PFAS Source Differentiation at Airports

March 21, 2024
1PM-2:30PM ET

NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM

Today's Learning Objectives

(1) Develop targeted mitigation and remediation strategies using best practices and techniques for differentiating between PFAS sources

(2) Gain insight into the regulatory landscape and emerging technologies for PFAS detection and management, ensuring compliance with environmental standards and guidelines

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American Institute of Certified Planners (AICP)

1.5 Certification Maintenance Credits

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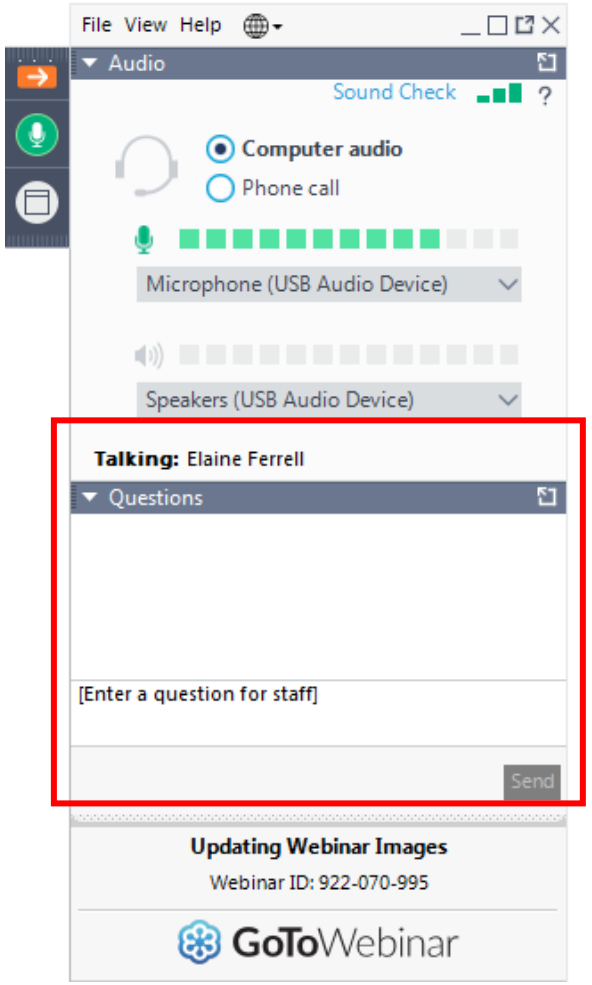
Log into the American Planning Association website to claim your credits

Questions and Answers

Please type your questions into your webinar control panel

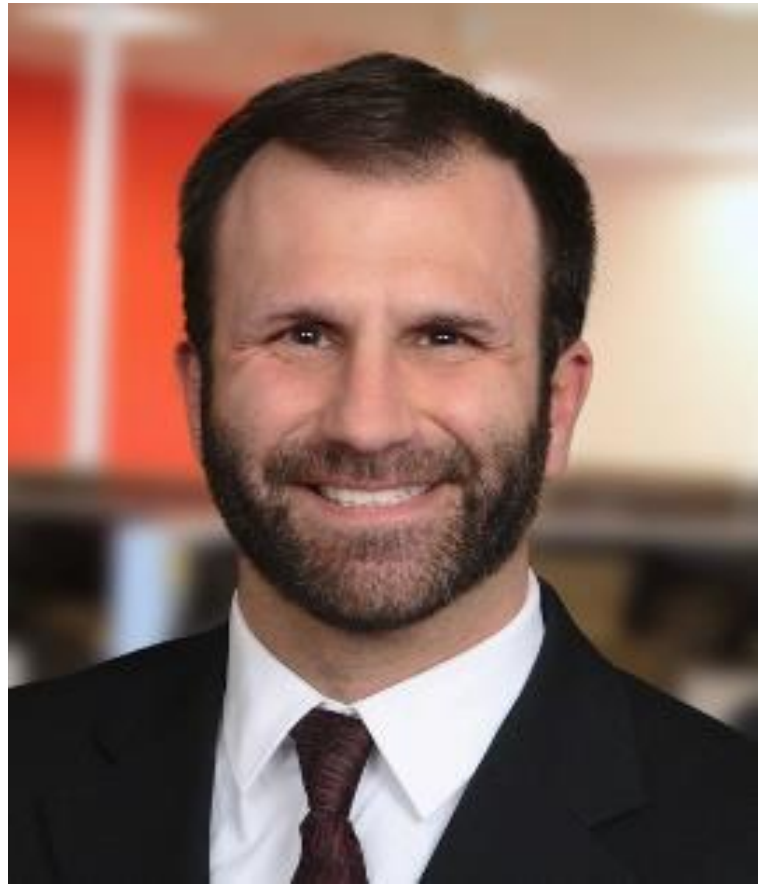
We will read your questions out loud, and answer as many as time allows

#TRBwebinar



Zachary Puchacz
Mead & Hunt, Inc.

- Aviation Planner
- 22 years of airport management and aviation consulting experience
- degree in Aviation Science and Administration from Western Michigan University
- Former airport operations coordinator at Teterboro Airport
- Former airport operations officer at the Capital Region International Airport
- experience with aqueous film forming foams (AFFF)
- contributed to ACRP Research Report 173, *Use and Potential Impacts of AFFF Containing PFASs at Airports*, and ACRP Research Report 255, *PFAS Source Differentiation Guide for Airports*



