NIST Technical Note
NIST TN 2260

Per- and Polyfluoroalkyl Substances in Firefighter Turnout Gear Textiles Exposed to Abrasion, Elevated Temperature, Laundering, or Weathering

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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Abstract

This is the second report in NIST's response to the National Defense Authorization Act for Fiscal Year 2021, titled the "Guaranteeing Equipment Safety for Firefighters Act of 2020.". The first report, NIST Technical Note 2248, provides a baseline that defines the type, concentration, and prevalence of per- and polyfluoroalkyl substances (PFAS) in textiles used in the construction of new/unused Firefighter's jacket and pants. In this report, NIST Technical Note 2260, NIST is reporting the PFAS measured in the same jacket and pants textiles and using the same PFAS analyte list in TN 2248 after these new/unused fabrics are physically stressed.

Textiles used in the construction of structural firefighter turnout gear have been found to contain per- and polyfluoroalkyl substances (PFAS) as well as fluoropolymer membranes and durable water repellent treatments containing fluorinated polymers. Additionally, older and used turnout gear has been found to contain greater concentrations of PFAS compared with new gear, though the source of these elevated PFAS concentrations is still under investigation. To determine if the stresses that turnout gear textiles encounter during typical use could contribute to the observation of higher PFAS concentrations, this National Institute of Standards and Technology Technical Note reports the concentrations of 51 PFAS in 20 firefighter turnout gear textiles following exposure to abrasion, elevated temperature, laundering, or weathering, which is a combined exposure to ultraviolet radiation and elevated humidity. Compared with corresponding concentrations in unstressed textiles, individual and summed PFAS concentrations in all textile types were higher following abrasion but were similar or lower following laundering. Additionally, summed PFAS concentrations were higher in outer shell textiles following exposure to elevated temperature and weathering. For example, the median summed PFAS concentrations among durable water repellent treated outer shell textiles rose from 1430 µg/kg when new to 3500 µg/kg following abrasion, 4420 µg/kg following exposure to elevated temperatures, and 3540 µg/kg following weathering, while it fell to 963 µg/kg following laundering. These changes in summed PFAS concentrations with stressing largely reflected changes in the concentrations of PFAS that were present in the highest concentration in unstressed turnout gear textiles: 6:2 FTMAC and 6:2 FTOH. While physical stressing may contribute to altered PFAS concentrations in stressed compared with unstressed turnout gear textiles, the mechanisms responsible for these changes cannot be authoritatively identified by the targeted analytical approach employed here. For example, the analytical approach used in this report cannot distinguish between PFAS produced by the chemical transformation of PFAS that were excluded from the targeted analyte list and increased PFAS extraction due to degradation of firefighter gear textiles and associated fluorinated polymer treatments.

Keywords

Abrasion; durable water repellent; firefighter; laundering; moisture barrier; outer shell; per- and polyfluoroalkyl substances; PFAS; stressing; turnout gear; thermal liner; weathering; ultraviolet radiation

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Preface

This National Institute of Standards and Technology publication (Technical Note 2260) is the second publication provided in response to Section 338 of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, titled the "Guaranteeing Equipment Safety for Firefighters Act of 2020." This act directed NIST to: "complete a study of the contents and composition of new and unused personal protective equipment worn by firefighters" and NIST TN 2248 "Per- and Polyfluoroalkyl Substances in New Firefighter Turnout Gear[1] Textiles" was released in response to this directive. The act further directs NIST to examine "the conditions and extent to which per- and polyfluoroalkyl substances are released into the environment over time from the degradation of personal protective equipment from normal use by firefighters…" This Technical Note addresses that directive by reporting per- and polyfluoroalkyl substance (PFAS) occurrence and concentration in structural firefighter jacket and pants textiles following exposure to abrasion, elevated temperature, laundering, or weathering, each carried out according to experimental procedures described in the performance standards that firefighter gear must meet for use in the United States.

This NIST TN was produced through the combined efforts of researchers in the Fire Research Division of the NIST Engineering Laboratory and the Chemical Sciences Division of the NIST Material Measurement Laboratory. Researchers at the National Personal Protective Technology Laboratory of the National Institute of Occupational Safety & Health provided outer shell textiles where the durable water repellent coatings had been scoured by the manufacturer and were responsible for laundering all the textiles in this study.

This is the first report of PFAS concentrations in firefighter gear following exposure to controlled stressing processes and details the change in 51 nonvolatile, semi-volatile, and volatile PFAS following exposure to each of four stresses. Upcoming reports will examine PFAS occurrence and concentrations in other firefighter gear than turnout gear, such as structural firefighter gloves and hoods, and wildland firefighting gear, as well as investigate the lifetime PFAS release potential of firefighter gear during repeated stressing.

[1] Structural firefighter "turnout gear" consists of jackets, suspenders, pants, and boots worm by structural firefighters. The NIST Technical Note 2248 and 2260 analyzes the PFAS in the jacket and pants only not in the suspenders or boots.

Acknowledgments

We thank United States Senator Jeanne Shaheen and her staff for their support of PFAS-firefighter gear research at NIST. Additionally, we thank Crystal Forester from the National Personal Protective Technology Laboratory for providing scoured firefighter turnout gear textiles and laundering all turnout gear textiles.

Author Contributions

Bruce Benner: Methodology, Investigation; **Rick Davis:** Conceptualization, Project Administration, Resources, Supervision; **Michelle Donnelly:** Resources; **Samuel Escobar Veras:** Investigation; **Ryan Falkenstein-Smith:** Methodology, Investigation; **Oliva Hernandez:** Investigation; **Kathleen Hoffman:** Investigation; **John Kucklick:** Validation; **Andrew Maizel:** Conceptualization, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing; **Trung Ngu:** Investigation; **Benjamin Place:** Resources, Validation, Writing – review & editing; **Jessica Reiner:** Methodology, Validation, Writing – review & editing; **Catherine Rimmer:** Resources; **Alix Rodowa:** Methodology, Investigation, Validation, Writing – review & editing; **Andre Thompson:** Conceptualization, Investigation, Methodology, Resources, Supervision; **Meghanne Tighe:** Investigation, Supervision; **Nadine Wetzler:** Investigation.

Executive Summary

This National Institute of Standards and Technology publication (Technical Note 2260) evaluates if exposure to physical stressors, similar to those experienced by firefighting gear, alters per- and polyfluoroalkyl substance (PFAS) occurrence and concentrations in the textiles that make up firefighter gear. Twenty moisture barrier, outer shell, and thermal liner textiles were subjected to the abrasion, elevated temperatures, or laundering, while outer shell textiles were also subjected to weathering with ultraviolet radiation and elevated humidity. Fifty-one PFAS were quantified in stressed textiles by targeted analytical methods that coupled solvent extraction with either gas or liquid chromatography-mass spectrometry. This NIST TN follows NIST TN 2248, which determined PFAS occurrence and concentrations in new firefighter gear textiles. The same textiles and PFAS target list were used in both studies.

Across all stressed textiles, 36 PFAS were quantified above reporting limits, with three PFAS (i.e., 6:2 fluorotelomer methacrylate; 6:2 FTMAC, 6:2 fluorotelomer alcohol; 6:2 FTOH, and perfluorobutane sulfonic acid; PFBS) present above 200 µg/kg in at least one stressed textile. Following stressing, summed PFAS concentrations were higher in outer shell textiles than moisture barrier textiles, and lowest in thermal liner and outer shell textiles from which the durable water repellent had been scoured. Abrasion increased summed PFAS concentrations for all textile types (median change in summed PFAS concentration: + 213 %) while weathering (+ 177 %) consistently increased summed PFAS concentrations in outer shell textiles. Laundering produced relatively small changes in summed PFAS concentrations across all textiles (median change - 24 %) and exposure to elevated temperature increased summed PFAS in outer shell textiles (+ 259 %) but resulted in smaller changes in the remaining textile types (- 26 %). Overall, the largest absolute changes in PFAS concentration were observed in outer shell textiles with weathering, where the median summed PFAS concentration increased from 964 µg/kg to 3520 µg/kg. Where stressing increased summed PFAS concentrations, these changes were primarily due to increases in the concentrations of 6:2 FTMAC and 6:2 FTOH, which were also the highest concentration PFAS in unstressed turnout gear textiles, rather than the appearance of previously unobserved PFAS.

Numerous processes may contribute to changes in PFAS concentrations in textiles with stressing such as: changes in the extractable fraction of PFAS due to fluorinated polymer or textile degradation, fluorinated polymer degradation into nonpolymeric PFAS, transformations between PFAS, wash out or volatilization of PFAS, and loss of PFAS associated with dissipated textile fragments. However, the targeted analytical methods used in this study cannot distinguish between PFAS transformations and changes of the fraction of PFAS that are extractable and therefore cannot definitively determine mechanisms underlying changes in measured PFAS concentrations.

