



PFAS Forensics at Airports and Beyond

September 24, 2024

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TRB



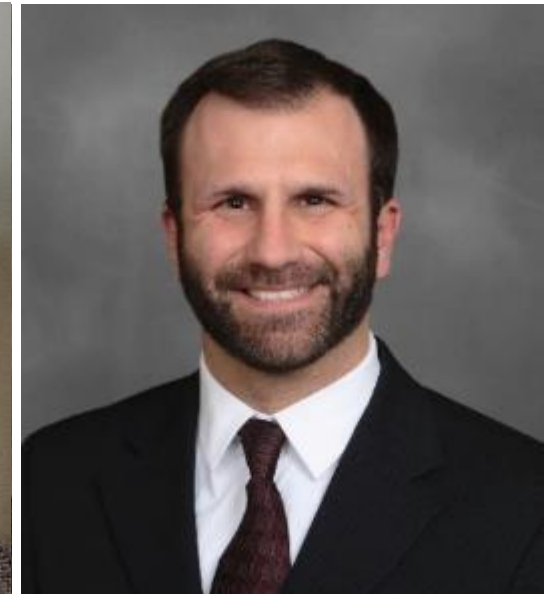
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UNDERSTANDING PFAS SOURCES.

DATA-DRIVEN APPROACH.

PRACTICAL SOLUTIONS.



Research Team



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Goal

- Develop a practical guidance document that airport personnel can use
- Not just another “high-level technical report” or “white paper”
- Provide relevant information for a wide range of audiences



Today's Presentation

Part 1 – PFAS Landscape

Part 2 – Developing “Lines of Evidence” to support PFAS Source Identification and Differentiation

Part 3 – Screening Tool and Next Steps/
Research Needs

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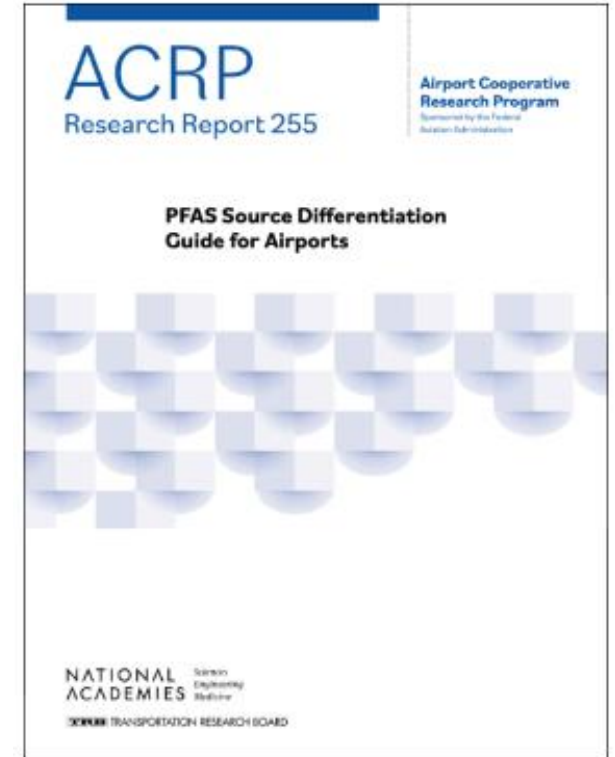


What's Inside the Guidebook?



Scan QR Code for document

- Introduction
 - Relevant PFAS as it relates to this research
 - History of PFAS in AFFF
- Airport PFAS Issue Awareness
- Source Differentiation Approaches to Build Lines-of-Evidence (Desktop – Analytical – Forensics)
- Screening Level Data Visualizations based on novel analyses of publicly available PFAS data
- Overview of Downloadable Differentiation Screening Tool



KEY POINT

Key point text boxes summarize significant concepts of this guide.

TECHNICAL DETAIL

Technical detail text boxes provide additional technical background information.

