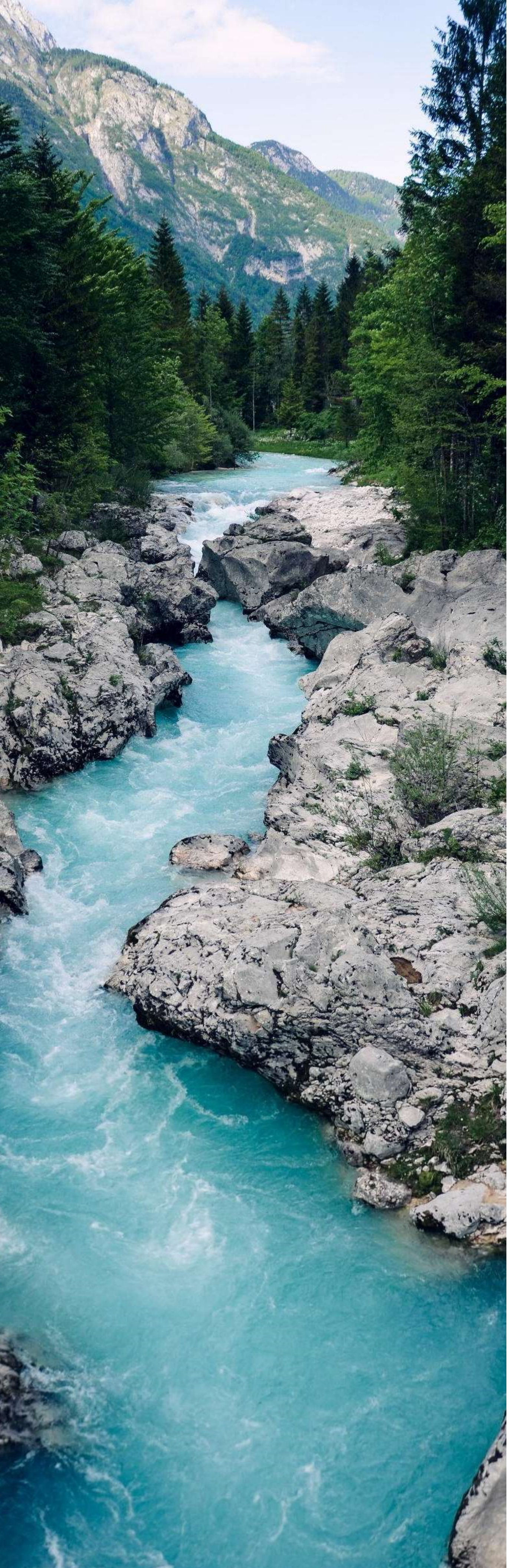

FREDsense
ect2
Montrose Environmental Group

Rapid PFAS Testing to Validate Novel AFFF Cleanout Process

September, 2025

A Unique Process for AFFF Cleanout Projects

With the approval of new PFAS free firefighting foams on the Qualified Products List (QPL), the US Federal Aviation Administration has given airports across the country an alternative to PFAS-laden Aqueous Film Forming Foam (AFFF). Airports can now change out AFFF with non-fluorinated products on Aircraft Rescue and Firefighting (ARFF) vehicles to protect the environment and enhance safety. ECT2 delivers advanced solutions for both fixed and mobile systems, ensuring high standards of decontamination while minimizing waste. The ECT2 team has leveraged their knowledge gained from treating billions of gallons of PFAS-impacted water and built a process designed specifically for the cleanout of firefighting equipment. This process involves a Clean-In-Place (CIP) loop with a proprietary heated cleaning formulation and a thorough Rinsing Cycle (Rinsate).

ECT2 offers various alternatives to handle the rinsate and used CIP solution generated during cleaning operations: the combined rinsate/CIP solution can be sent to a destruction vendor, can be treated onsite to non-detect levels and then sent to a POTW or released to the environment, or disposed of via deep-well injection or other means.

Challenge

ECT2 verifies the effectiveness of PFAS removal by collecting samples at both the Clean-in-Place (CIP) and rinsate stages, ensuring comprehensive evaluation of the entire cleaning process. The process is designed to achieve 99%+ reduction of PFAS mass, with verification through accredited laboratory analysis. While ECT2s's proven protocols and performance track record give confidence in the outcome of the process, the multi-week turnaround time confirmation of results is less than ideal.

Solution

FREDsense has developed the FRED-PFAS™ sensor, a portable detection unit for aqueous PFAS combining solid phase extraction and a fluorescence detection mechanism to measure PFAS species present within a sample. The patented fluorescence test mechanism is based on changes in fluorescence intensity resulting from a dye being displaced from the polymeric capture material by PFAS molecules.

With same-day onsite PFAS detection, the effectiveness of the clean can be determined with FRED-PFAS in hours, rather than weeks, to give stakeholders reassurance that their system is cleaned prior to cleanout crews demobilizing from site. It also enables ECT2 the ability to optimize their workflow avoiding unnecessary rinse cycles, or if an unusually contaminated vehicle is encountered, adding additional cleaning.

