WHITE PAPER

# PFAS Surface Wiping: AFFF Recovery

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## Summary

This study evaluates the effectiveness of Eurofins “triple wipe” surface testing method for detecting PFAS contamination from aqueous film-forming foams (AFFF). Two AFFF concentrates—AFFF A (legacy PFOS-based) and AFFF B (modern fluorotelomer-based)—were tested on stainless-steel surfaces. Targeted analysis revealed PFOS as the dominant compound in AFFF A, while 6:2 FTAB was predominant in AFFF B. The wiping procedure recovered 79–94% of PFAS applied, with the first wipe capturing approximately 60–65%, the second 15–20%, and the third 5–10%. Moderate variation among replicates was observed, and similar recovery profiles were noted for both foam types. The method demonstrated robustness even in the presence of high levels of non-fluorinated surfactants. While the stainless-steel surface provided a relevant model, caution is advised when applying the method to e.g. porous or plastic materials. Overall, the Eurofins “triple wipe” approach offers a practical and efficient tool for assessing PFAS contamination on AFFF-impacted surfaces.

Abbreviations:

DPOSA = Fluorotelomer sulfonamide amine oxide (6:2 FTNO = Capstone A); FTAB = Fluorotelomer sulfonamido betaine (6:2 FTAB = Capstone B); FTS or FTSA, fluorotelomer sulfonic acid; FTSAS = Fluorotelomer thioether amido sulfonate (also FTAoS); PFAS = Poly- and perfluoroalkyl substances; PFBA = Perfluorobutanoic acid; PFBS = Perfluorobutane sulfonic acid; PFCA = Perfluoroalkyl carboxylic acid; PFDoA = Perfluorododecanoic acid; PFHxA = Perfluorohexanoic acid; PFHpA = Perfluorohepatanoic acid; PFHpS = Perfluoroheptane sulfonic acid; PFHxS = Perfluorohexane sulfonic acid; PFNA = Perfluorononanoic acid; PFNS = Perfluorononane sulfonic acid; PFPeA = Perfluoropentaoic acid; PFPeS = Perfluoropentane sulfonic acid; PFOS = Perfluorooctane sulfonic acid; PFSA = Perfluoro sulfonic acid

## Introduction

Per- and polyfluoroalkyl substances (PFAS) are a large class of synthetic chemicals, potentially comprising over 15,000 individual compounds. Over the past 25 years, increasing evidence has linked PFAS exposure to adverse environmental and health effects. Aqueous film-forming foams (AFFF), used extensively in firefighting, are among the most significant sources of PFAS contamination. These foams are primarily used to combat flammable liquid fires, known as Class B fires. The use of AFFF at military bases, airports, and industrial sites has led to widespread pollution of soil, water, and other environmental matrices. Due to their strong carbon-fluorine bonds, PFAS are extremely persistent in the environment and are often referred to as “forever chemicals.”

In recent years, regulatory efforts have intensified to phase out PFAS-containing foams and promote environmentally safer alternatives. The European Union (EU) has implemented several key regulations, including Regulation (EU) 2019/1021 on persistent organic pollutants (POPs), which restricts PFOS, PFOA, and PFHxS in products. Regulation (EC) No 1907/2006 (REACH) also targets substances such as PFHxA and C9–C14 perfluorocarboxylic acids (PFCA). These regulations typically set concentration limits of 25 parts per billion (ppb) for individual PFAS in products, with PFOS to be lowered to this level as well from current higher limits. A new proposal under REACH (Dossier D102503/03, 2025) aims to introduce a general PFAS restriction in AFFF, with a limit of 1 mg/L. Additionally, the International Maritime Organization (IMO) has mandated a global ban on PFOS in AFFF used on ships starting 1 January 2026.

The composition of PFAS in AFFF formulations can vary significantly depending on the manufacturing method and time of production. Historically, AFFFs contained legacy PFAS such as PFOS, PFHxS, and PFOA, as well as precursor compounds that degrade into these substances. These precursors are often considered “related substances” under POP and REACH regulations. Modern AFFF formulations typically include more advanced fluorinated compounds, such as 6:2 telomer-based structures. Notable examples include 6:2 FTAB, DPOSA (6:2 FTNO), and 6:2 FTSAS, which also are precursors and potential “related substances”. Analytical methods such as target analysis and the Total Oxidizable Precursor (TOP) assay are used to quantify both known PFAS and their precursors, providing valuable data for assessment of regulatory demands and environmental monitoring.

Given the shift away from PFAS containing AFFF to fluorine free alternatives a need to test the cleaning of surfaces e.g. tanks, containers and pipes in fire protection systems will often arise. The aim of this study was to investigate the efficiency of Eurofins testing kit for surfaces with primary focus on the recovery of AFFF although the product as such can be employed for other PFAS contaminations.