This is the first report to quantify changes in PFAS occurrence and concentrations in firefighter turnout gear textiles due to controlled stressing. The results show that stressing, especially abrasion or weathering, can increase measured PFAS concentrations in firefighter gear textiles. Additional research examining firefighter gear for a broader array of target PFAS, determining the extent to which measured PFAS concentrations continue to increase during repeated stressing, and evaluating the extent to which firefighter gear may accumulate PFAS from fire scenes are critical to understand the overall potential PFAS exposure firefighters face from the use of turnout gear.

1. Introduction

Per- and polyfluoroalkyl substances (PFAS) are anthropogenically derived compounds containing at least one perfluoroalkyl moiety (C_nF_{2n+1}) and are present in numerous commercial products. One class of PFAS containing commercial products is durable water repellent (DWR) treatments which impart dirt, oil, and water resistance to high performance outer wear [1, 2]. However, there is growing evidence of adverse human health effects from exposure to certain PFAS, including the suppression of vaccine response in human studies [3] as well as negative impacts on development and multiple organ systems in animal studies [4]. In response, the United States Environmental Protection Agency's 2023 Proposed National Primary Drinking Water Regulation has classified both perfluorooctane sulfonic acid (PFOS) [5] and perfluorooctanoic acid (PFOA) [6] as likely human carcinogens in their public comment drafts. In the final 2021 toxicity assessment for GenX chemicals (including HFPO-DA), EPA determined that there is suggestive evidence of carcinogenic potential of oral exposure to GenX chemicals in humans, based on the available data [7]. Additionally, the International Agency for Research on Cancer has identified PFOA as possibly carcinogenic to humans [8] whereas in 2022, CalEPA designated PFOA as Known to the State of California to Cause Cancer.

Firefighters have higher PFAS serum concentrations than the public [9-17]. There are numerous potential PFAS exposure sources suggested for firefighters, such as the use of aqueous film-forming foams (AFFF) and firefighter gear that has been treated with fluorinated polymers or has accumulated PFAS during firefighting activities [18, 19]. Among firefighters, the use of AFFF [11, 12, 16] and direct engagement in firefighting activities (i.e., as opposed to employment as a driver) [9] are associated with higher serum PFAS concentrations. However, the contribution of PFAS from firefighter gear may not be fully appreciated as firefighter serum PFAS concentrations have not been reported for many of the PFAS identified in the highest concentrations in firefighter textiles such as N-methyl perfluorobutane sulfonamido ethanol (MeFBSE), 6:2 fluorotelomer methacrylate (6:2 FTMAC), and 6:2 fluorotelomer alcohol (6:2 FTOH) [20-22].

As specified in the National Fire Protection Association "*Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*" (NFPA 1971), structural firefighting turnout gear includes coats and pants or coveralls as well as gloves, helmets, and footwear [23]. Turnout gear coats, pants, and coveralls typically contain three layers, present in the following order from farthest to closest to the body: outer shell, moisture barrier, and thermal liner. To meet the performance requirements specified in NFPA 1971 for chemical, light, and water resistance, certain layers of turnout gear are commonly treated with fluorinated polymers or include fluoropolymer membranes [20-22, 24]. NFPA 1971 also includes performance specifications related to resistance from typical end-use stresses, such as abrasion (NFPA 1971, § 8.52), heat (§ 8.6), ultraviolet radiation (UV, § 8.62), and laundering (§ 8.24).

To the best of the authors' knowledge, there are no published reports on the effects of controlled stressing on PFAS occurrence and concentrations in firefighter gear, though exposure to UV radiation has been observed to degrade both polyaramid fibers as well as water repellent coatings in turnout gear outer shell textiles [25, 26]. PFAS concentrations in DWR-treated outerwear have been observed to change with exposure to heat, abrasion, weathering, and laundering [27-29]. Following outdoor [27] and laboratory [29] weathering, measured concentrations of individual PFAS in DWR-treated textiles were up to 100 times higher than measured in the corresponding unstressed textiles. Schellenberger et al. 2022 [27] observed that exposure to abrasion and washing decreased the total fluorine concentrations in DWR-treated textiles that had previously been exposed to outdoor weathering, while van der Veen et al. 2022 [30] observed decreasing perfluoroalkyl acid (PFAA) concentrations in DWR-treated textiles following repeated washing and drying but noted increases in the concentrations of some n:2 fluorotelomer alcohols (n:2 FTOH). The mechanisms responsible for changes in PFAS and total fluorine concentrations in DWR-treated textiles during stressing are still a matter of investigation. PFAS quantification in textiles is typically performed with solvent extraction and mass spectrometry, and the physical degradation of fluorinated polymers or the underlying textiles could increase the fraction of PFAS that are extractable while the degradation of fluorinated polymers could release nonpolymeric PFAS that are quantifiable by mass spectrometry. Additionally, PFAS initially present in a textile may be transformed from species that are not quantifiable to quantifiable with mass spectrometry.

The objective of this NIST report is to communicate the extent to which exposing firefighter gear textiles to stresses related to firefighting activities alter the occurrence and concentration of target PFAS in those textiles. To allow for direct comparison of changes due to stressing, the same textiles and PFAS target list were used in this study as in the unstressed gear study (NIST TN 2248). Twenty firefighter gear textiles were subjected to four stressing processes based on performance tests detailed in NFPA 1971 [23]. Following exposure to abrasion, elevated temperature, laundering, or weathering, the concentrations of 51 PFAS were determined and compared to equivalent concentrations measured in the corresponding textiles prior to stressing. The concentrations reported here provide insight into the amount and mechanisms by which PFAS concentrations in firefighter gear may change as that gear is used for firefighting activities.

2. Materials and Methods

Experimental chemicals and consumables were identical to those used in NIST TN 2248, which reported the occurrence and concentration of PFAS in unstressed firefighter turnout gear textiles and are detailed below (Section 2.1) [22]. Twenty firefighter turnout gear textiles were obtained either from a distributor of firefighter gear or from collaborators at the National Institute for Occupational Safety and Health (NIOSH; Section 2.2). PFAS analytical standards (Sections 2.3 and A.1.2), and analytical techniques (Sections 2.4 and A.2) were also identical to those used in NIST TN 2248 [22], except where indicated below. Details about the methods used to expose textiles to abrasion (Section 2.5), elevated temperature (Section 2.6), laundering (Section 2.7), and weathering (Section 2.8) are also included below.

It should be noted that none of the equipment used for stressing, such as the abrasion foam backing and abrading textile, contributed PFAS to the textiles; therefore, the reported PFAS is from the textiles themselves.

2.1. Chemicals and Consumables

Ammonium acetate (Optima LC-MS grade), ammonium hydroxide (Optima grade), ethyl acetate (Optima HPLC and GC grade), and water (Optima LC-MS grade) were obtained from Thermo Fisher Scientific (Waltham, MA).[2] Methanol (OmniSolv LC-MS grade) for high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) mobile phase solutions was obtained from Supelco (Bellefonte, PA), while methanol (Optima LC-MS grade) for all other purposes was obtained from Thermo Fisher Scientific. Nitrogen gas (Ultra High Purity grade) and helium gas (Ultra High Purity grade) were obtained from Roberts Oxygen (Rockville, MD).

High-performance liquid chromatography (HPLC) vials (2 mL capacity, amber glass) and glass vial inserts (250 µL) were obtained from Agilent Technologies (Santa Clara, CA). Polyethylene 2 mL vial caps for nonvolatile and semivolatile analysis were obtained from Phenomenex (Torrence, CA) while 2 mL vial caps with polytetrafluoroethylene (PTFE)/silicone septa for volatile analysis were obtained from Agilent Technologies. HPLC vials, inserts, and caps were used as received from their vendors. Supelco Analytical (Bellefone, PA) Supelclean ENVI-Carb solid phase extraction (SPE) tubes (6 mL x 500 mg) were rinsed with 20 mL (2 x 10^{-5} m^3) of 0.1 mol/L (10^2 mol/m^3) ammonium hydroxide in methanol and dried prior to use. Glass 20 mL capacity scintillation vials, glass Pasteur pipettes, and polypropylene 15 mL centrifuge tubes (Cole-Parmer Instrument Company, Vernon Hills, IL) were used as received. Syringes (1 mL capacity) and syringe filters (0.22 µm, nylon) were obtained from Thermo Fisher and rinsed with 1 mL (10^{-6} m^3) methanol prior to use.

2.2. Structural Firefighter Turnout Gear Textiles

A variety of common turnout gear textiles was purchased in 2020 from a distributor and repairer of firefighter gear, who received them directly from manufacturers. 1.39 m^2 (1.52 m x 0.914 m) each of six moisture barrier (MB-A, MB-B, MB-C, MB-D, MB-E, MB-F), five thermal liner

[2] Certain commercial equipment, instruments, or materials are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

(TL-A, TL-B, TL-C, TL-D, TL-E), and seven outer shell textiles (OS-A, OS-B, OS-C, OS-D, OS-E, OS-F, OS-G) were purchased without regard to color. NIST purchased the textiles prior to assembly in firefighter turnout gear and comply with NFPA 1971 requirements [6].

