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PFAS Risk in the Oil and Gas Industry

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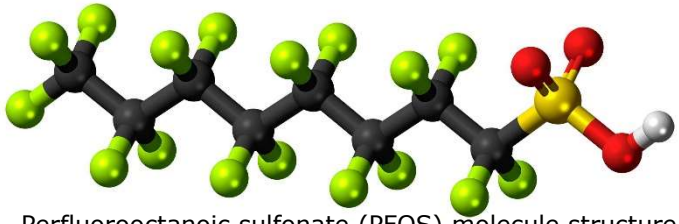
Context and Outline

- Firefighting Foam 101
  - Lessons Learned
  - Recommendations

Per- and poly**f**luoro**a**lkyl **s**ubstances

- "Forever Chemicals"
- Emerging contaminants of concern due to persistence, bioaccumulation, and potential toxicity
- Health impacts for high levels of exposure may include reproductive and developmental impacts, endocrine system disruption, lowered immune system, possibly carcinogenic
- Regulatory framework in Canada is rapidly evolving



Perfluorooctanoic sulfonate (PFOS) molecule structure
(from Jynto, CC0, via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Perfluorooctanesulfonic-acid-3D-balls.png)

Recent research on PFAS compounds link exposure to certain PFAS compounds to worse COVID-19 outcomes
(photo from Chemistry World https://www.chemistryworld.com/news/pfas-exposure-found-to-increase-risk-of-severe-covid-19/4012992.article)

Firefighting Foam 101

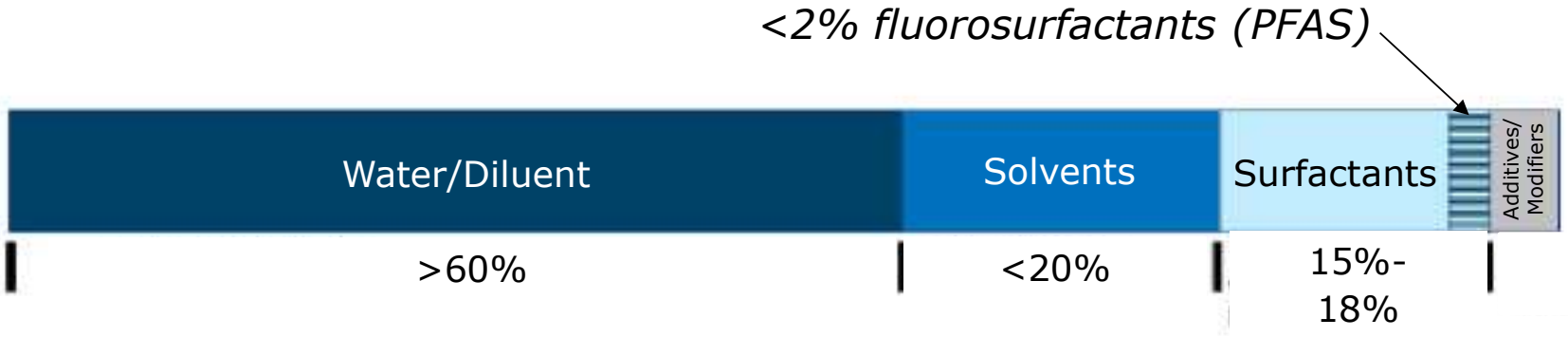
PFAS in Firefighting Foam

- Active ingredients in aqueous film-forming foam (**AFFF**) used to extinguish Class B fires (liquid hydrocarbon) and suppress hazardous vapours
- Defence and airline industries are ahead of Oil and Gas when it comes to managing PFAS risk from AFFF
- O&G facilities that rely on AFFF for emergency response include processing units, extraction plants, pipeline and tank terminals and retail facilities
- Municipal fire-fighters also use AFFF (3rd party risk)

www.springwellwater.com/how-afff-firefighting-foam-can-pollute-drinking-water/

What's in Aqueous Film-Forming Foam (AFFF)

