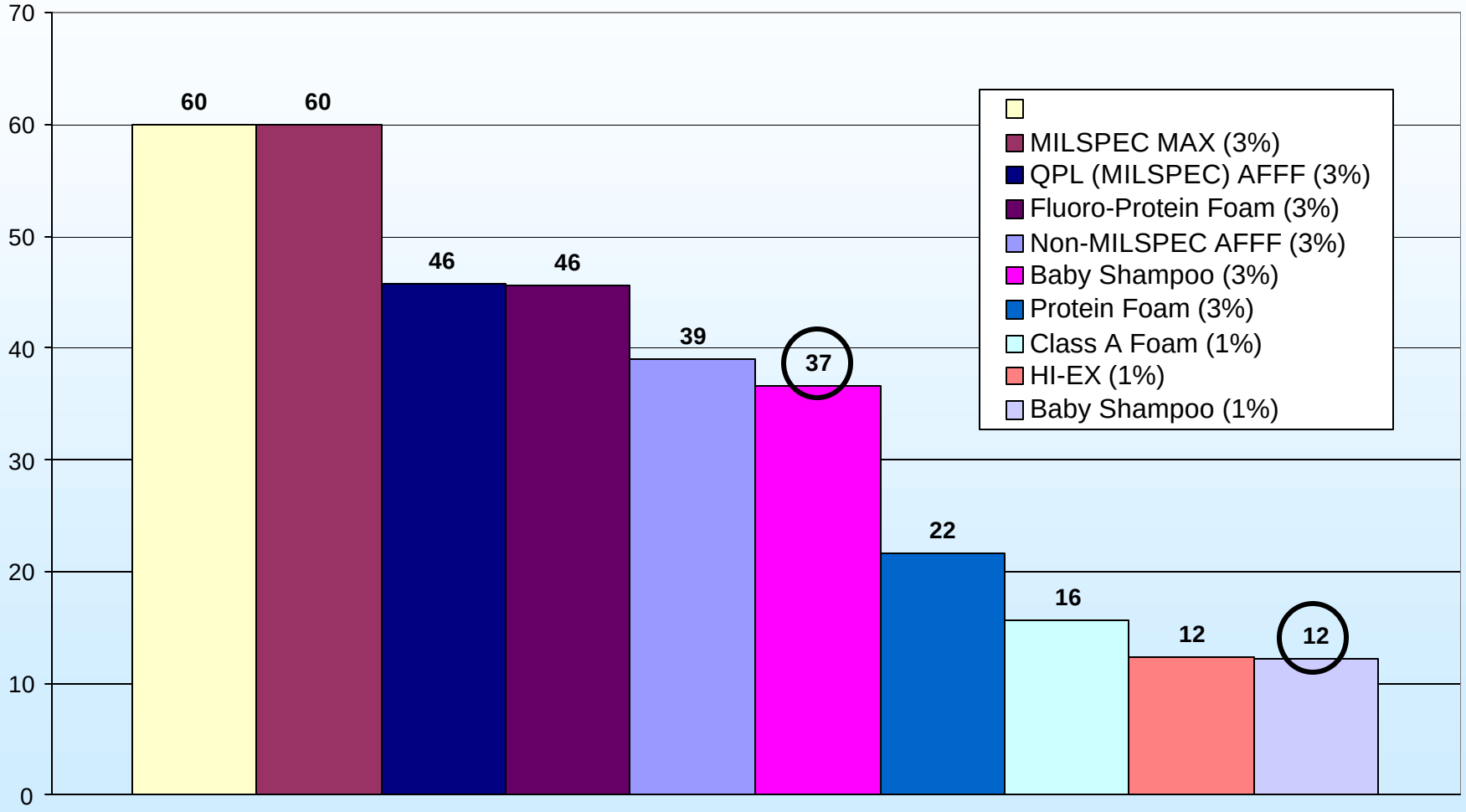
Environmental Consequences

Media: Surface Water Via Direct Discharge to WWTP

- Disrupts plant through:
  - Foaming
    - Disrupts mechanical devices
    - Causes ‘sludge bulking’
    - Causes Froth
  - High Oxygen Demand
    - Removes all oxygen - killing microorganisms used to treat sewage
    - Causes ‘sludge bulking’
  - Aquatic Toxicity
    - Of lower concern than Foaming and Oxygen Demand
    - May cause ‘sloughing’ of organisms from certain processes
- Disrupted plant:
  - Contaminates receiving water
  - Could cause fish kill
  - Makes water unfit for:
    - Drinking
    - Recreation, etc.

Representative Dilution Factors for Treatment of MAX MILSPEC AFFF at a WWTP




70
60
50
40
30
20
10
0
60
60
46
46
39
37
22
16
12
12
MILSPEC MAX (3%)
QPL (MILSPEC) AFFF (3%)
Fluoro-Protein Foam (3%)
Non-MILSPEC AFFF (3%)
Baby Shampoo (3%)
Protein Foam (3%)
Class A Foam (1%)
HI-EX (1%)
Baby Shampoo (1%)

Summary

- Under Context of Current Laws/Regulations, AFFF and all other Foams Regulated Based On:
  - Properties
    - BOD, COD, Foaming and Aquatic Toxicity
  - "Listed" Chemical Constituents
    - Butyl Carbitol, Surfactants, Ethylene Glycol, Urea, etc.
  - Water Issues are Most Prevalent
  - Foaming is Major Issue for WWTP
- Potential Environmental Impacts Generally Low
  - Impacts Consequence of
    - Foaming
    - O_2 Demand
    - Aquatic Toxicity
  - Upset of WWTP Creates Greatest Impact