Two “scoured” outer shell textiles (OS-ASC, OS-FSC) were obtained from the National Personal Protective Technology Laboratory of NIOSH, who received the textiles from the manufacturer following the scouring of applied DWR treatments. Except for the scouring of DWR treatments, these textiles were similar to two DWR-treated outer shell textiles included in this study (i.e., OS-A and OS-F), except for colors (Table 74). Due to the lack of DWR treatment, the two scoured outer shell textiles were not established to be NFPA 1971 compliant. Average area densities and images of all turnout gear textiles used in this report are shown in A.1.1 (Table 74).

Moisture barrier textiles were comprised of an expanded polytetrafluoroethylene (ePTFE) membrane with an aramid fiber substrate while outer shell textiles consisted of aromatic polyamide (aramid) fiber blends that were woven with either plain, twill, or ripstop weave patterns. Thermal liner textiles were made from aramid fiber or aramid-blend cloth and included one or two additional layers of attached aramid fiber batting. Prior to stressing, textiles were individually stored in the dark, at room temperature, in plastic resealable baggies.

2.3. PFAS Analytical Standards

In addition to the 53 PFAS that were quantified in unstressed firefighter gear textiles in NIST TN 2248 [22], PFAS concentrations in of two n:2 fluorotelomer acrylates: 8:2 fluorotelomer acrylate (8:2 FTAcr) and 10:2 fluorotelomer acrylate (10:2 FTAcr) are reported here. However, due to analytical issues, concentrations of four n:2 fluorotelomer sulfonates (n:2 FTSs) that were quantified in NIST 2248 are not reported here or included in evaluations of the effects of stressing, with the exception of n:2 FTS concentrations in moisture barrier textiles MB-E (Section 3.5). Information for the 51 PFAS quantified in this technical note along with their associated reference standards is provided in Table 1 and Section A.1.2.

2.4. PFAS Analysis

Three analytical methods for the identification and quantification of PFAS were utilized and are referred to as “nonvolatile”, “semivolatile”, and “volatile”. The analytical method used to quantify PFAS concentration is shown in Table 1. Extensive description of these methods were previously described in NIST TN 2248 [22]. Briefly, in the nonvolatile method PFAS were extracted from stressed firefighter gear textiles by sonication in methanol at 25 °C with subsequent centrifugation, filtration through graphitized carbon (ENVI-Carb SPE tubes; 500 mg x 6 mL), and evaporation to dryness under nitrogen at 40 °C. Dried nonvolatile extracts were reconstituted in methanol and analyzed by LC-MS/MS. PFAS analyzed by the semivolatile and volatile analytical methods were extracted simultaneously by sonication in ethyl acetate at 25 °C and subsequent centrifugation, filtration through graphitized carbon (ENVI-Carb SPE tubes, 500 mg x 6 mL), and evaporation to 2 mL under nitrogen at 35 °C. The combined semivolatile and volatile extracts were then analyzed by LC-MS/MS or GC-MS, respectively.

Summed PFAS concentrations that were below reporting limits or did not meet quality control standards were given a value and variance of zero. Reporting limits are PFAS specific. Reporting limits for nonvolatile and semivolatile PFAS were < 0.5 µg/kg. Reporting limits for volatile PFAS were much higher; no reporting limit was < 8.6 µg/kg and some were over 100 µg/kg. More details on report limits are available in Appendix A.3.4 and Tables 5 – 73.

Prior to analysis, the samples were stored in the dark, at ambient temperature, and inside plastic resealable bags for up to 602 days. To investigate if volatile PFAS concentrations could change during extended storage, volatile PFAS concentrations were compared among thirteen simultaneously prepared cuttings of outer shell textile OS-FRM that were extracted after between 62 and 602 days of storage. In these cuttings, the concentrations of two volatile PFAS (6:2 FTMAC and 6:2 FTOH) were consistently observed above reporting limits and linear regressions of their measured concentrations over time were not found to be significantly different from 0 (i.e., $F < 1$). Therefore, no evidence was found that indicated volatile PFAS concentrations were changing over the durations that stressed textiles were stored.

It is worth noting that reporting limits were markedly different for some PFAS in some textiles before and after stressing. The difference in reporting limits between the analysis of stressed and stock textiles especially complicates analysis of the apparent change in 6:2 FTMAC and 6:2 FTOH concentrations in the two scoured textiles (i.e., OS-ASC and OS-FSC). 6:2 FTMAC reporting limits were elevated in the analysis of unstressed compared with stressed textiles because measurements of volatile PFAS in unstressed textiles were made with a model of GC-MS vial cap that contributed 6:2 FTMAC to the measured concentrations. For the analyses of stressed textiles, a different model of GC-MS vial cap was used that contributed lower amounts of 6:2 FTMAC and allowed lower reporting limits to be determined. Similarly, 6:2 FTOH reporting limits were elevated for the determination of unstressed compared with stressed textiles and this was largely due to the use of a calibration range that included lower concentrations of 6:2 FTOH for the analysis of stressed textiles.

Table 1. PFAS class names and abbreviations, individual compound names and abbreviations, analytical methods used for quantification of individual PFAS (i.e., NV for nonvolatile, SV for semivolatile, or V for volatile), and Chemical Abstract Service Registry Numbers (CAS RN) of all PFAS analyzed in this technical note.

Class	**Name**	**Analytical Method**	**CAS RN**
Perfluorocarboxylic acids (PFCA)	Perfluorobutanoic acid (PFBA)	NV	375-22-4
	Perfluoropentanoic acid (PFPeA)	NV	2706-90-3
	Perfluorohexanoic acid (PFHxA)	NV	307-24-4
	Perfluoroheptanoic acid (PFHpA)	NV	375-85-9
	Perfluorooctanoic acid (PFOA)	NV	335-67-1
	Perfluorononanoic acid (PFNA)	NV	375-95-1
	Perfluorodecanoic acid (PFDA)	NV	335-76-2
	Perfluoroundecanoic acid (PFUnDA)	NV	2058-94-8
	Perfluorododecanoic acid (PFDoDA)	NV	307-55-1
	Perfluorotridecanoic acid (PFTrDA)	NV	72629-94-8
	Perfluorotetradacanoic acid (PFTeDA)	NV	0376-06-07
Perfluoroalkane sulfonic acids (PFSA)	Perfluoropropane sulfonic acid (PFPrS)	NV	423-41-6
	Perfluorobutane sulfonic acid (PFBS)	NV	375-73-5
	Perfluoropentane sulfonic acid (PFPeS)	NV	2706-91-4
	Perfluorohexane sulfonic acid (PFHx	NV	108427-53-8
	Perfluoroheptane sulfonic acid (PFHpS)	NV	375-92-8
	Perfluorooctane sulfonic acid (PFOS)	NV	45298-90-6
	Perfluorononane sulfonic acid (PFNS)	NV	68259-12-1
	Perfluorodecane sulfonic acid (PFDS)	NV	335-77-3
Perfluoroalkane sulfonamides (FASA)	Perfluorobutane sulfonamide (FBSA)	NV	30334-69-1
	Perfluorohexane sulfonamide (FHxSA)	NV	41997-13-1
	Perfluorooctane sulfonamide (FOSA)	NV	754-91-6
	N-Methyl perfluorobutane sulfonamide (MeFBSA)	SV	68298-12-4
	N-Methyl perfluorooctane sulfonamide (MeFOSA)	SV	31506-32-8
	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	SV	4151-50-2
Perfluoroalkane sulfonamido acetic acids (FASAA)	Perfluorooctane sulfonamido acetic acid (FOSAA)	NV	2806-24-8
	N-Methyl perfluorooctane sulfonamido acetic acid (MeFOSAA)	NV	2355-31-9
	N-Ethyl perfluorooctane sulfonamido acetic acid (EtFOSAA)	NV	2991-50-6
Perfluoroalkane sulonamido ethanols (FASE)	*N*-Methyl perfluorooctane sulfonamido ethanol (MeFOSE)	SV	24448-09-07
	N-Ethyl perfluorooctane sulfonamido ethanol (EtFOSE)	SV	1691-99-2
Per- and polyfluoroalkyl ether acids (PPEA)	Perfluoro-3-methoxypropanoic acid (PF4OPeA)	NV	377-73-1
	Perfluoro-2-ethoxyethane sulfonic acid (PFEESA)	NV	113507-82-7
	Perfluoro-4-methoxybutanoic acid (PF5OHxA)	NV	863090-89-5
	Perfluoro-3,6-dioxaheptanoic acid (3-6-OPFHpA)	NV	151772-58-6
	Hexafluoropropylene oxide dimer acid (HFPO-DA)	NV	13252-13-6
	4,8-Dioxa-3H-perfluorononanoate (ADONA)	NV	958445-44-8
	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	NV	756426-58-1
	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	NV	763051-92-9

Table 1. (Continued)