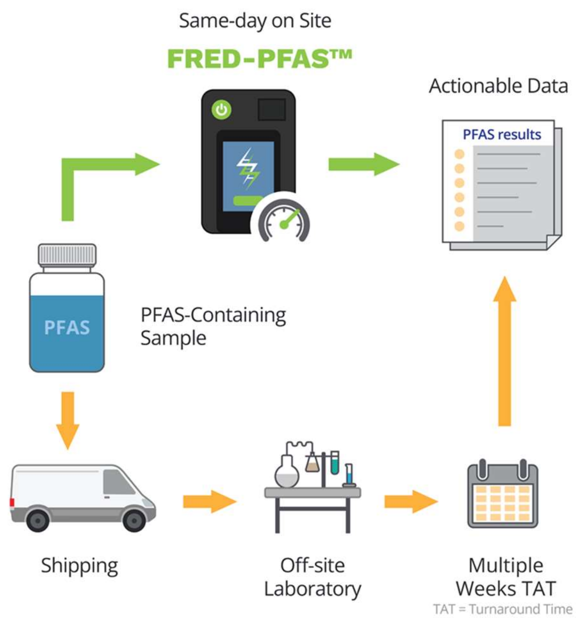

Figure 1- Real-Time Detection of PFAS

During a U.S.-based airport AFFF transition cleanout project led by ECT2, FREDsense Technologies' field-deployable sensor (FRED-PFAS™) was evaluated on both the CIP and rinsate streams, with results benchmarked against three laboratory methods (Total Oxidizable Precursor Assay, Total Organic Fluorine, and EPA 1633) to validate project performance.

Experimental Set-Up

- Project Location: Southern California
- Project Type: AFFF Cleanout of ARFF vehicles
- Project timeline: May 2025
- Predominant foam: Chemguard C306-MS 3%
- Number of FRED-PFAS devices used: 5

Figure 2 - ARFF Trucks at airport facility

Samples were collected onsite for both CIP and Rinsate streams and distributed to FREDsense. A total of ten (10) samples were tested across five (5) different FRED-PFAS units, enabling comparison between five (5) replicates for each of the CIP and Rinsate sample types. In parallel, both CIP and Rinsate were sent to third party laboratories for analysis by US EPA Method 1633, the Total Oxidizable Precursor (TOP) Assay, and Total Organic Fluorine (TOF).

Results

The FRED-PFAS results compared to laboratory methods are shown in Table 1. PFAS mass removal, as expressed by the percentage reduction in PFAS measured in the CIP vs. the rinsate is included in Figure 3.

Table 1: Summary of FRED-PFAS results for both CIP and Rinsate streams compared to laboratory methods.

Sample Name	CIP Result (ppb, µg/L)	Rinsate Result (ppb, µg/L)
FRED-PFAS (Average, n=5)	32,788	202
Sum of PFAS via EPA 1633 (Third Party Lab 1)	379	5.6
TOF (Third Party Lab 2)	98,000	660
Sum of PFAS via TOP (Third Party Lab 1)	50,002	598

Amongst the five replicates of FRED-PFAS, both Standard Deviation (ppb) and Relative Standard Deviation (RSD, %) were recorded.

Table 2: Summary of FRED-PFAS Averages, Standard Deviations, and Relative Standard Deviations for 5 replicates in each of CIP and rinsate streams.

Stats	FRED-PFAS CIP Result	FRED-PFAS Rinsate Result
Average (ppb, µg/L)	32,788	202
Standard Deviation (ppb, µg/L)	5,621	22
Relative Standard Deviation (%)	17	11

When evaluating **PFAS mass reduction as a percentage**, FRED-PFAS produced results that were highly comparable to those obtained from laboratory analytical methods.

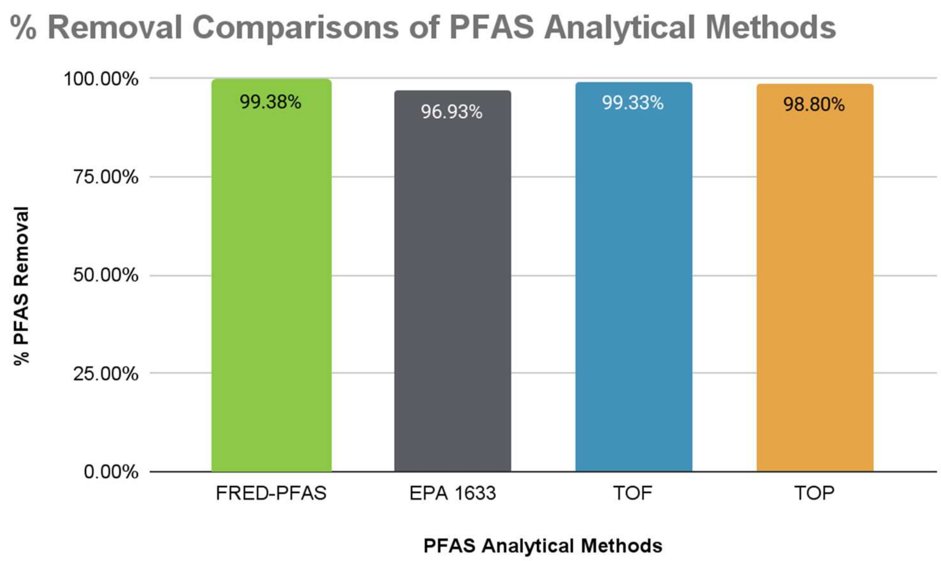

Figure 3 - FRED-PFAS mass reduction % as compared to laboratory methods

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Conclusion

In summary, FRED-PFAS™ demonstrated **high analytical precision, showing variability as low as 11% across five replicates** of the same sample run on different devices. Furthermore, FRED-PFAS results exhibited **strong correlation with all three third-party analytical methods**, consistently yielding values higher than the EPA 1633 sum of 40 PFAS analytes, but lower than those obtained using TOF and TOP approaches. This is consistent with previous claims that FRED-PFAS senses certain precursors which are not included in the EPA 1633 regulated analyte list, but are indicated by total methods such as TOF. When assessing percent reduction in PFAS mass, FRED-PFAS measurements aligned with the TOF method to **within 0.05%**.

> ***With FRED-PFAS real-time detection, we can verify the effectiveness of our AFFF cleaning process before leaving the customer's site – providing faster proof of efficacy, accurate results, and real savings.***
>
> ***— Dave Kempisty, Vice President, Technology, ECT2***