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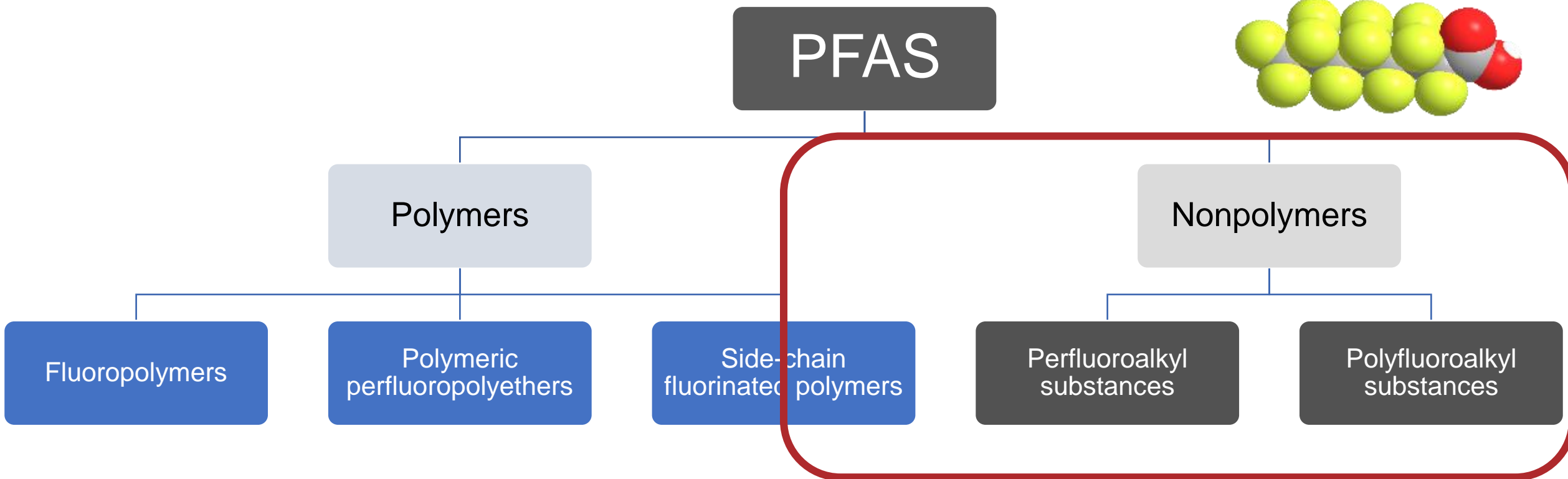
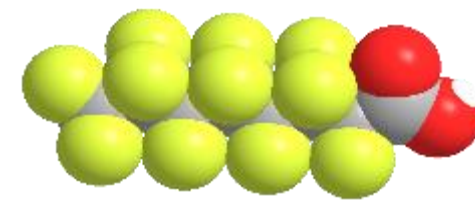
Airport PFAS Issue Awareness

- Guidebook includes chapter to provide higher-level overview of airport PFAS issues
- Includes PFAS 101 information
- FAQ about Airport PFAS and AFFF
- Regulatory Review (snapshot in time)
- “Triggering Events” that may drive differentiation



PFAS 101 – PFAS Family Tree

>12,000 PFAS Grouped by Chemistry
All Very Different Chemistries and Uses



PFAS of relevance

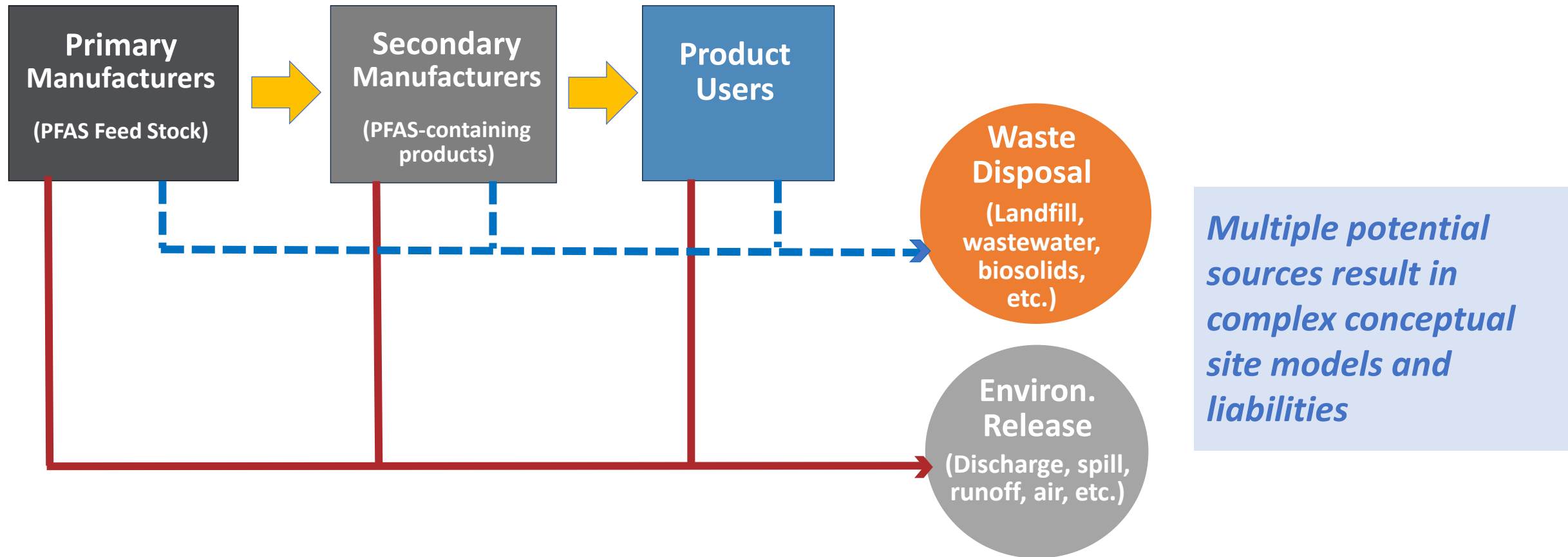
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PFAS 101 – Environmental Releases