Class	Name	Analytical Method	CAS RN
n:2 Fluorotelomer acrylates (n:2 FTAcr)	8:2 Fluorotelomer acrylate (8:2 FTAcr)	V	27905-45-9
	10:2 Fluorotelomer acrylate (10:2 FTAcr)	V	17741-60-5
n:2 Fluorotelomer methacrylates (n:2 FTMAC)	6:2 Fluorotelomer methacrylate (6:2 FTMAC)	V	2144-53-8
	8:2 Fluorotelomer methacrylate (8:2 FTMAC)	V	1996-88-9
	10:2 Fluorotelomer methacrylate (10:2 FTMAC)	V	2144-54-9
n:2 Fluorotelomer acetates (n:2 FTOAc)	8:2 Fluorotelomer acetate (8:2 FTOAc)	V	37858-05-02
	10:2 Fluorotelomer acetate (10:2 FTOAc)	V	37858-05-02
n:2 Fluorotelomer alcohols (n:2 FTOH)	4:2 Fluorotelomer alcohol (4:2 FTOH)	V	2043-47-2
	5:2 Fluorotelomer alcohol (5:2 FTOH)	V	914637-05-1
	6:2 Fluorotelomer alcohol (6:2 FTOH)	V	647-42-7
	7:2 Fluorotelomer alcohol (7:2 FTOH)	V	24015-83-6
	8:2 Fluorotelomer alcohol (8:2 FTOH)	V	678-39-7
	10:2 Fluorotelomer alcohol (10:2 FTOH)	V	87017-97-8
n:2 Fluorotelomer sulfonic acids (n:2 FTS)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	NV	757124-72-4
	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	NV	27619-97-2
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	NV	39108-34-4
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	NV	120226-60-0

2.5. Abrasion

Previously unstressed firefighter turnout gear textiles were abraded against a standard abradant fabric following a method described in NFPA 1971, § 8.52 [23], International Organization for Standardization (ISO) standard 12947-3 "*Determination of Abrasion Resistance of Fabrics by the Martindale Method-Part 3*" [31] and ASTM standard D4966 "*Standard Test Method for Abrasion Resistance of Textile Fabrics, Martindale Abrasion Tester Method* " [32] using a Martindale abrasion tester (James and Heal Co. Ltd, United Kingdom). Briefly, circular textile sections, approximately 38 mm in diameter, were cut from each firefighter gear textile with scissors and the mass of each cut section was recorded**.** The sections were then placed into a specimen holder with a polyurethane foam backing disk. The assembled specimen holder was placed in the Martindale abrasion tester and weight was added to produce a pressure of 9.0 kPA ± 0.2 kPA between the textile and the abradant fabric. Abradant fabrics, made of worsted wool with a plain weave, were supported on a standard felt. To limit contamination between samples, both the abradant fabrics and polyurethane foam backing disks were replaced between textiles. Additionally, up to four textile samples were abraded simultaneously and therefore glass dome dividers were manufactured and incorporated into the abrasion tester to prevent contamination of one textile from airborne particles released by the abrasion of another textile. Glass dome dividers were rinsed with methanol between stressing sessions to further reduce cross contamination. Each textile specimen was subjected to 20000 rubs with a translational movement that followed a Lissajous figure at a rate of 47.5 revolutions per minute with a maximum stroke length of 60.5 mm. Afterwards, each textile was removed from the abrasion tester and had its mass recorded again. Abraded textiles were stored in the dark at ambient temperature in 15 mL polypropylene centrifuge tubes for between 12 days and 372 days until extraction.

2.6. Elevated Temperature

Previously unstressed firefighter turnout gear textiles were exposed to elevated temperature in a hot air circulating oven (EQ-DHG-9000JB, MTI Corporation, Richmond, CA) using a method described in NFPA 1971 § 8.6 [23] and ASTM standard F2894-19 "*Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven*" [33]. Briefly, a convection oven was heated to between 260 °C and 268 °C for at least 30 minutes with the temperature verified by a thermocouple suspended inside the oven. Sections of each firefighter gear textile were cut to approximately 152 mm by 50 mm with scissors and the masses of the cut sections were determined. During exposure to elevated temperatures, sections were suspended inside the oven by a metal hook to prevent contact with oven surfaces. Textile sections were exposed to elevated temperatures individually to reduce the risk of contamination. When sections were placed inside the oven, the door was closed no longer than 10 seconds after it was first opened. Each section was left in the oven with the air recirculating for 5 minutes after the measured temperature returned to 260 °C. Then, the section was removed and suspended on a cooling rack to return to ambient temperature before its mass was recorded again. The part of each textile section that had been in contact with the metal hook was removed with scissors. Following exposure to elevated temperature, sections were stored in the dark at ambient temperature inside plastic resealable bags for between 21 days and 594 days until extraction.

2.7. Laundering

Previously unstressed firefighter turnout gear textiles were laundered at the National Personal Protective Technology Laboratory, following a process described in National Fire Protection Association Standard 1851 *"Standard on Selection, Care and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting"* (NPFA 1851) [34]. Sections of each textile were cut to approximately 150 mm by 920 mm and stored separately from other sections until laundering. Each section was laundered individually to reduce cross-contamination in a washer-extractor (Pellerin Milnor Corporation, Kenner, LA) along with ten cotton towels (100% cotton; approximately 0.725 kg each) to act as ballast during the washing and better simulate typical laundering conditions. Citrosqueeze (SC Products Group, Dallas, TX), a detergent marketed as being NFPA 1851 compliant for the cleaning of turnout gear and personal protective equipment, was added to each wash cycle. To the best of our knowledge, Citrosqueeze doesn't contain PFAS. Each section was washed three times and dried in a drying cabinet between washings. Moisture barriers and the thermal liners were laundered using an NFPA-specified gear liner laundering cycle that subjects gear to lower g-forces than the cycles specified for the outer shells. Following the third wash cycle, each section was subjected to a final rinse cycle in a household washing machine to remove any residual detergent before being hung to air dry.

Following laundering, many sections were wrinkled or had gathering and bunching along the stitching. Additionally, some sections exhibited fraying along unfinished edges. To limit the impact of gathering, bunching, or fraying on PFAS measurements, samples for PFAS analysis were cut from the interior of laundered section where no visible fraying or bunching was present. Laundered textile sections were stored inside plastic resealable bags at ambient temperatures in the dark for between 201 days and 565 days until extraction.

2.8. Weathering

Previously unstressed firefighter turnout gear outer shell textiles were subjected to accelerated weathering by alternating exposure to ultraviolet light and moisture using an accelerated weathering tester (QUV by Q-Lab, Westlake, OH), following NFPA 1971 § 8.62 [23], International Organization for Standardization standard 4892-3:2016 "*Method of Exposure to UV Lamp Sources*" [35] and ASTM International standard G154 "*Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials"* [36]. Only outer shell sections were exposed to weathering as they are expected to receive the highest solar radiation during use of any turnout gear layer. Outer shell sections were cut to dimensions of approximately 76 mm by 152 mm with methanol-rinsed scissors, mounted in a QUV specimen holder, and placed into the QUV tester. The QUV tester was programmed to expose textile sections to an 8 hours dry exposure period with an irradiance of 0.76 W/m^2 at 340 nm and the black-panel temperature of 50 °C ± 3 °C, followed by a 0.25 hours water spray period with UV lamps off and uncontrolled black-panel temperature, and finally a 3.75 hours condensation exposure period with the UV lamps off and the black-panel temperature set to 50 °C ± 3 °C. These periods were sequentially repeated 24 additional times for a total exposure duration of 300 hours. While up to seven textile samples were weathered simultaneously, samples did not share QUV specimen holders which prevented water that condensed on one textile from running onto another. The weathered sections were then removed from the QUV tester and regions of the outer shell sections that had been shielded by the QUV specimen holder, and therefore not exposed to UV radiation, were trimmed off with methanol-rinsed scissors. QUV specimen holders were cleaned with methanol between the weathering of each textile. Weathered outer shell textile sections were stored inside plastic resealable bags at ambient temperatures in the dark for between 62 days and 637 days until extraction.

3. Results

PFAS were quantified in firefighter gear textile sections that had been exposed to abrasion, elevated temperature, laundering, or weathering, as detailed below. Each textile sample was only exposed to a single stressing process and no PFAS are reported for textiles that were exposed to multiple stressing processes. Additionally, changes in section mass that occurred during exposure to abrasion or elevated temperature are also reported.

3.1. Abrasion

3.1.1. Change in Textile Mass with Abrasion

Small changes in the mass of textile sections occurred during abrasion (i.e., median change: - 0.61 %), likely due to small amounts of each textile being worn away by the abrasive fabric. Measured fractional changes in the mass of each textile are shown in Table 2. The changes in mass shown in Table 2 may underestimate the actual changes in mass due to abrasion as part of each textile section was protected from abrasion by the attachment device of the abrader. Because of this potential underestimation and the small magnitude of the observed changes, PFAS concentrations in abraded textiles are reported in units of µg-PFAS / kg of abraded textile.