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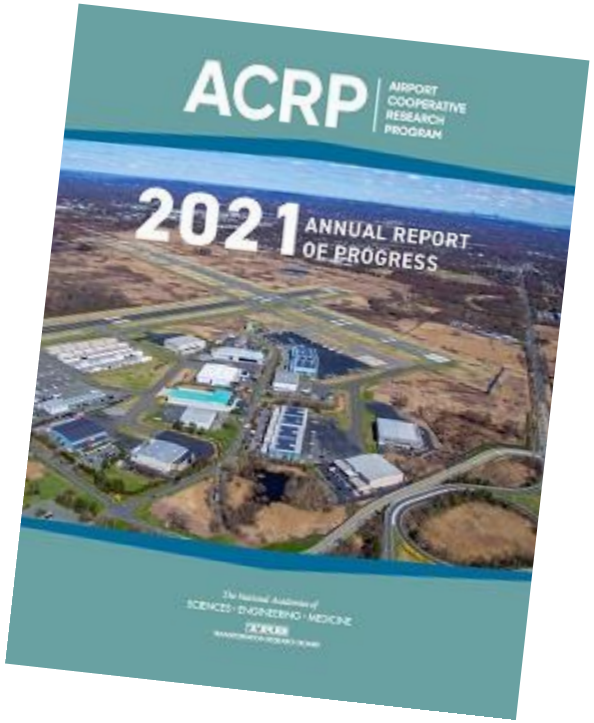
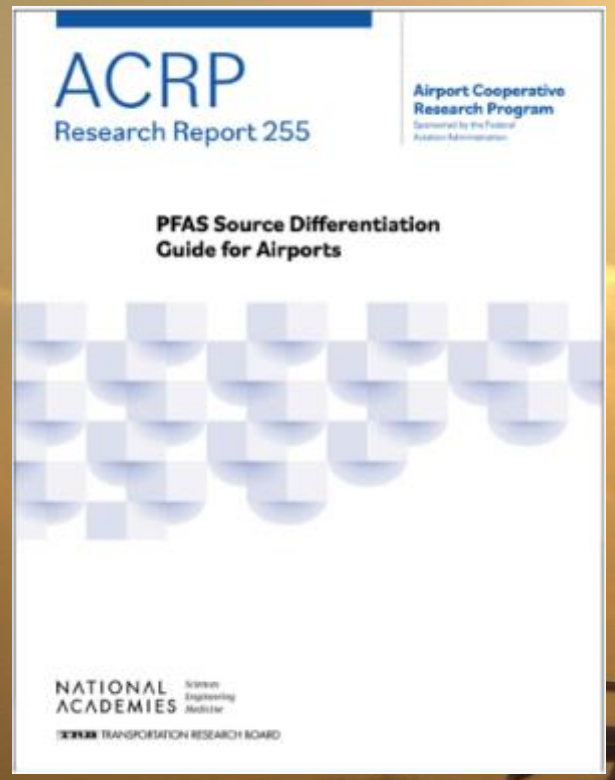
ACRP is an Industry–Driven Program

- Managed by TRB and sponsored by the Federal Aviation Administration (FAA).
- Seeks out the latest issues facing the airport industry.
- Conducts research to find solutions.
- Publishes and disseminates research results through free publications and webinars.





PFAS Source Differentiation at Airports

March 21, 2024

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Mead&Hunt

eurofins

BATTELLE

SMITH

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**

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Today's Presentation

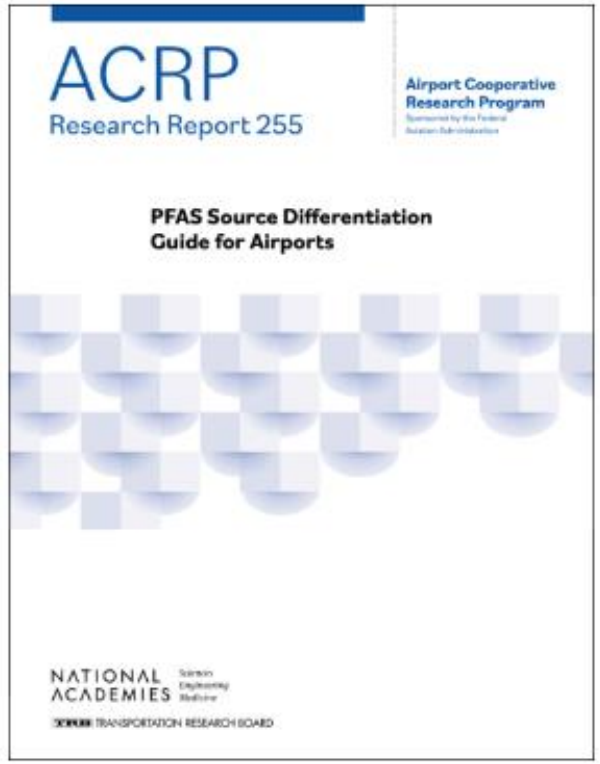
Part 1 –PFAS Landscape

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

Part 3 – Screening Tool and Next Steps/ Research Needs

What's Inside the Guidebook?

- 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

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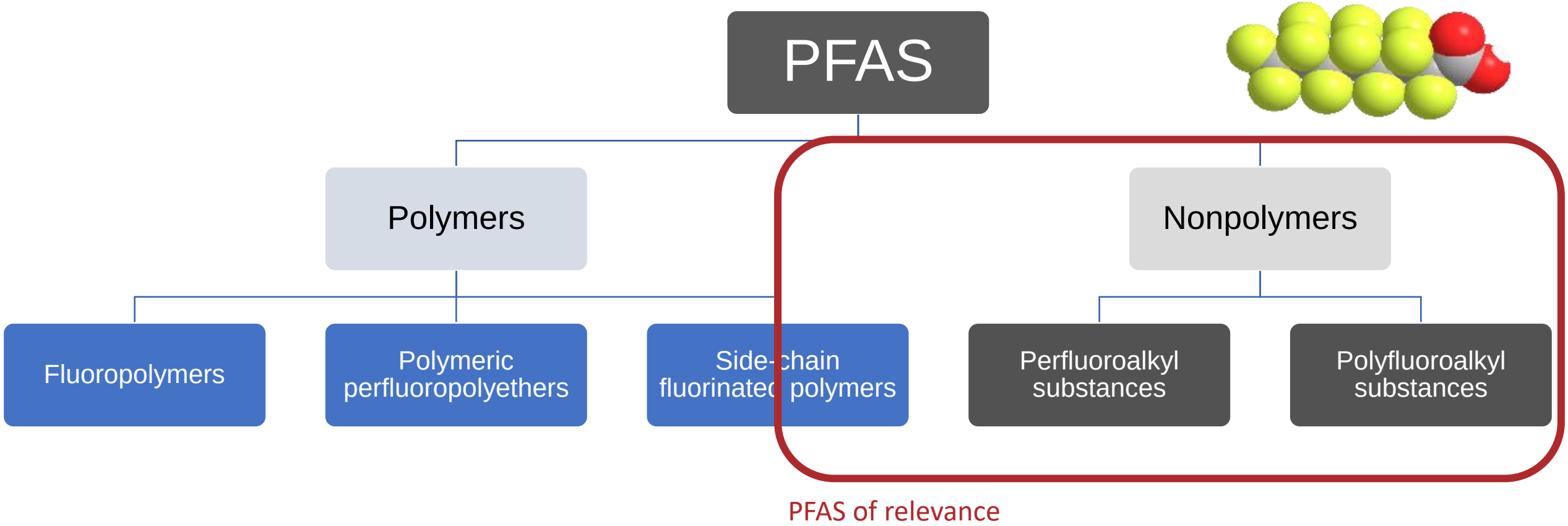
PFAS 101 – PFAS Family Tree