Proprietary mixture of water or other diluent, solvents, and surfactants

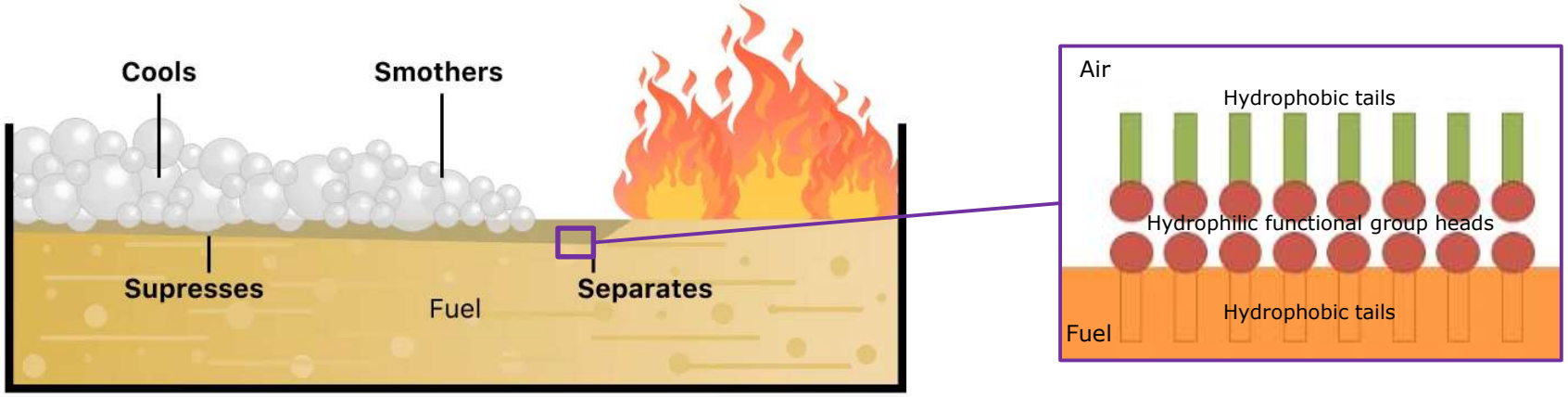


Composition of a typical 3% Modern AFFF concentrate

ITRC – Firefighting Foams – pfas-1.itrcweb.org/3-firefighting-foams/

How AFFF Works

- Mixes with air and water to create foam
- Foam blanket cools and smothers fire
- PFAS film spreads over surface of fuel with hydrophobic tails oriented outward and hydrophilic functional group heads oriented inward
- Film creates a barrier to suppress vapor and prevent reignition