Cuttings from six textiles were observed to increase ($P < 0.05$, paired *t*-test) in mass which could be attributed to small amounts of material from the abradant fabric or polyurethane foam backing disk transferring to the textile during abrasion. There. was no measurable PFAS in the abradant fabric or foam, therefore, PFAS measured in the abraded samples are only from the firefighter textiles themselves.

Table 2. Mean and standard deviation of measured fractional mass change in textile following abrasion. Positive values indicate increased mass while negative values indicate decreased mass. * Indicate significantly different (P < 0.05, paired *t*-test) masses before and following abrasion.

Textile	Mean ± Standard Deviation Mass Change Following Abrasion (%)	Number of Replicates
MB-A	1.36 ± 0.72*	8
MB-B	0.98 ± 1.80*	8
MB-C	-1.07 ± 0.95*	8
MB-D	-1.16 ± 0.29*	8
MB-E	-1.13 ± 0.26*	6
MB-F	0.50 ± 0.44*	8
OS-A	-0.15 ± 0.65*	4
OS-ASC	-1.95 ± 0.98*	8
OS-B	1.03 ± 0.29*	8
OS-C	-0.11 ± 0.54	8
OS-D	0.04 ± 0.23	8
OS-E	-0.72 ± 0.42*	12
OS-F	-0.60 ± 0.09*	8
OS-FSC	-5.62 ± 0.88*	8
OS-G	-0.62 ± 0.77	8
TL-A	-4.09 ± 3.45	4
TL-B	-3.73 ± 0.86*	4
TL-C	1.49 ± 0.45*	4
TL-D	-2.29 ± 1.35*	4
TL-E	3.19 ± 0.06*	4

3.1.2. PFAS Occurrence and Concentration in Abraded Firefighter Gear Textiles

Across 20 abraded firefighter turnout gear textiles, 28 PFAS were quantified above reporting limits with between 2 and 18 PFAS quantified in individual textiles (Figure 1; Table 5 -**Table 73**) including perfluorocarboxylic acids (PFCAs) with between 3 and 13 perfluorinated carbons, perfluoroalkane sulfonic acids (PFSAs) with 3 to 8 and 10 perfluorinated carbons, and per- and polyfluoroalkylsulfonamides (FASAs) with 4, 6, and 8 perfluorinated carbons. The most identified PFAS were the PFAAs perfluoropenanoic acid (PFPeA; present in 18 abraded textiles), perfluorobutanoic acid (PFBA; 17 textiles), and perfluorobutane sulfonic acid (PFBS; 16 textiles), however, their individual concentrations were all under 120 µg/kg. Two 6:2 fluorotelomer PFAS were quantified above reporting limits in at least 11 abraded textiles and were present at the highest individual concentrations of any observed PFAS: 6:2 FTMAC was quantified in 11 abraded textiles at up to 5440 µg/kg ± 560 µg/kg (OS-D; Table 38) while 6:2 FTOH was quantified in 13 textiles at up to 1710 µg/kg ± 320 µg/kg (OS-D).

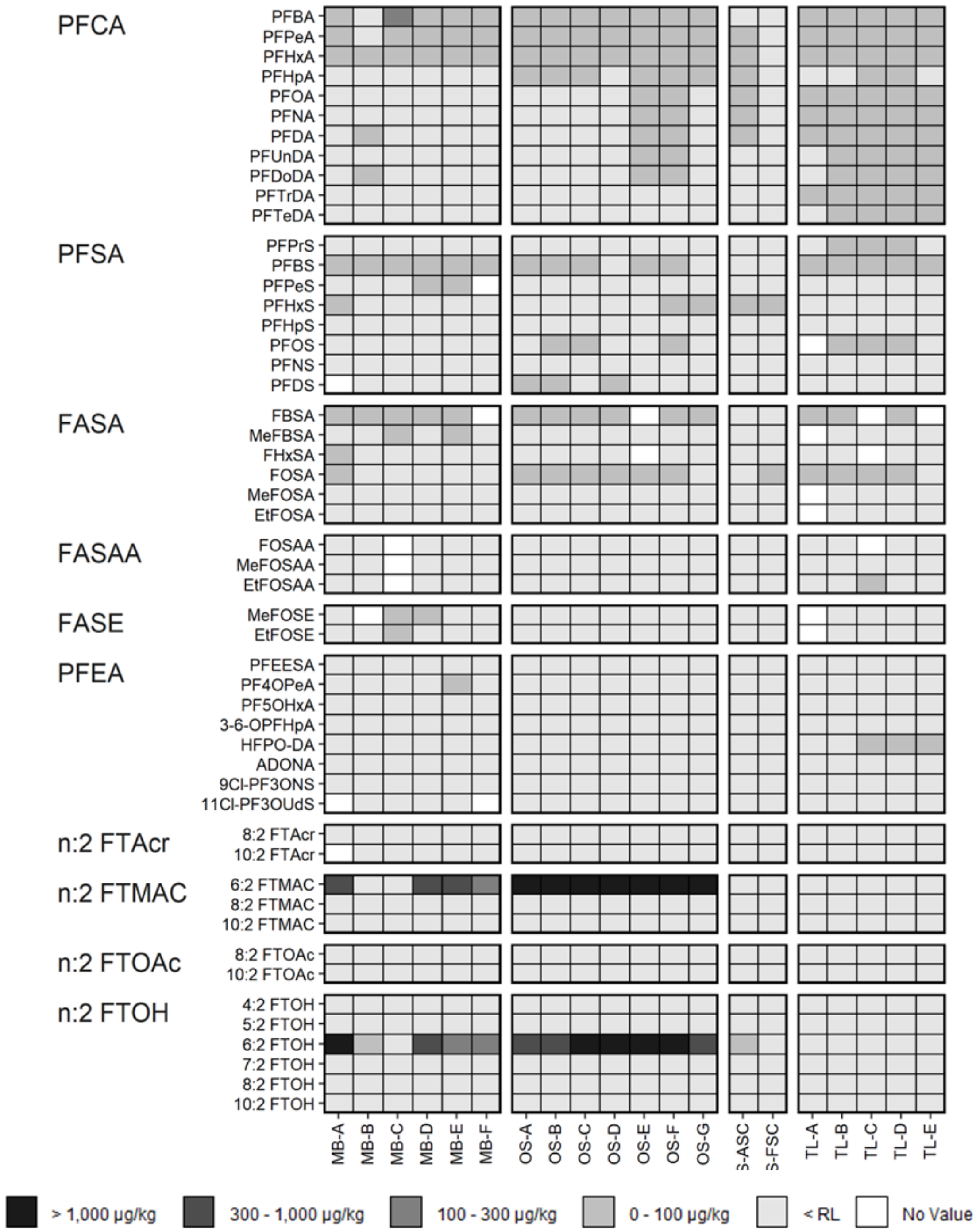

Figure 1. Mean PFAS concentrations (µg PFAS/kg textile or ppb mass ratio) determined from triplicate analysis of firefighter turnout gear textiles following abrasion.

Following abrasion, DWR-treated outer shell textiles had the highest summed PFAS concentrations of any abraded textiles (Figure 2), with summed PFAS concentrations ranging from 2170 µg/kg ± 200 µg/kg (mean of summed concentrations from triplicate analysis ± combined standard uncertainty; OS-G; Table 55) to 7160 µg/kg ± 640 µg/kg (OS-D; Table 39), followed by moisture barrier textiles with summed PFAS concentrations ranging from 44.9 µg/kg ± 5.1 µg/kg (MB-B; Table 8) to 2040 µg/kg ± 410 µg /kg (MB-A; Table 5). Despite up to 17 PFAS being identified above reporting limits in individual abraded thermal liner textiles summed PFAS concentrations ranged from 2.81 µg/kg ± 0.18 µg/kg (TL-E; Table 71) to 10.7 µg/kg ± 1.7 µg/kg (TL-C; Table 65) and were much lower than summed PFAS concentrations in moisture barrier or DWR-treated outer shell textiles. Two PFAS were identified in the scoured outer shell OS-FSC at a summed concentration of 0.064 µg/kg ± 0.012 µg/kg (Table 51) while eight were identified in OS-ASC at a summed concentration of 37.8 µg/kg ± 8.0 µg/kg (Table 27).