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



PFAS of relevance

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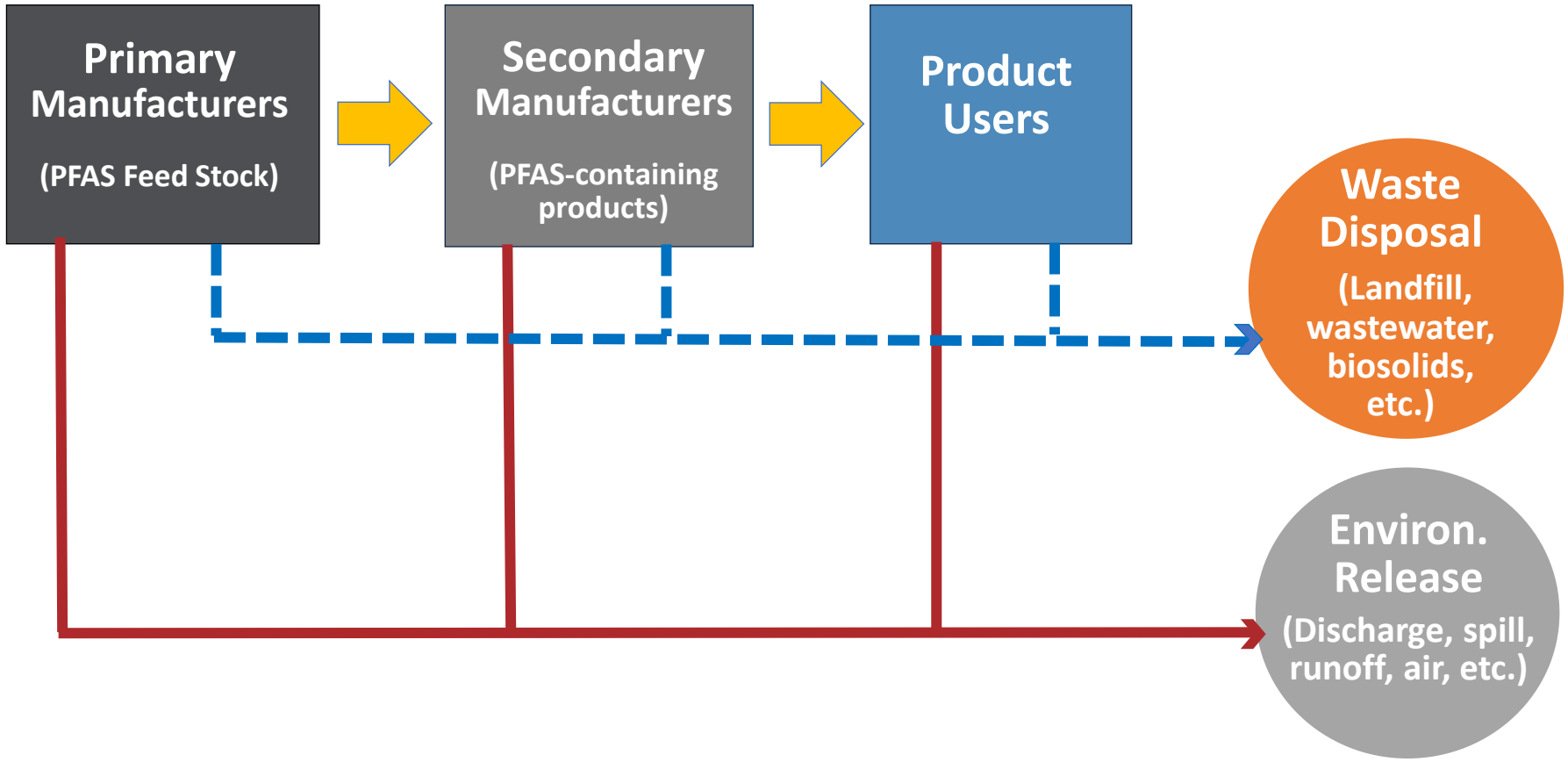
PFAS 101 – Environmental Releases



Multiple potential sources result in complex conceptual site models and liabilities

Everchanging Relevant Regulations

Drinking Water
- MCLs proposed for 6 PFAS
- Monitoring (UCMR 5; currently underway, completion in 2025)

Storm Water
- NPDES Discharge permit requirements

Clean Up
- Screening levels and/or remediation goals for groundwater, soil, surface water
- Designation as hazardous substances/constituents under CERCLA and RCRA
- Joint and several liability and selective enforcement proposed by EPA
- Cost allocation