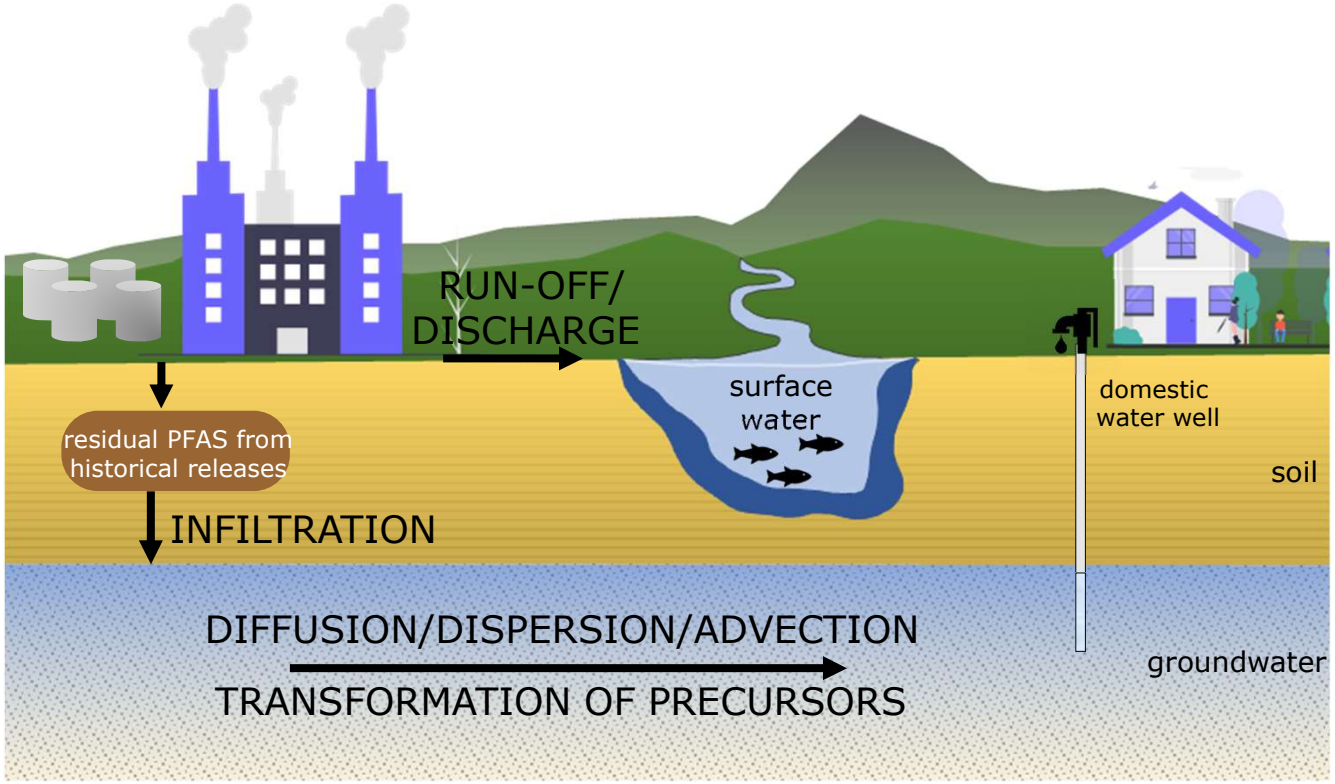
https://www.necaaae.org/assets/docs/3.29.19%201030%20CocTerr_NEC-AAEs-Airports-Conference-PPT-Draft-030419%20-%20Richart.pdf

Types of Class B Firefighting Foams

Common Name	Technical Classification	PFAS Manufacturing Process	PFAS Content
"C8"	Legacy PFOS AFFF a.k.a. 3M Lightwater (1960s-2002)	Electrochemical Fluorination	Long-chain PFAS compounds (PFOS and other PFSAs)
	Legacy Fluorotelomer AFFF (1970's – 2016)	Fluorotelomerization	Long-chain PFAS compounds (LC-PFCA precursors)
"C6"	Modern Fluorotelomer AFFF (2016 – Present)	Fluorotelomerization	Short-chain PFAS compounds (trace LC-PFCAs)
"F3"	Fluorine-Free Foam	n/a	***Do not contain PFAS***

Modified from ITRC
https://pfas-1.itrcweb.org/3-firefighting-foams/#3_1

Environmental Pathways



Lessons Learned

Sampling & Analysis

Challenges:

- Cross contamination potential is high
- Sampling waste must be disposed of properly
- High costs, long turnaround times
- Limited sampling suite via standard methods (i.e. sum of PFAS is not equal to Total PFAS!)

Lessons:

- Follow sampling protocols and develop rigorous QA/QC program (blanks!)
- Manage soil and purge water
- Build buffer into Cost, Schedule, and Budget (don't overcommit)
- Understand analytical options and limitations

Banned materials for PFAS investigations include sunscreen, insect repellent, Sharpie markers, latex gloves, water-resistant clothing, blue ice, and cosmetics (photo from LimnoTech https://www.limno.com/sampling-for-pfas-requires-caution/)

Limiting Migration

Challenges:

- Soluble in oil and water – migration potential
- Adsorb to soil, concrete and equipment (can act as "reservoirs")
- Managing weather events

Lessons:

- Clean up spent foam ASAP
- Understand and limit drainage
- Decontaminate surfaces that contacted PFAS (and be prepared to manage rinse-water)
- Ensure adequate storage

Spent AFFF from a nearby air force base rings the shoreline of a small lake in Michigan (photo from Michigan Bridge https://www.bridgemi.com/michigan-environment-watch/environmentalists-outraged-michigan-warning-about-pfas-went-unheeded)

Characterizing AFFF Source

Challenges:

- AFFF formulations are proprietary, compositions vary from batch to batch
- PFAS precursors transform soon after AFFF use - limited ways to characterize PFAS "Dark Matter"
- Changes in concentration can be easily misinterpreted

Lessons:

- Collect post-response samples close to source where feasible
- Understand precursor potential / uncertainties
- Consider supplementary lab analyses (TOF and/or TOPS)

COMPOSITION/INFORMATION ON INGREDIENTS

This product is a mixture.