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EPA's Recent "Trifecta" of PFAS-Related Actions



- Interim Guidance on PFAS Destruction and Disposal Document (April 16, 2024) [Link to EPA D & D Fact Sheet](#)
- Final PFAS National Primary Drinking Water Regulation (April 10, 2024) [Link to EPA NPDWR Fact Sheet](#)
- Final Rule – Designation of PFOA and PFOS as Hazardous Substances under CERCLA (May 8, 2024) [Link to EPA PFAS Haz Substance Designation Fact Sheet](#)

Chemical	Maximum Contaminant Level Goal (MCLG)	Maximum Contaminant Level (MCL)
PFOA	0	4.0 ppt
PFOS	0	4.0 ppt
PFNA	10 ppt	10 ppt
PFHxS	10 ppt	10 ppt
HFPO-DA (GenX chemicals)	10 ppt	10 ppt
Mixture of two or more: PFNA, PFHxS, HFPO-DA, and PFBS	Hazard Index of 1	Hazard Index of 1

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Airport PFAS Landscape

On-Airport PFAS Sources

- AFFF use in emergency response (mobile and fixed systems)
- Firefighter training (burn pits, etc.)
- Part 139 certification
 - ARFF truck foam proportioning system calibration
 - AFFF training areas
 - Timed response
- Maintenance of ARFF vehicles
- Accidental discharge (e.g., hangar)
- Spills and leaks from handling and storage of AFFF
- And maybe others...



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AFFF

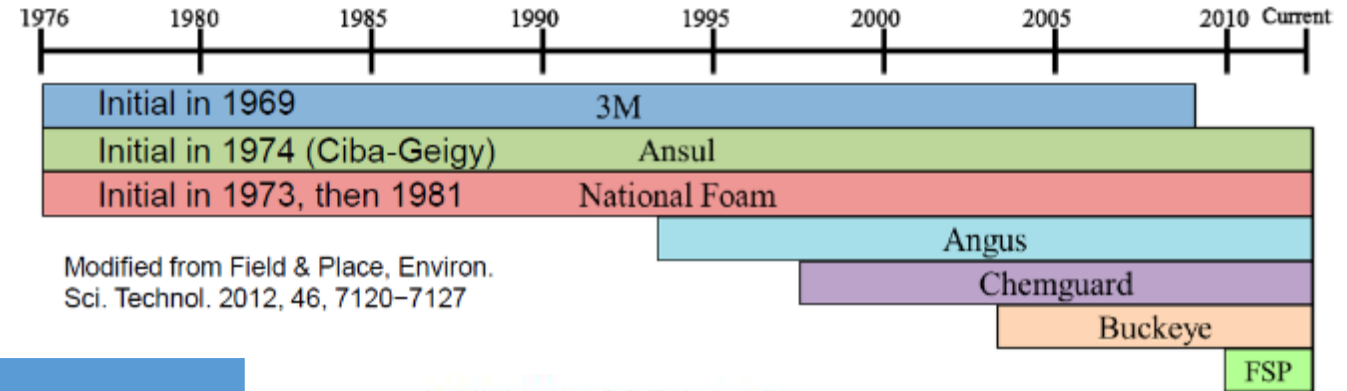
Not all Class B Firefighting Foams Contain PFAS

Foams with PFAS

- Aqueous film-forming foam (AFFF)
- Alcohol-resistant aqueous film-forming foam (AR-AFFF)
- Film-forming fluoroprotein foam (FFFP)
- Alcohol-resistant film-forming fluoroprotein foam (AR-FFFP)
- Fluoroprotein foam (FP)
- Alcohol-resistant fluoroprotein foam (FPAR)

Foams without PFAS

- Protein foam
- Alcohol-resistant protein foam
- High expansion foams
- Synthetic fluorine-free foam (FFF or F3)
- *new* Fluorine Free (F3) Mil-Spec/FAA Approved foams



1967 USS Forrester fire



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Fluorine Free Foams

FAA approved F3 in September 2023 that meets current performance specifications

REGULATION REMEDIATION LIABILITY

FAA Allows Use Of PFAS-Free Firefighting Foam After DOD Certification

September 19, 2023

Tweet

The Federal Aviation Administration (FAA) has notified airports that they may begin using PFAS-free firefighting foam recently certified by the Defense Department (DOD), although airports are not required to use the new foam.