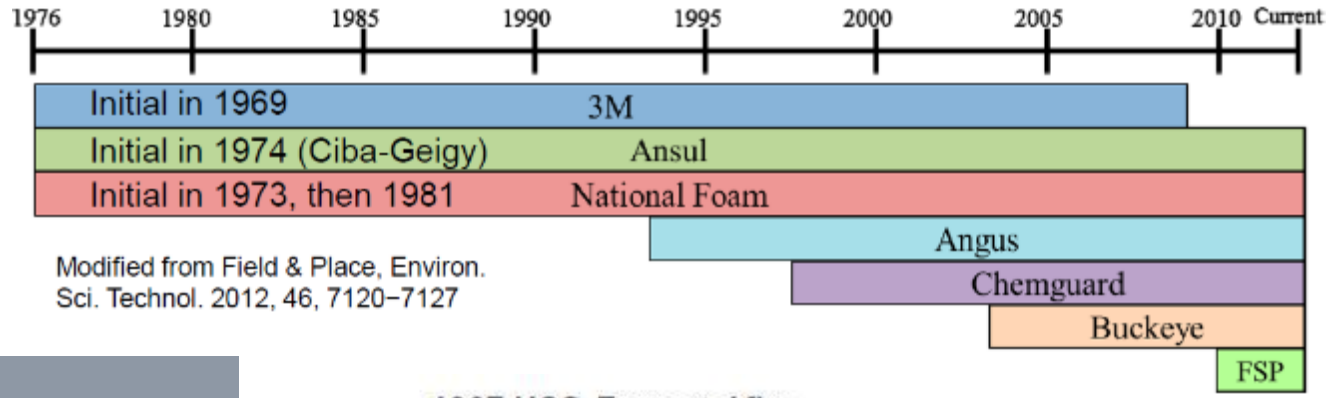
Airport PFAS Landscape

On-Airport PFAS Sources

- AFFF use in emergency response (mobile and fixed systems)
- Firefighter training
- 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…

AFFF

Not all Class B Firefighting Foams Contain PFAS



Modified from Field & Place, Environ. Sci. Technol. 2012, 46, 7120–7127

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 *Forrestal* 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.

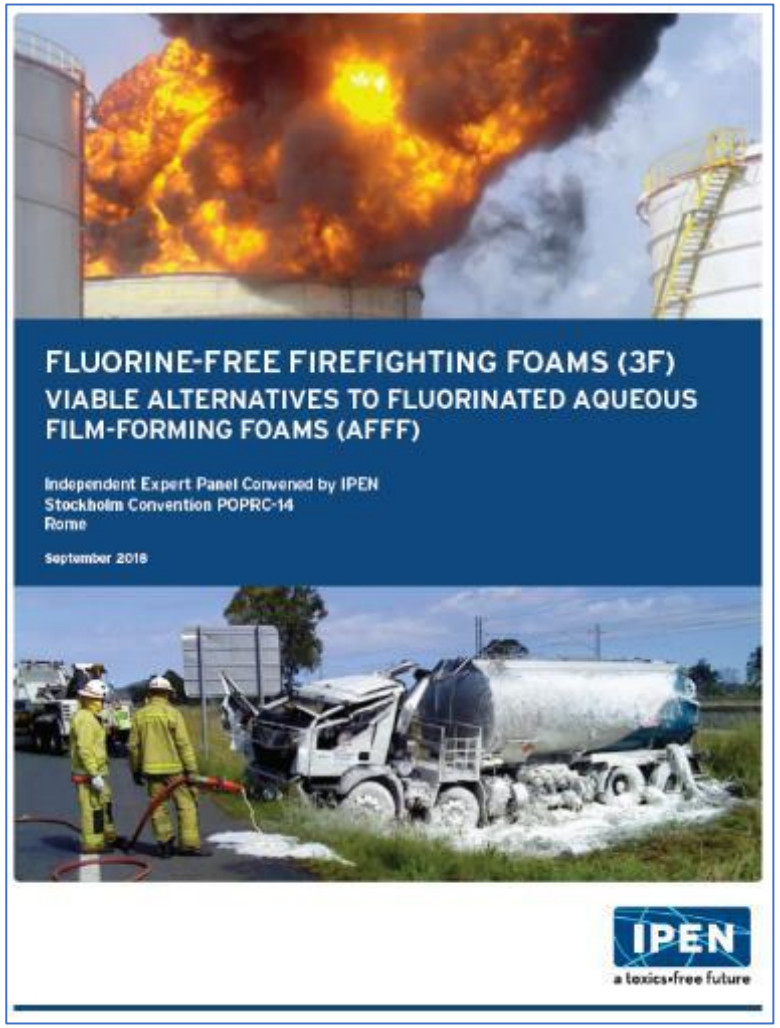
The alert also notes that the Naval Sea Systems Command (NAVSEA) will continue to update a DOD database with approved F3 concentrates.

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 Click on the appropriate link to see more.

Mfr Designation	Source Name	CAGE Code	Related Links
SOLBERG 3% MIL-SPEC SFFF ***SEE SOURCE NOTES*** NSN: 4210-01-713-4388 (55-GAL CONT.)	PERIMETER SOLUTIONS LP 8000 MARYLAND AVE STE 350 SAINT LOUIS, MO 63105-3810 USA www.phoschek.com Test References: NRL Report 3900 Ser 6180/0233/2023 dtd 7/26/23; NAVSEA LTR 9555 SER 05P/238 OF 9/11/23 (Approved by NAVSEA LTR 059/2223-323 dtd 9/12/23)***SEE SOURCE NOTES***	1RKV8	[source] [Part#] [source] [Notes]