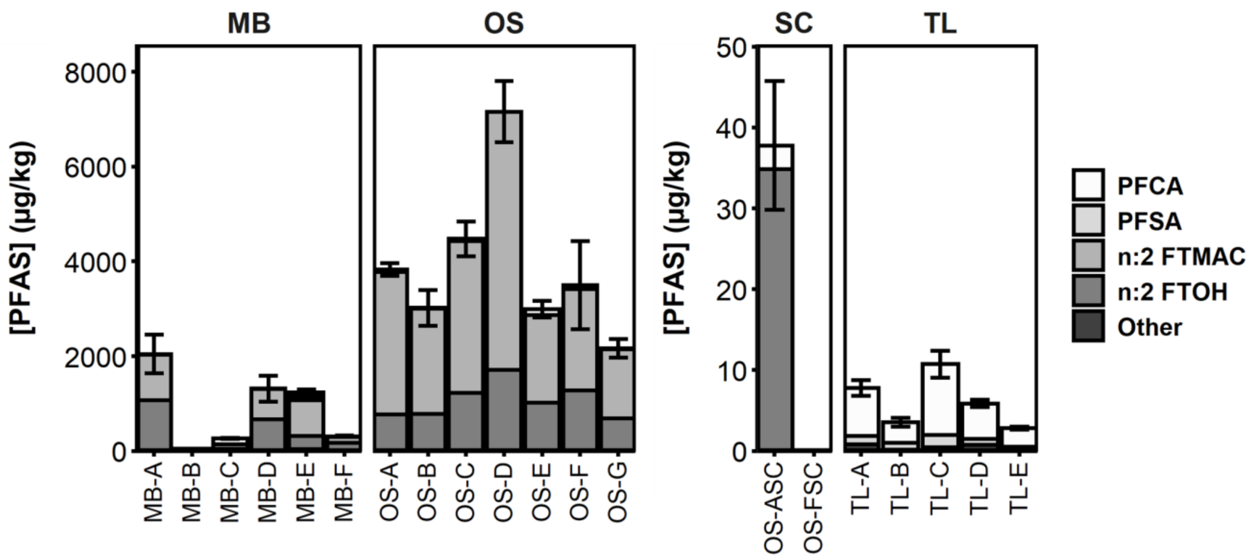

Figure 2. Summed PFAS concentrations determined from triplicate analysis of firefighter turnout gear textiles following abrasion. Error bars indicate the combined standard uncertainty of summed concentrations. PFAS class is indicated by shade.

N:2 FTS concentrations are not included in summed PFAS concentrations following abrasion, or other stressing processes, because intermittent instrumental contamination prevented their analysis from consistently meeting quality control (QC) standards. However, n:2 FTSs were a small contributor to the overall summed PFAS concentrations in unstressed textiles (i.e., < 0.6 % of summed PFAS mass and < 8 µg summed n:2 FTS/kg) except for MB-E where n:2 FTSs contributed 614 µg/kg ± 15 µg/kg which accounted for 32.9 % of the overall summed PFAS mass. Because n:2 FTS measurements were repeated for stressed MB-E after contamination issues had been addressed, n:2 FTS concentrations are reported and discussed for stressed MB-E in Section 3.5. For all stressed textiles, n:2 FTS measurements that did meet QC standards, including measured PFAS concentrations and reporting limits, are shown in Table 5 - Table **73** though they are not included in summed PFAS measurements.

Nonvolatile PFAS were determined with the same extraction and analytical procedures as the stressed firefighter gear textiles in both the worsted wool abradant fabric and the polyurethane foam used in the abrasion process to determine if firefighter textiles could accumulate PFAS during abrasion. PFPeA (0.046 µg/kg ± 0.004 µg/kg), perfluorononanoic acid (PNFA; 0.050 µg/kg ± 0.004 µg/kg), perfluorohexane sulfonic acid (PFHxS; 0.151 µg/kg ± 0.030 µg/kg), and PFOS (0.286 µg/kg ± 0.036 µg/kg) were all quantified above reporting limits in the abradant fabric, as was PFBA (0.278 µg/kg ± 0.004 µg/kg) in the polyurethane foam. Due to the low individual and summed PFAS concentrations observed in these materials, they were unlikely to appreciably contribute to the observed PFAS concentrations in abraded textiles and therefore acceptable for use in abrasion stressing.

3.1.3. Change in PFAS Occurrence and Concentration Following Abrasion

Higher numbers of PFAS were quantified in abraded firefighter textiles compared with corresponding unstressed textiles. The number of total identified PFAS across all textiles increased from 23 to 28 with abrasion and the median number of PFAS quantified above reporting limits in each textile rose from 7 to 10 following abrasion. Graphical representations of the changes in PFAS occurrence and concentration with abrasion are in Figure 21 -Figure **27**.

Summed PFAS concentrations were higher following abrasion compared with unstressed textiles in five out of six moisture barrier textiles, as well as all DWR-treated outer shell and thermal liner textiles (Figure 3). Compared with corresponding unstressed textiles, the median summed PFAS concentrations following abrasion was 467 µg/kg higher for moisture barrier textiles (i.e., increased from 307 µg/kg to 774 µg/kg), 2070 µg/kg higher for DWR-treated outer shell textiles (1430 µg/kg to 3500 µg/kg), and 4.65 µg/kg higher for thermal liner textiles (1.18 µg/kg to 5.84 µg/kg). Summed PFAS concentrations were slightly lower in only two abraded textiles compared with the corresponding unstressed textiles: MB-E (1251 µg/kg ± 89 µg/kg to 1240 µg/kg ± 54 µg/kg) and OS-FSC (0.335 µg/kg ± 0.032 µg/kg to 0.065 µg/kg ± 0.012 µg/kg). The largest relative increase in summed PFAS concentrations with abrasion occurred in the scoured outer shell textile OS-ASC (22.2 times increase) and the thermal liner textiles TL-D (16.3 times) and TL-E (14.8 times), all of which had summed concentrations below 2 µg/kg when unstressed. While the combined standard uncertainties associated with measurements of abraded textiles were larger in absolute terms than those associated with unstressed textiles (Figure 3), the ratios of combined standard uncertainties to summed PFAS concentrations are similar between unstressed and abraded textiles. Among all unstressed textiles, the combined standard uncertainty of the summed PFAS concentration ranged from 3.3 % to 31.7 % of the summed PFAS concentration with a median value of 8.9 %, while among abraded textiles the same range was 3.4 % to 26.7 % with a median of 10.2 %.

It should be noted that the reported increase in summed PFAS concentration in OS-ASC with abrasion overestimates the true change because of our assumption that concentrations determined to be below reporting limits are zero for the purposes of summed PFAS concentrations. In unstressed OS-ASC the concentration of 6:2 FTOH was determined to be below the reporting limit of 183 µg/kg, while in abraded OS-ASC it was determined to be 34.8 µg/kg ± 7.9 µg/kg with a reporting limit of 31.0 µg/kg. Because the reporting limit of 6:2 FTOH in unstressed OS-ASC was higher than the reported value of 6:2 FTOH in abraded OS-ASC, it cannot be known if 6:2 FTOH concentrations actually increased with abrasion. In fact, 6:2 FTOH concentrations could have actually decreased by over 80 % with abrasion (i.e., 182 µg/kg to 34.8 µg/kg), but because the concentration of 6:2 FTOH in unstressed OS-ASC was determined to be below the reporting limit, it is assumed to have increased from zero to 34.8 µg/kg ± 7.9 µg/kg for the purposes of determining the change in summed PFAS concentrations.

6:2 FTMAC and 6:2 FTOH were primarily responsible for the increases in summed PFAS concentrations in moisture barrier and DWR-treated outer shell textiles following abrasion. Of the 13 moisture barrier and DWR-treated outer shell textiles, changes in the summed concentration of 6:2 FTMAC and 6:2 FTOH with abrasion was equivalent to between 95.9 % and 114 % of the total change in summed PFAS concentration The summed concentrations of nonvolatile PFAS (Figure 29) also increased in most textiles during abrasion, though absolute amount of increase was much smaller than for volatile PFAS.

Seven PFAS were present in at least one abraded textile that were not observed in any unstressed textile (i.e., EtFOSAA, HFPO-DA, MeFBSA, PF4OPeA, PFHxS, PFPeS, and PFTrDA) while two PFAS were identified in at least one unstressed textile and missing from all textiles following abrasion (i.e., FOSAA and PFHpS). However, these PFAS were present at relatively low concentrations and summed to less than 9 µg/kg in any abraded textile (up to 0.46 % of overall summed PFAS mass) and less than 0.5 µg/kg in any unstressed textile (up to 0.08 % of overall summed PFAS mass).