In a **Sept. 13 "CertAlert"**, FAA notifies Part 139 airports and industry that there are now fluorine-free foams (F3) that meet DOD's new military specification (MIL-SPEC) and can be used at FAA-certified airports.


The alert also notes that the Naval Sea Systems Command (NAVSEA) will continue to update a DOD database with approved F3 concentrates.

FAA's alert follows NAVSEA's Sept. 12 addition of the first F3 products to its Quality Product List (QPL) webpage and comes ahead of an Oct. 1 deadline for DOD to halt purchase of firefighting foam that contains detectable levels of PFAS for land-based use.

Green - Source is Certified, Yellow - Source is due for Certification, Red - Source is overdue for Certification. Contact QA for additional information.
Total part count - 1

▼▲Wtr Designation	▼▲Source Name	▼▲CAGE Code	Related Links
SOLBERG 3% MIL-SPEC SFFF ***SEE SOURCE NOTES*** NSN: 4210-01-715-4388 (55-GAL. CONT.)	PERIMETER SOLUTIONS LP 8500 MARYLAND AVE 5111 3RD SAINT LOUIS, MO 63116-1910 USA www.phoscheck.com Test Reference: NRL Report 3800 Ser 0150V0233/2023 dtd 7/26/23; NAVSEA LTR 9555 SER 06P/238 OF 9/11/23 (Approved by NAVSEA LTR 959/2023-323 dtd 9/12/23)***SEE SOURCE NOTES***	1RKKV	[Source Filter] [Source Filter] [Source Filter]



Page 1 of 1 1 Go to Page



FLUORINE-FREE FIREFIGHTING FOAMS (3F) VIABLE ALTERNATIVES TO FLUORINATED AQUEOUS FILM-FORMING FOAMS (AFFF)

Independent Expert Panel Convened by IPEN
Stockholm Convention POPRC-14
Rome

September 2018



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But It's Not Just AFFF....

Examples of products that MAY contain PFAS	
Aerosol propellants	Metallic and ceramic surfaces
Antifoaming agent	Pipes, pumps, fittings and liners
Ammunition	Plastic and rubber
Coatings, paints and varnishes	Refrigerant systems
Dispersions	Resins
Fire-fighting foam	Sealants and adhesives
Flame retardants	Soldering
Lubricants and greases	Wire and cable insulation, gaskets and hoses

Modified from *Gluge et al. 2020*

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So.... Whose PFAS Is It? (also: How Many Source Areas Are There?)



- Guidance for the airport environmental manager
- Data-driven, practical approach
- Used input from real-world experts and airports currently “in the mix”
- Designed to be applicable at any point - from initial questions to assessing multiple years of PFAS data
- Includes analysis of 800,000+ PFAS data to develop PFAS source area patterns

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“Lines of Evidence” Approach



DESKTOP REVIEW

- On-Airport Sources
- Off-Airport Sources
- Site Characteristics



CONVENTIONAL SAMPLING

- Available Methods
- Best Practices
- Source Screening



ADVANCED FORENSICS

- State-of-the-Science
- When to Consider
- What to Expect

- There is no “silver bullet” when it comes to PFAS forensics
- Many advanced technologies are becoming available, but still need to be validated
- There are numerous evaluations that can be done with conventional data and a good conceptual site model

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Desktop Review – Potential PFAS Sources

Resource for Information About Potential On- and Off-airport PFAS Sources

- Environmental Site Assessments (Phase 1 and Phase 2)
- Toxic Release Inventory (TRI)
- NPDES permits
- EPCRA sections 311-312 reporting
- Federal and state environmental databases
- Other resources (11 additional listed in **Table 3.5, ACRP Research Report 255**)



Image Source: <https://efficiency.com/organizecomputerfiles/>

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Conventional Sampling – Complicated data interpretation, but can be useful

- **Use the full set of PFAS data**
 - Don't focus on only "risk-driving" PFAS
- **Importance of well-defined conceptual site model**
 - Hydrogeology/Geology/Soils
 - Depth to groundwater
 - Flow direction
 - Bedrock type and competency
 - Soil properties
 - Climatological setting
 - Manufactured conduits (utility corridors/trenches)
- **Stormwater infrastructure**
- **Consideration of precursor transformation**
- **Consideration of PFAS-specific fate and transport**