## Material and Methods

Eurofins offers a “triple wipe” solution for surface testing, with a recommended procedure involving the sequential use of three supplied isopropanol (IPA) wipes (3 × 6 cm unfolded) on the same surface, covering a maximum area of 20 × 20 cm. The three wipes are collected in the provided 50 mL sample tube and, by default, analyzed as a composite sample. A pair of nitrile gloves is also included and should be worn during sampling (Fig. 1).

Fig 1. Eurofins surface wiping kit containing four isopropanol wipes (one extra), one 50 ml tube and a pair of nitrile gloves

In the current experiment, two unknown AFFF concentrates (designated AFFF A and AFFF B) were diluted to assumed working solutions of 6% (AFFF A) and 3% (AFFF B), representing typical mixture concentrations. Targeted analysis of AFFF A revealed a high concentration and dominance of PFOS, with PFHxS and PFOA present as minor constituents (see below). In AFFF B, 6:2 FTAB was identified as the major PFAS substance, with 6:2 FTS being the only other compound detected.

Using a plastic pipette, 0.5 mL of each working solution was applied in small droplets onto a pre-cleaned stainless-steel surface (20 × 20 cm). The foam was further distributed across the surface using the pipette tip. The surface was allowed to dry for 20 minutes. Wiping was performed as described above, using a crisscross motion until each wipe appeared saturated (~1 minute). Instead of forming a composite sample, each of the three wipes was collected in separate tubes to enable individual analysis. Testing was conducted in three independent replicates for each foam.

## Results and Discussion

### *Composition of AFFF*

Targeted PFAS analysis of AFFF A revealed that the unknown sample was dominated by PFOS, with a concentration of 6800 mg/kg in the concentrate. This value falls within the range typically observed in legacy PFOS-based foams (Houtz et al., 2013; Liu et al., 2024). An appreciable concentration of PFHxS was also detected (570 mg/kg), while other PFSAs such as PFBS, PFPeS, and PFHpS were present at approximately 100 mg/kg each. Among the PFCAs, PFOA and PFHxA exhibited concentrations around 100 mg/kg, and PFBA, PFPeA, and PFHpA were found at levels of approximately 20–25 mg/kg. Low concentrations of PFNS and PFNA were also observed. The overall PFAS profile clearly indicated an ECF-produced product, most likely manufactured by 3M (e.g., ITRC, 2023). Notably, 6:2 FTS was not detected—a compound strongly indicative of fluorotelomer (FT) components—suggesting that the AFFF was relatively pure.

In contrast, 6:2 FTAB was the dominant compound in AFFF B, with a concentration of 1040 mg/kg in the concentrate. 6:2 FTS was also detected at a level of 11 mg/kg. No other PFAS were identified, including PFOA, PFHxA, PFOS, and 8:2 FTS, indicating a modern 6:2 (or C6)-based FT foam with minimal by-products and degradation products. The concentration of 6:2 FTAB was consistent with levels commonly found in concentrated foams (e.g. Dauchy et al., 2017).

### *Performance of surface wiping: AFFF A*

Four compounds—PFOS, PFOA, PFHxS, and PFHxA—were selected based on their concentrations and regulatory relevance. The results from the individual wipes clearly demonstrated that the first wipe recovered the majority of the applied foam (Fig. 2). High levels of PFAS were adsorbed, with up to approximately 150 µg per wipe. The first wipe accounted for 59–67% of the total PFAS applied, while the final wipe contained 4–6%. The standard deviation (s.d.) among replicates was generally moderate, particularly when compared to the total amount of AFFF applied. All compounds exhibited a similar distribution profile across the three wipes.

Considering the overall recovery from the three wipes, values ranging from 79–91% were calculated (mean ± s.d.; PFOS: 91 ± 14%; PFHxS: 79 ± 5%; PFOA: 82 ± 11%; PFHxA: 91 ± 9%), indicating limited losses and thus an efficient sampling procedure. Furthermore, these recoveries should be interpreted in the context that the amount of AFFF applied represents a highly contaminated surface, also containing elevated levels of non-fluorinated surfactants—rather than a system that has undergone cleaning.