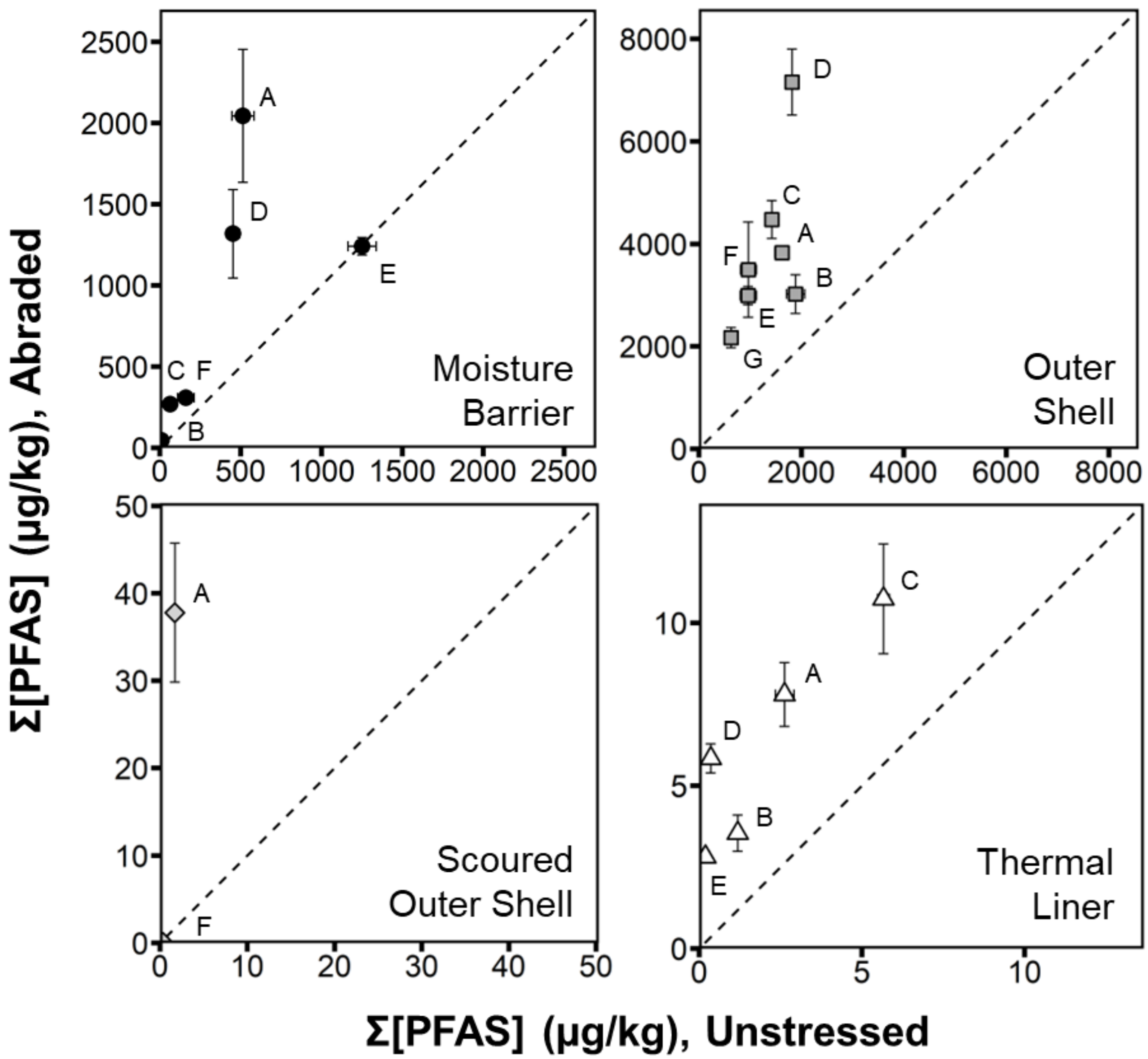

Figure 3. Summed PFAS concentrations determined by triplicate analysis of firefighter gear textiles following abrasion on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Textile type is indicated in panel label and individual textiles are indicated with marker labels. A 1:1 concentration ratio (i.e., identical concentrations measured in textile prior to and following stressing) is indicated with a dashed line.

3.2. Elevated Temperature

3.2.1. Change in Textile Mass with Exposure to Elevated Temperature

The mass of textile sections was determined prior to and following exposure to elevated temperature and all textile sections were observed to have lost mass during stressing (Table 3). Additionally, changes in mass experienced during exposure to elevated temperature were larger than those experienced by the textiles during abrasion. However, PFAS concentrations in textiles exposed to elevated temperatures are reported in units of µg PFAS / kg of textile following exposure to elevated temperature due to the low magnitude of the measured mass changes.

Table 3. Measured mass changes in textile samples following thermal stressing. Positive values indicate increasing mass and negative values indicate decreasing mass. Statistical significance of mass changes was not evaluated due to the low number of replicates. Where multiple measurements were made, individual measurements are separated by a comma.

Textile	Measured Mass Change(s) with Exposure to Elevated Temperature (%)
MB-A	-7.0, -6.1
MB-B	-5.2, -5.4
MB-C	-6.6, -5.3
MB-D	-8.1, -10.7
MB-E	-2.8, -7.1
MB-F	-8.4, -3.6
OS-A	-5.2
OS-ASC	-2.8
OS-B	-9.5
OS-C	-3.7, -2.4
OS-D	-5.0
OS-E	-5.8
OS-F	-7.0, -4.7
OS-FSC	-1.2
OS-G	-8.1
TL-A	-9.4, -10.5
TL-B	-16.4, -16.9
TL-C	-4.8, -2.7
TL-D	-3.8, -11.5
TL-E	-8.3, -5.9

3.2.2. PFAS Occurrence and Concentration in Firefighter Gear Textiles Exposed to Elevated Temperatures

22 PFAS were quantified above reporting limits in at least one textile following exposure to elevated temperatures, with individual stressed textile containing between zero and 14 PFAS (Figure 4). PFCAs with fewer than six perfluorinated carbons, PFBS, 6:2 FTMAC, and 6:2 FTOH which were all quantified above reporting limits in at least 11 textiles following exposure to elevated temperatures. 6:2 FTMAC and 6:2 FTOH were the only volatile PFAS quantified above reporting limits in any textile following exposure to elevated temperatures, however, they were quantified at the highest concentrations of any individual PFAS, with 6:2 FTMAC present at up to 5200 µg/kg ± 110 µg/kg (OS-F; Table 48) and 6:2 FTOH present at up to 2026 µg/kg ± 58 µg/kg (OS-F). While no per- and polyfluoroalkyl ether acid (PPEA) was identified in unstressed textiles, HFPO-DA, perfluoro-2-ethoxyethane sulfonic acid (PFEESA), and perfluoro-4-methoxybutanoic acid (PF5OHxA) were each identified at low concentrations (i.e., summed mass less than 0.9 µg/kg and fraction of summed PFAS mass less than 15 %) in one or two textiles following exposure to elevated temperature.

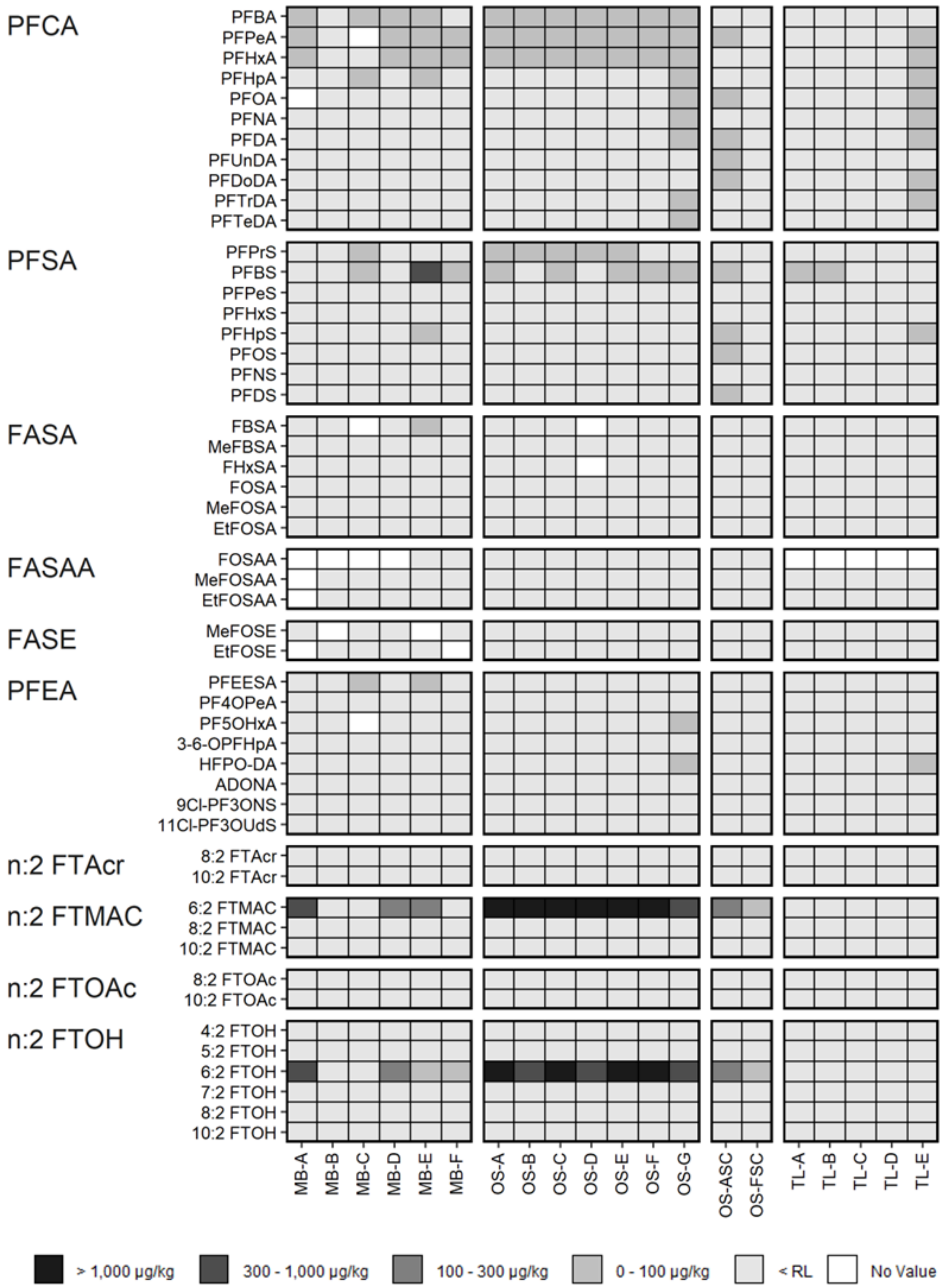

Figure 4. Mean PFAS concentrations (µg PFAS/kg textile or ppb mass ratio) determined from triplicate analysis of firefighter turnout gear textiles after exposure to elevated temperature.