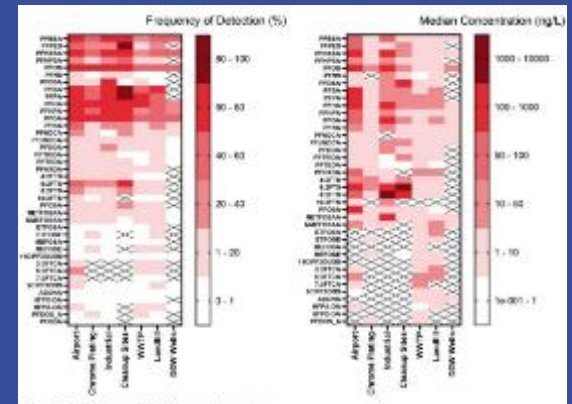
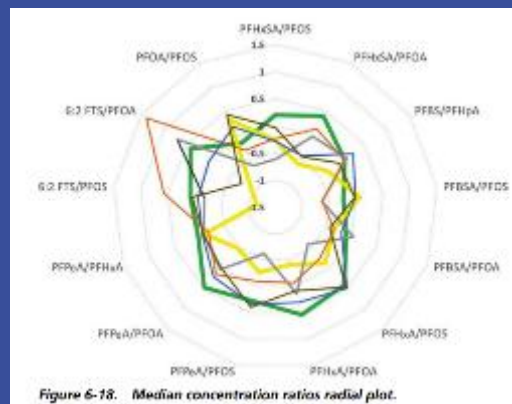
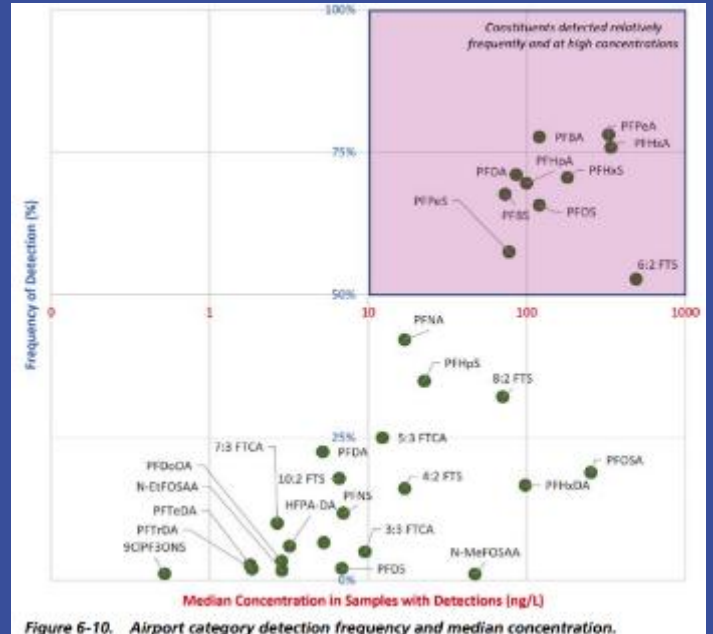
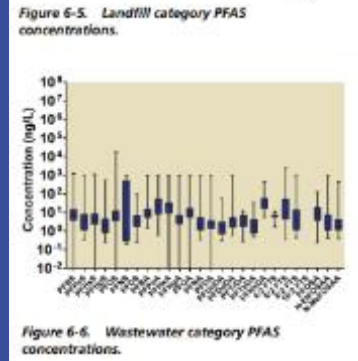
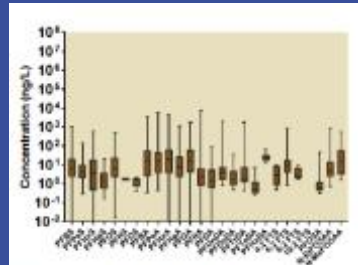
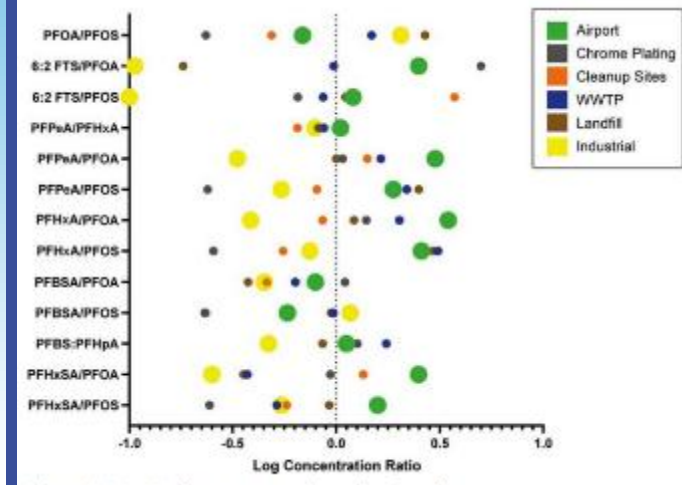
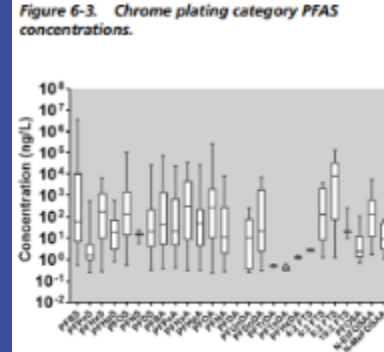
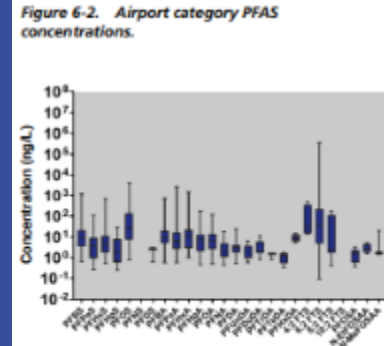
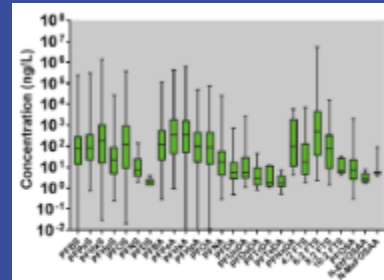
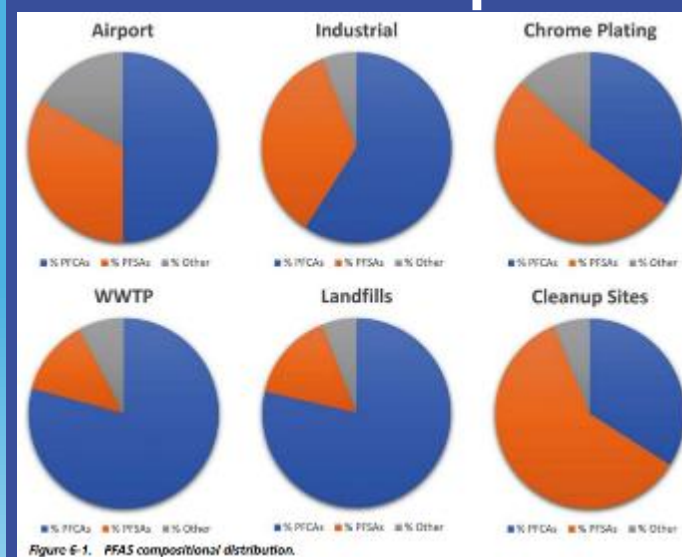
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PFAS Compositional Distribution Visualizations