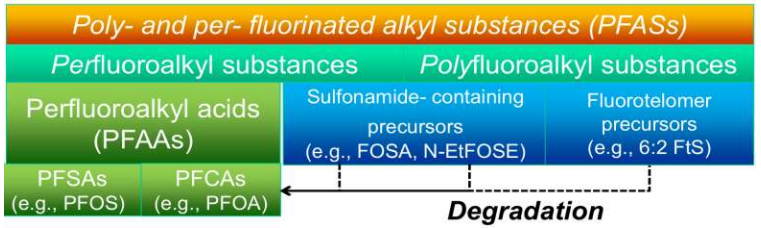
Component	CAS Number	Concentration*
Sodium decyl sulfate	142-87-0	1 - 5%
Alkylpolyglycoside	132778-08-6	1 - 5%
Dipropylene Glycol Monomethyl Ether	34590-94-8	1 - 5%

*Exact concentration withheld as trade secret.

3. Composition / Information on Ingredients

Components	CAS #	Percent
Butyl Carbitol	112-34-5	10 - 20
Other components below reportable levels		80 - 90

Information provided in Safety Data Sheets (SDS) for AFFF products generally do not specify PFAS compound concentrations.



Source: Citizens for Safe Water Around Badger https://cswab.org/wp-content/uploads/2018/10/PFAS-CSWAB-Presentation-Oct-2018.pdf

Disposal of AFFF and impacted liquids and solids

Challenges:

- PFAS are difficult to destroy
- Standards for testing PFAS in waste are still under development

Lessons:

- Consider US EPA Interim Guidance on PFAS Destruction and Disposal (storage, downhole disposal, hazardous waste landfills, industrial landfills, thermal treatment)
- Understand costs and risks associated with disposal methods before making decision

Table 1-1. Destruction and Disposal Technologies Discussed in This Guidance, with Examples of PFAS-Containing Materials

Destruction and Disposal Technology, by Physical Phase of Materials	Examples of PFAS-Containing Materials (Within the Scope of the FY 2020 NDAA) That Could Be Managed Using These Technologies

Solid phase:
Landfill disposal
Thermal treatment
	• Drinking water, groundwater, and wastewater treatment residuals
	  ○ Biosolids
	  ○ Spent granular activated carbon (GAC)
	  ○ Ion exchange resins
	  ○ Filters
	  ○ High-pressure membranes
	• Air waste stream treatment residuals
	  ○ Spent GAC
	  ○ Fly ash
	• Contaminated soil
	• End-of-life products (e.g., textiles)

Liquid phase: Underground injection Thermal treatment	• Landfill leachate • Aqueous film-forming foam • End-of-life products (e.g., spent cleaning solvents) • Pollution control residuals (e.g., concentrates) from PFAS production and use
Gas phase: Thermal treatment	• Landfill gas • Emissions from manufacture, use, or destruction

Source: United States Environmental Protection Agency. 2020. Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances. https://beta.regulations.gov/document/EPA-HQ-OLEM-2020-0527-0002