Page 1 of 1 1 Go to Page



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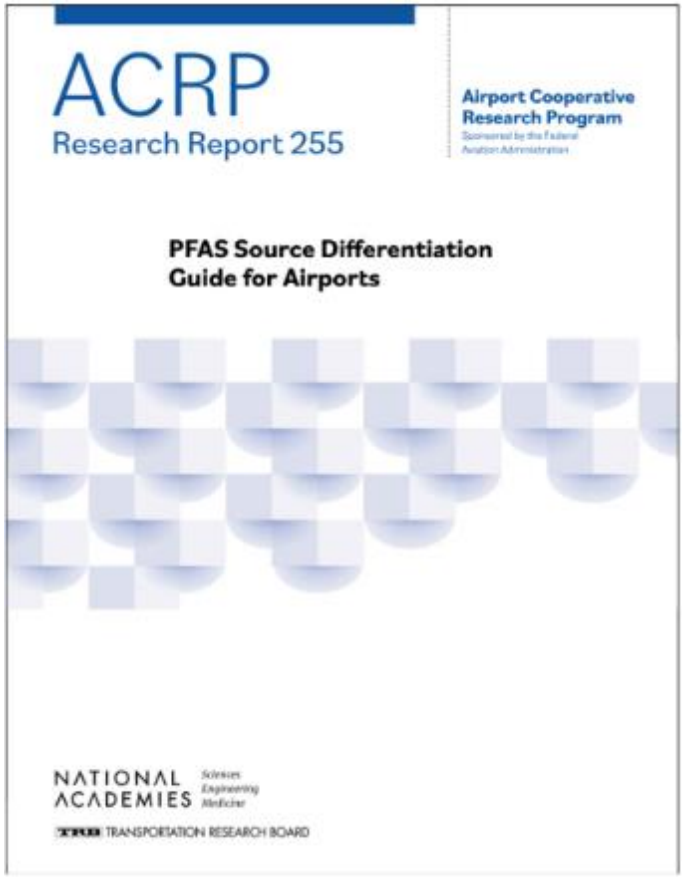
But It's Not Just AFFF....

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*

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

- **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://officiency.com/organizecomputerfiles/

Conventional Sampling –
Complicated Data Interpretation, but Can Be Useful

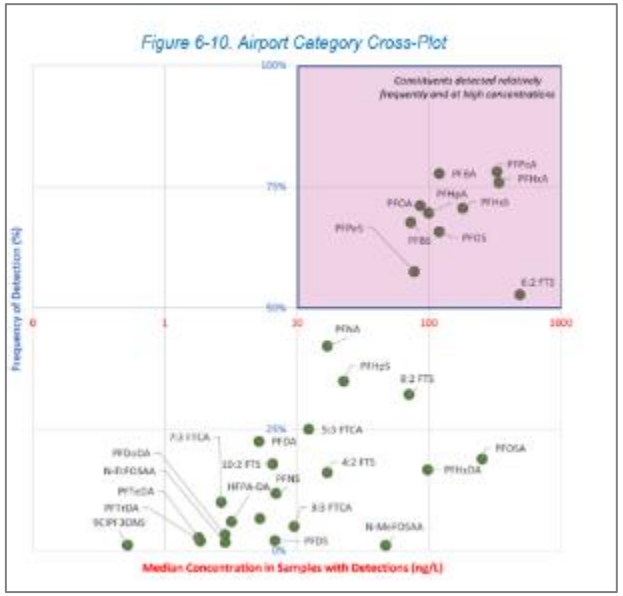
- **Use the full set of PFAS data**
  - Don't focus on only "risk-driving" PFAS
- **Make sure the conceptual site model is well-defined**
  - Hydrogeology/Geology/Soils
  - Depth to groundwater
  - Flow direction
  - Bedrock type and competency
  - Soil properties
  - Climatological setting
  - Manufactured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

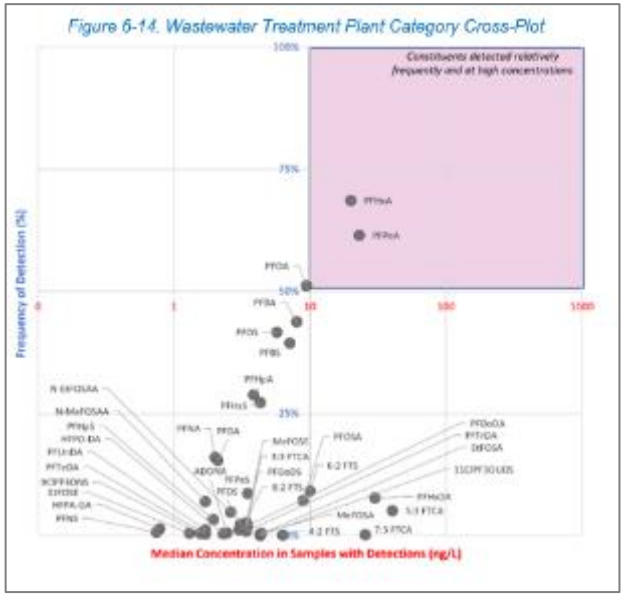
PFAS Compositional Distribution Visualizations

Pattern Identification Options:

- **Family Tree Pie Charts**
  - sulfonates v. carboxylates
  - chain-length
- **ECF-based products (w/PFOS) versus FT-based products (no PFOS)**
- **PFAS Ratios**
- **Linear versus branched isomers**
- **Principal Component Analysis**
- **Etc. (many more…)**

Patterns derived from >800,000 PFAS data points:





Limitations:
No geospatial information is available for most of the data points
Most likely "near source" samples dominate database

Data Visualization Categories:

Airport	Chrome Plating	Industrial	Cleanup Sites	WWTP	Landfill

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PFAS Compositional Distribution Visualizations

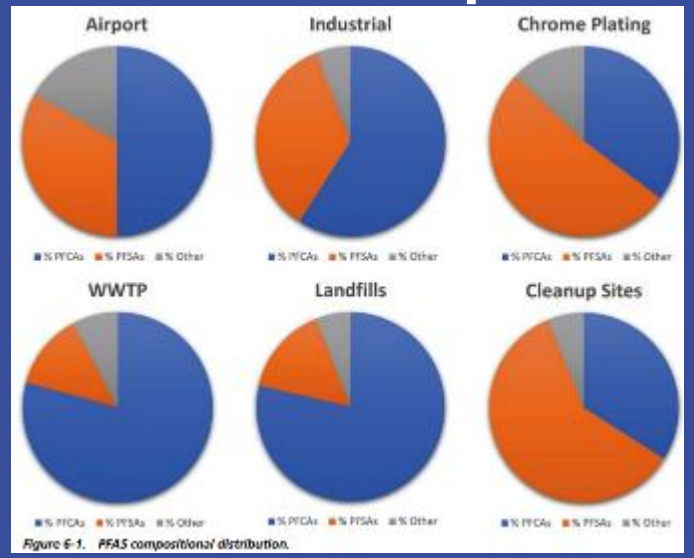

Figure 6-1. PFAS compositional distribution.