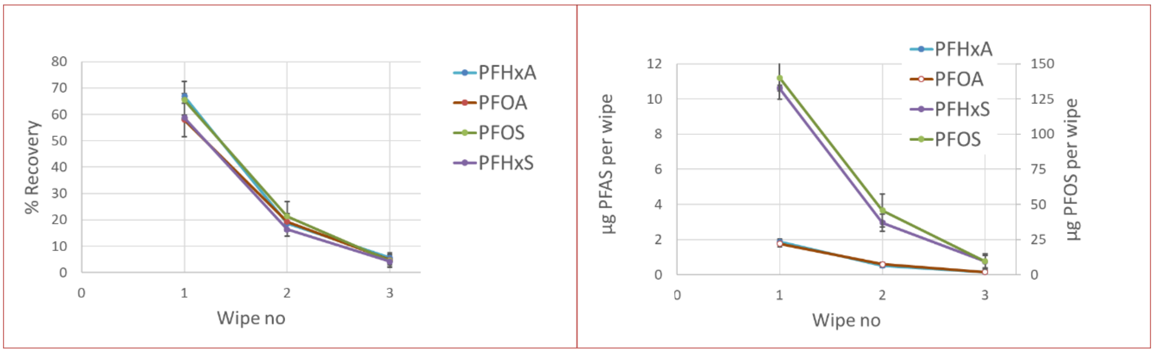

Fig. 2. (a) % Recovery per wipe related to the total amount AFFF applied (mean ± s.d.; n=3), (b) µg PFAS (PFHxA, PFOA, PFHxS; first y-axis) or PFOS (second y-axis) adsorbed per wipe (mean ± s.d.; n=3).

*Performance of surface wiping: AFFF B*

The second AFFF tested was a fluorotelomer (FT)-based foam, with its major PFAS constituent, 6:2 FTAB, representing a typical component for this type of formulation (D'Agostino and Mabury, 2014; Dauchy et al., 2017; Li et al., 2024). The results showed a profile directly comparable to that of AFFF A (Fig. 2 and 3). The variation (s.d.) was also similar to the AFFF A test for most samples, although a slightly higher value was observed for 6:2 FTS in the first wipe (15% relative to the total amount). The variation for the remaining 6:2 FTS and 6:2 FTAB wipes, in relation to total amounts, ranged between 1–6% (s.d.). The total quantities of 6:2 FTAB (16 µg) and 6:2 FTS (0.16 µg) reflected the lower overall PFAS concentrations in AFFF B (Fig 3).

The total recovery for 6:2 FTAB was 90 ± 5%, and for 6:2 FTS, 94 ± 13%—values consistent with those obtained for AFFF A. As in the previous case, the PFAS load was substantial, and the surface should be considered heavily contaminated.

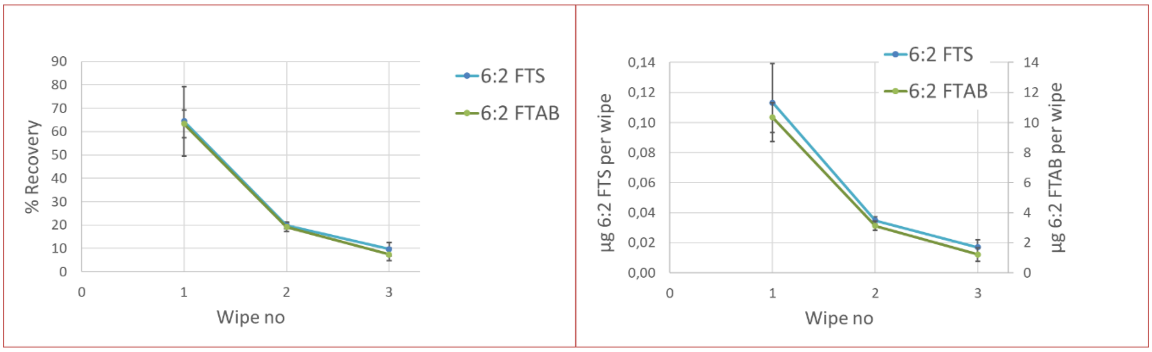

Fig. 3. (a) % Recovery per wipe related to the total amount 6:2 FTS or 6:2 FTAB applied (mean ± s.d.; n=3), (b) µg 6:2 FTS (first y-axis) or 6:2 FTAB (second y-axis) adsorbed per wipe (mean ± s.d.; n=3).

*Overall performance*

Both experiments demonstrated good recoveries of the PFAS applied to the test surface. A distinct advantage of the method is its robust performance in the presence of AFFFs containing high levels of other surfactants and constituents. While full (100%) recovery should not be expected, potential losses during sampling and handling—such as adsorption to gloves—must be considered. The chosen setup, involving a flat stainless-steel surface, likely provides a representative model for surfaces found in sprinkler systems and foam tanks.

However, caution is warranted when evaluating the procedure and interpreting results for other materials, such as porous surfaces and plastics. In such cases, the current approach should be regarded more as an indicative or semi-quantitative methodology.

## Conclusions

This study demonstrates that Eurofins' "triple wipe" approach can be effectively applied to assess the presence of PFAS on surfaces contaminated with AFFF. The testing included major PFAS compounds such as PFOS, PFOA, PFHxS, and 6:2 FTAB. Good recoveries—typically ranging from 80–90%—were observed for PFAS in both AFFFs tested. The majority of PFAS (approximately 60–65%) was adsorbed on the first wipe, with around 15–20% on the second and 5–10% on the third. Moderate variation among replicates was also noted. The study was conducted on a stainless-steel surface, and caution should be exercised when evaluating other types of surfaces.

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