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PFAS Source Forensics Uncertainty

Table 6-3. High detection and frequency PFAS for source categories.

Source Type	Airport	Chrome Plating	Industrial Sites	Other Cleanup Sites	Wastewater Treatment Plants	Landfill
Compounds that exhibited high median concentrations and high frequencies of detection	PFPeA PFHxA PFBA PFHxS PFOS PFHpA PFOA PFBS PFPeS 6:2 FTS	PFOS PFHxA 6:2 FTS	PFOA PFHxA PFOS PFHxS PFHpA PFHxS PFBS PFBA PFPeA PFDS	PFBA PFPeA PFHxS PFOS PFHxA PFOA 6:2 FTS	PFHxA PFPeA	PFBA PFHxA PFPeA PFOA

Understanding PFAS Source Forensics Limitations

- No such thing as a definitive PFAS signature using conventional commercial data.
- Because there were only a few primary manufacturers of PFAS, products tend to have several PFAS in common (e.g., PFAAs) and may even share similar chemical signatures.
- Degradation eventually converts polyfluorinated precursor compounds to a limited set of perfluorinated end products (PFAAs), common among all PFAS source types.

It is critical to carefully consider supporting CSM information

A multiple-lines-of-evidence approach is necessary



Source: <https://imperialwriters7.medium.com/research-project-why-limitations-of-the-study-should-come-at-the-end-of-the-project-3282c8c1e36>

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Advanced Forensics

What

- Specialized commercial or academic analytical methods
- High-resolution mass spectrometry, non-target analysis, and computer learning algorithms
- May include alternative sample processing and analysis methods (e.g. TOP assay)
- Largely QUALITATIVE
- Significant on-going research

When

- Confirming screening results from conventional data
- Informing inconclusive information
- If source allocation is of relevance

Who

- Analytical chemistry experts
- U.S. Environmental Protection Agency Office of Research and Development
- Battelle PFAS Signature®
- Others...