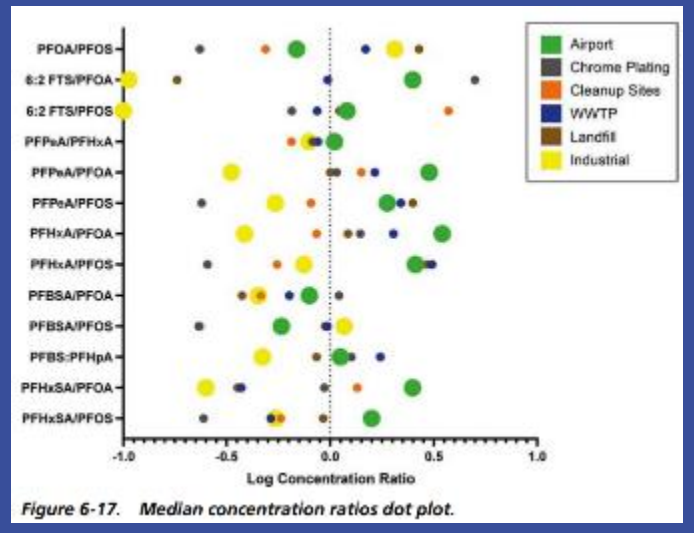

Figure 6-17. Median concentration ratios dot plot.

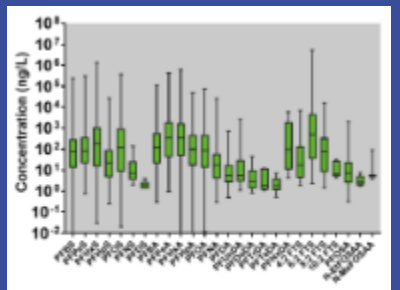

Figure 6-2. Airport category PFAS concentrations.

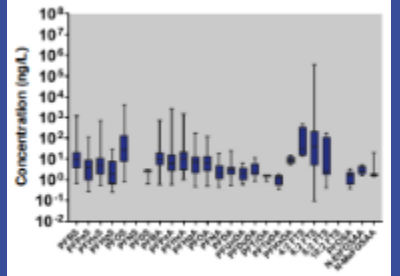

Figure 6-3. Chrome plating category PFAS concentrations.

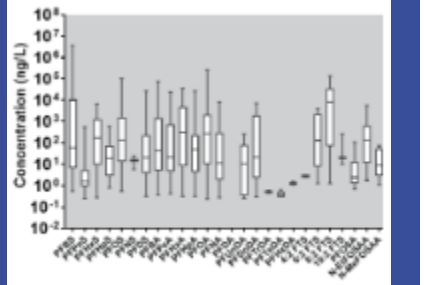

Figure 6-4. Industrial category PFAS concentrations.

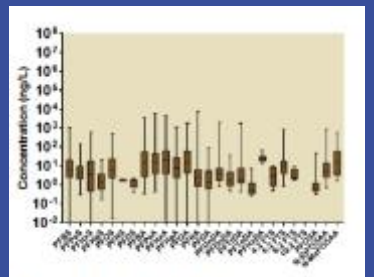

Figure 6-5. Landfill category PFAS concentrations.

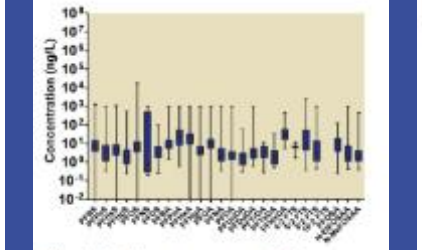

Figure 6-6. Wastewater category PFAS concentrations.

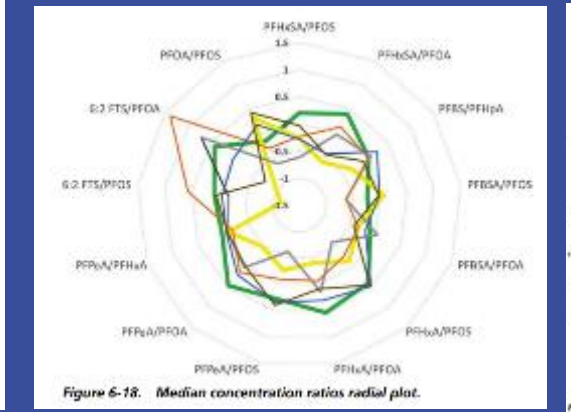

Figure 6-18. Median concentration ratios radial plot.

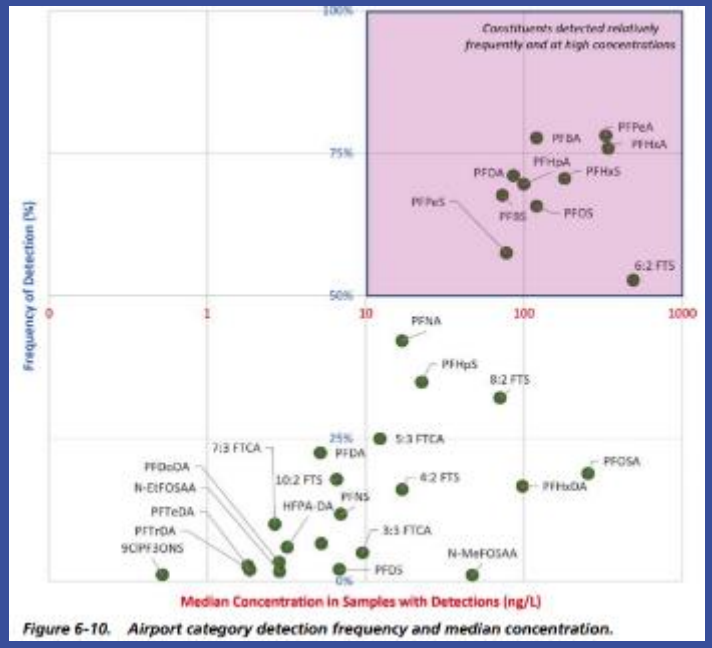

Figure 6-10. Airport category detection frequency and median concentration.