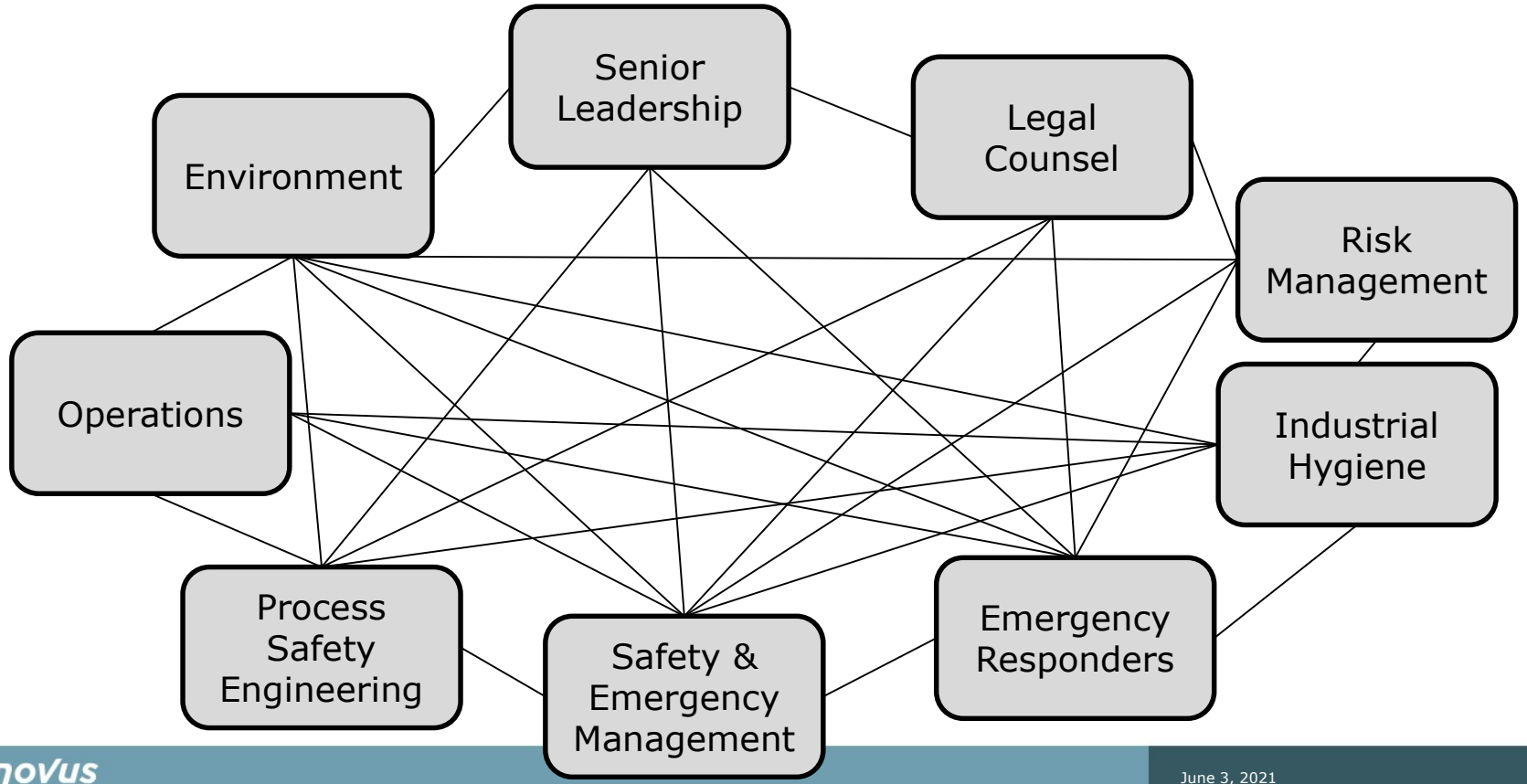
Recommendations

Step 1: Learn, Educate, Repeat

- Interstate Technology Regulatory Council PFAS Site
  - Frequently updated global regulatory guidelines for soil and water
  - Fact Sheets, training videos, toolkits etc.
- Webinars, Conference presentations
- Peer-reviewed journal articles
- Government guidance

Be cautious with information from foam manufacturers/distributors, media articles, environmental NGOs, and industry advocacy groups

Step 2: Collaborate with Internal Stakeholders



Step 3: Develop Mitigations

- Develop best practices for AFFF storage, use, and containment
- Update ERP, tactical, and spill response documents to specifically address AFFF containment and clean-up post-incident
- Consider using lower risk firefighting foams

www.michigan.gov/pfasresponse/0,9038,7-365-86514-496805--,00.html

Contact

Thank you!

Questions, comments, concerns?

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