Limitations:

- Not necessarily definitive, largely unvalidated
- Difficult to communicate/validate
- Generated using non-standardized methods
- Costly and limited commercial availability

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PFAS Source Differentiation Preliminary Screening Application

- Downloadable Excel-based Application
- Available from ACRP Report download page
- Focuses on Desktop Review
- Includes Compositional Distribution Data Visualization Tool



Desktop Review Progress Tracker

PFAS Source Differentiation Desktop Review Feedback

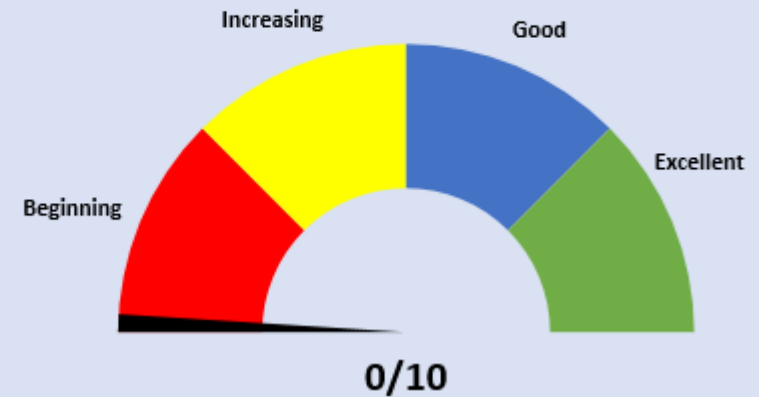
Objective:

Provide progress feedback on PFAS source differentiation desktop review efforts.

Instructions:

Input responses to the questions or statements for each category (separate tabs) on the level of consideration given to the topics related to PFAS sources .

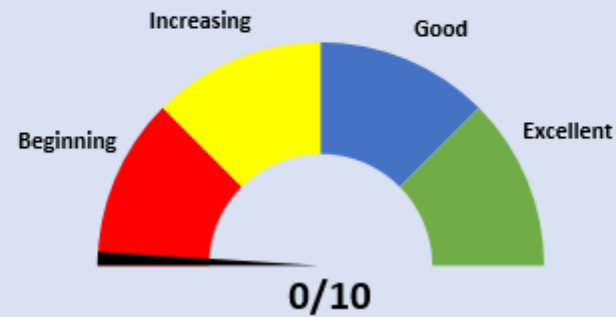
Overall Progress



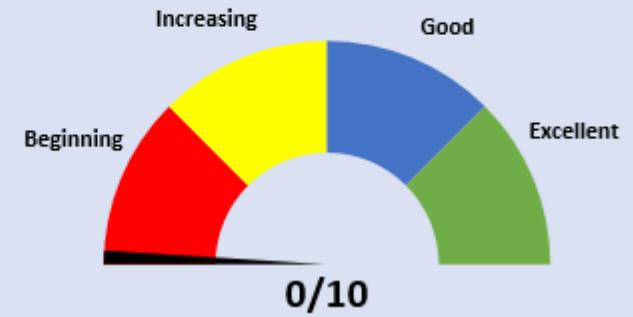
On-Airport Sources Progress



Off-Airport Sources Progress



Site Characteristics Progress



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On-Airport Source Review

Have you considered the following ARFF-related potential AFFF use?		Response	W
1	AFFF use during emergency response (aircraft accident, vehicle fires, etc.)		
2	ARFF truck Part 139 foam proportioning system testing	No consideration Some consideration Reviewed extensively Fully explored Not applicable	
3	ARFF firefighter AFFF training with mobile fire units		
4	ARFF firefighter training pits/sites		
5	AFFF use during Part 139 annual certification timed response drills		
6	Operational testing of ARFF truck foam system		
7	Maintenance of ARFF vehicles with AFFF discharge		
8	Unintentional release of AFFF including from handling, storage, or other activities		
Have you considered the following non-ARFF potential AFFF use?			
9	Hangar fire suppression systems with AFFF		
10	Fuel farm fire suppression systems with AFFF		
11	Military ARFF activities		
Have you considered other sources of relevant PFAS releases?			
12	Aircraft hydraulic fluid releases		
13	Application of biosolids from wastewater treatment facilities		
14	On-airport tenant industrial or manufacturing activities with PFAS exposure		
15	Historical land use at your airport with PFAS exposure (e.g., former landfill, former military)		
16	Soil stockpiles originating from potential areas of PFAS concern (e.g., former ARFF use locations)		
17	Areas where potential PFAS-impacted fill was used for infrastructure development projects		



Desktop Review Progress Tracker

35

Questions
to Explore

25

Questions
to Explore

22

Questions
to Explore



- Feedback on progress over time as it relates to desktop review
- *Not intended* to be used as a comparison between airports
- Tool could help communicate progress to:
 - Staff/Managers
 - Airport Executives
 - Boards/Commissions
 - Public
 - Other Interested Parties