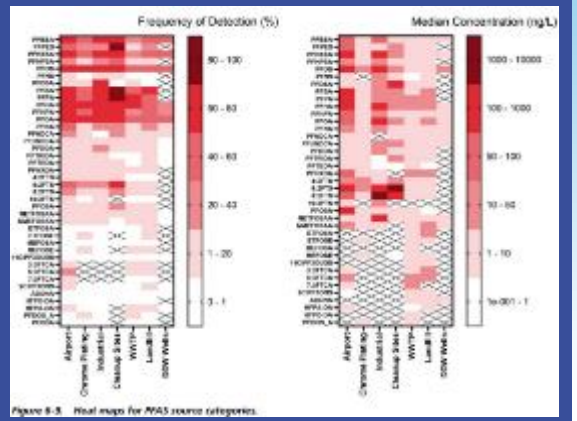

Figure 6-9. Heat maps for PFAS source categories.

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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 PFPeS 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

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

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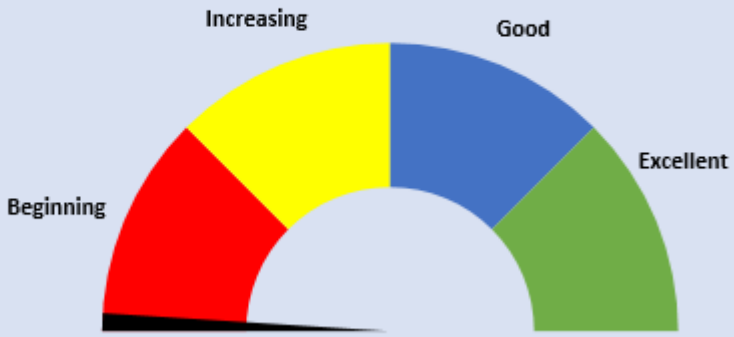
Desktop Review Progress Tracker

PFAS Source Differentiation Desktop Review Feedback

Objective:
Provide progress feedback on PFAS source differentiation desktop review efforts.

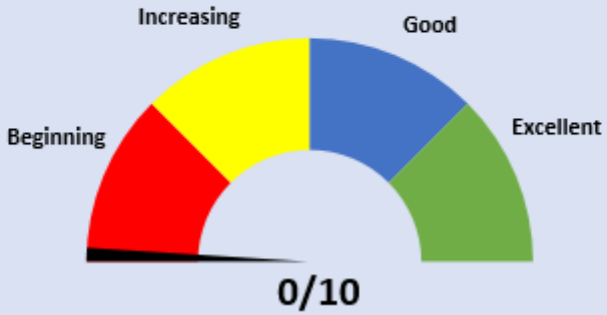
Instructions:
Input responses to the questions or statements for each category (separate tabs) on the level of consideration given to the topics related to PFAS sources .

Overall Progress

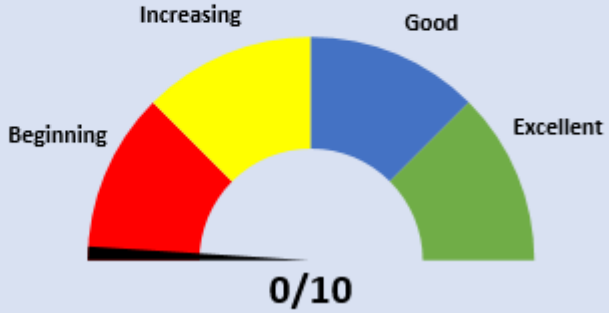


On-Airport Sources Progress

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		
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		

No consideration
Some consideration
Reviewed extensively
Fully explored
Not applicable

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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DATA-DRIVEN APPROACH.
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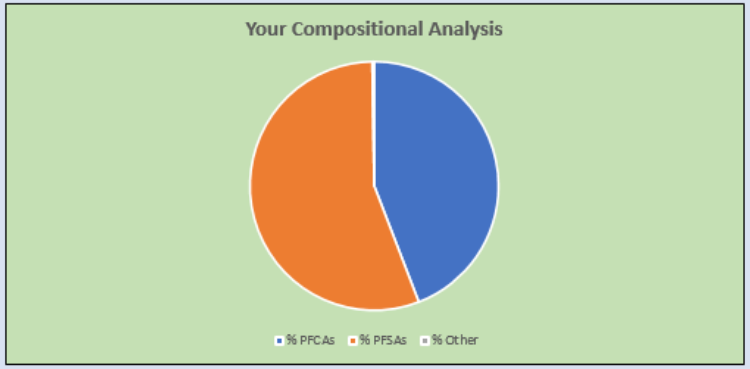
Compositional Analysis Visualization

Compositional Analysis Comparative Tool

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

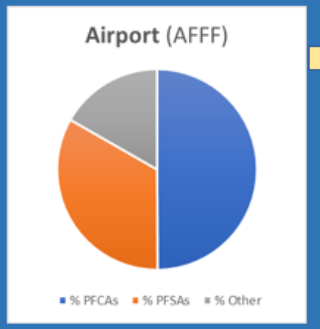
Instructions:
Input PFAS data from a single monitoring point in the table below to generate a graphical representation of your data that can be compared to the information provided with the Guidebook (see Section 6 of the Guidebook). Source category screening data visualizations are provided to the right 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**

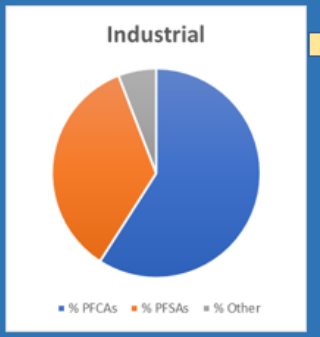


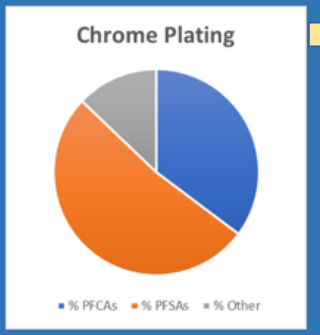
RESULTS	% Compound Type	
% PFCAs	44%	Help
% PFSAs	56%	Help
% Other	0%	Help

YOUR DATA

PFAS	Abbreviation	CAS Number	PFAS Concentration (ng/L)	
Perfluorobutanoic acid	PFBA	375-22-4	28	PFCA
Perfluoropentanoic acid	PFPeA	2706-90-3	55	PFCA
Perfluorohexanoic acid	PFHxA	307-24-4	73	PFCA
Perfluoroheptanoic acid	PFHpA	375-85-9	26	PFCA
Perfluorooctanoic acid	PFOA	335-67-1	51	PFCA
Perfluorononanoic acid	PFNA	375-95-1	56	PFCA
Perfluorodecanoic acid	PFDA	335-76-2	10	PFCA
Perfluoroundecanoic acid	PFUnDA	2058-94-8	3.4	PFCA
Perfluorododecanoic acid	PFDoDA	307-55-1	1.2	PFCA
Perfluorotridecanoic acid	PFTrDA	72629-94-8	<0.42	PFCA







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Main Conclusions

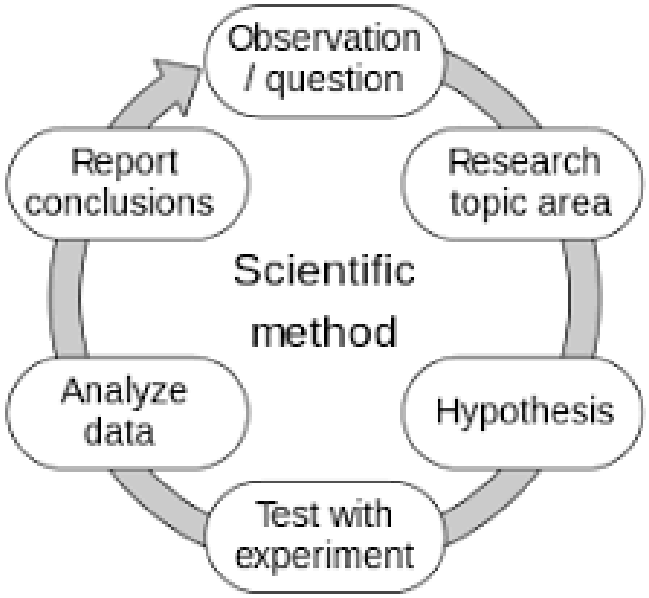
There is no "silver bullet" when it comes to PFAS source differentiation.

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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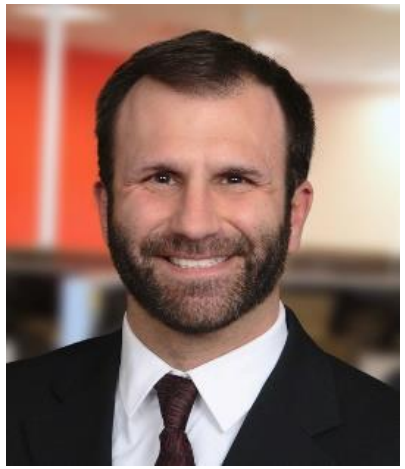

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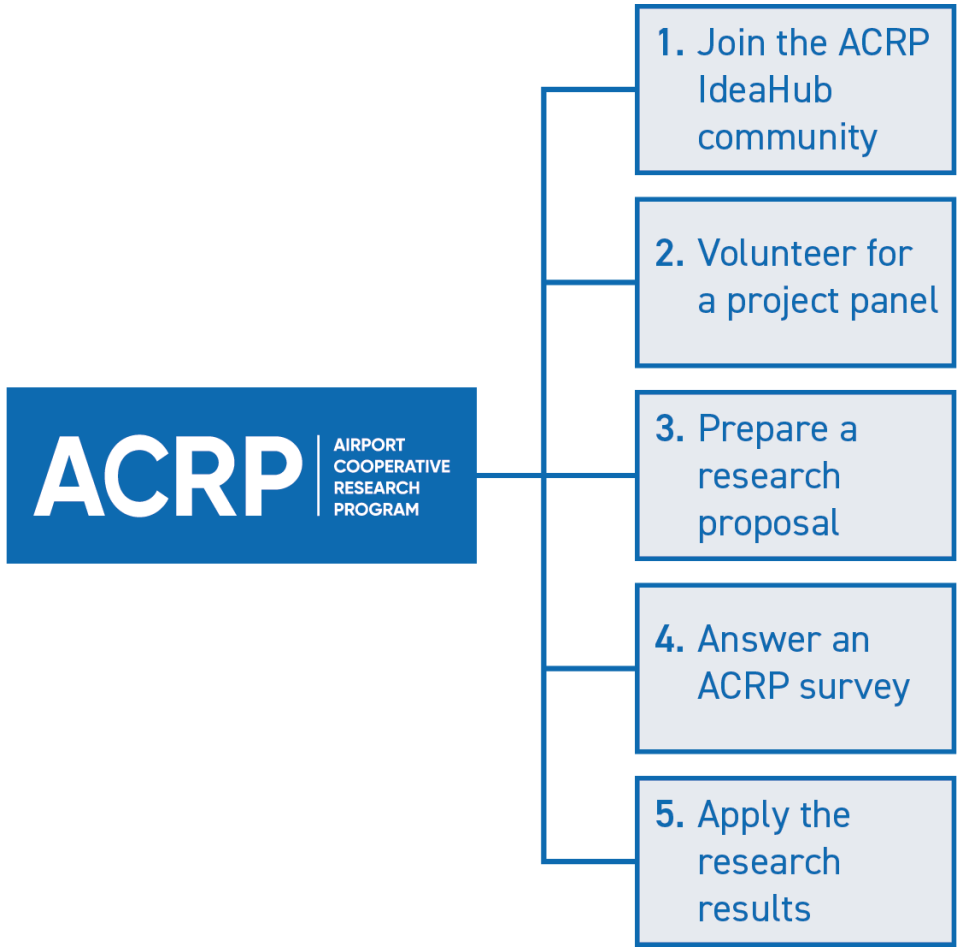

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