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Compositional Analysis Visualization

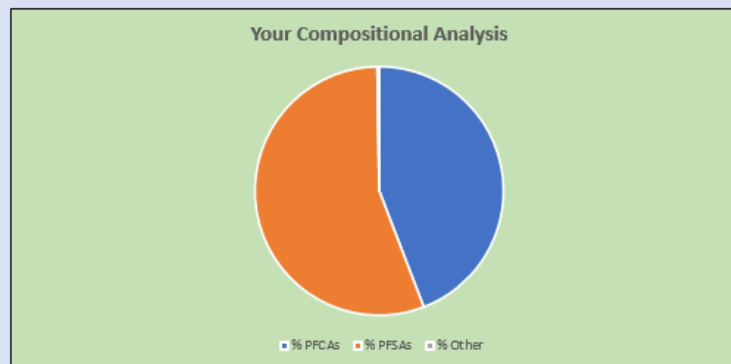
Compositional Analysis Comparative Tool

Objective:

Provide graphical representation of PFAS compositional analysis to allow comparison to exploratory source screening output as developed to assist in PFAS source differentiation.

Instructions:

Input PFAS data from a single monitoring point in the table below to generate a graphical representation of your data that can be compared to the information provided with the Guidebook (see Section 6 of the Guidebook). Source category screening data visualizations are provided to the right for ease of reference. Data from different monitoring points can also be compared to evaluate spatial patterns in PFAS composition and to help identify any locations where other sources (upgradient, off site) could be contributing. **Please note: this comparative analysis should not be considered definitive and should be incorporated into a lines-of-evidence approach**



RESULTS	% Compound Type	Help
% PFCAs	44%	Help
% PFSAs	56%	Help
% Other	0%	Help

YOUR DATA

PFAS	Abbreviation	CAS Number	PFAS Concentration (ng/L)
Perfluorobutanoic acid	PFBA	375-22-4	28
Perfluoropentanoic acid	PFPeA	2706-90-3	55
Perfluorohexanoic acid	PFHxA	307-24-4	73
Perfluoroheptanoic acid	PFHpA	375-85-9	26
Perfluorooctanoic acid	PFOA	335-67-1	51
Perfluorononanoic acid	PFNA	375-95-1	56
Perfluorodecanoic acid	PFDA	335-76-2	10
Perfluoroundecanoic acid	PFUnDA	2058-94-8	3.4
Perfluorododecanoic acid	PFDoDA	307-55-1	1.2
Perfluorotridecanoic acid	PFTeDA	73679-94-8	0.42

PFCA
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Airport (AFFF)



Industrial



Chrome Plating



Other Cleanup Sites



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Main Conclusions

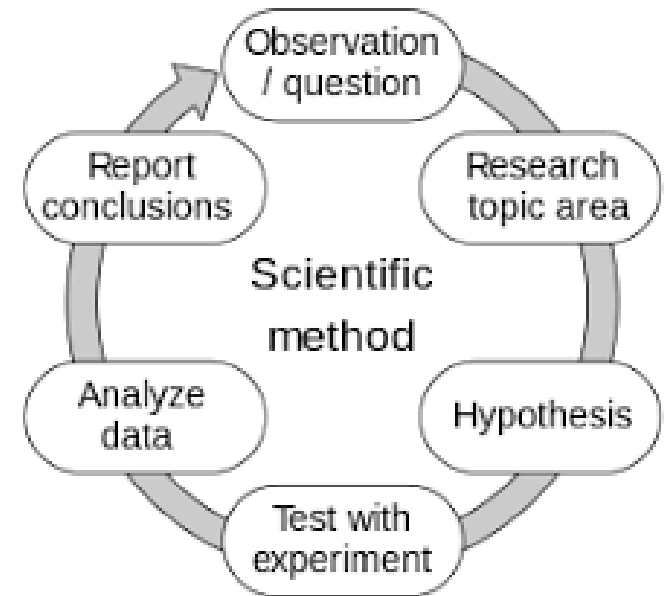
There is no “silver bullet” when it comes to PFAS source differentiation.

A “lines-of-evidence” approach is recommended using available information, which may include desktop reviews, info on historical operations, airport site characteristics, potential off-site sources, and laboratory analytical data.

The visualizations are only part of the evidence. They should be used in conjunction with other lines to build a source differentiation approach and consideration.

Potential Research and Next Steps

- This research largely completed by end of 2022
- Are there different data sources publicly available now than we did our analysis?
 - Can 800,000 points become two million?
 - How would that increase value in data visualizations?
- Case study of airport moving through source differentiation journey
- State-of-technology on PFAS forensics – what's changed since the research was conducted?



Questions?

Thanks for Your Attendance!

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