Following exposure to elevated temperatures, summed PFAS concentrations were highest in DWR-treated outer shell textiles, ranging from 1470 µg/kg ± 190 µg/kg (OS-G; Figure 5) to 7290 µg/kg ± 130 µg/kg (OS-F), and lower in moisture barrier textiles which ranged from none above reporting limits (MB-B) to 764 µg/kg ± 24 µg/kg (MB-A). Summed PFAS concentrations in thermal liner textiles ranged from none quantified above reporting limits (TL-C) to 4.86 µg/kg ± 0.88 µg/kg (TL-E).

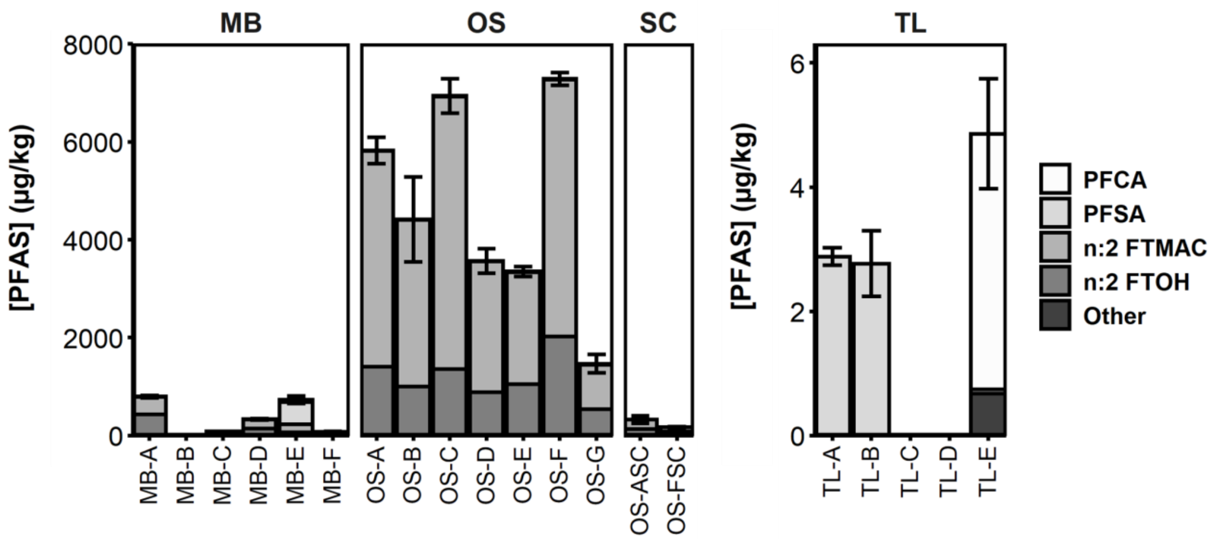

Figure 5. Summed PFAS concentrations determined from triplicate analysis of firefighter turnout gear textiles following exposure to elevated temperature. Error bars indicate the combined standard uncertainty of summed concentrations. Shading indicates PFAS class.

3.2.3. Change in PFAS Occurrence and Concentration Following Exposure to Elevated Temperature

A similar number of PFAS were quantified above reporting limits across all textiles exposed to elevated temperatures compared with corresponding unstressed textiles (i.e., 22 vs. 23), and a similar number of PFAS were quantified in each textile, with the median number decreasing from seven to six. In three textiles (i.e., MB-B, TL-C, TL-D) no PFAS were quantified above reporting limits following exposure to elevated temperatures. Summed PFAS concentrations were higher than in the equivalent unstressed textiles for two of six moisture barrier textiles, all nine outer shell textiles, and three of five thermal liner textiles (Figure 6). Median PFAS concentrations following exposure to elevated temperatures were 100 µg/kg lower among moisture barriers, 2990 µg/kg higher among DWR-treated outer shell textiles, and 1.59 µg/kg higher among thermal liners. Graphical representations of the changes in PFAS occurrence and concentration with exposure to elevated temperature are shown in Figure 21 - Figure **27**.

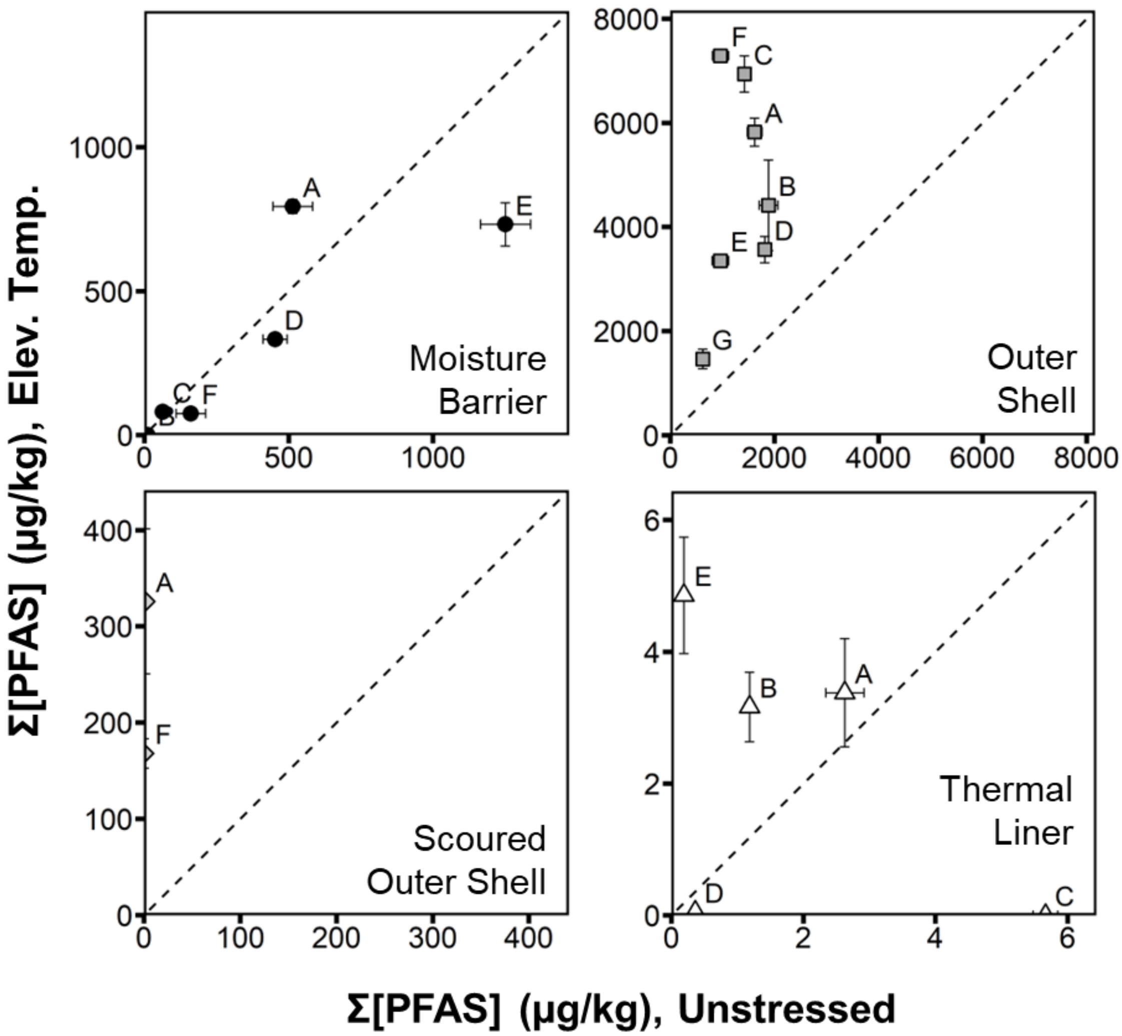

Figure 6. Summed PFAS concentrations determined by triplicate analysis of firefighter gear textiles following exposure to elevated temperatures on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Textile type is indicated in panel label and individual textiles are indicated with marker labels. A 1:1 concentration ratio (i.e., identical concentrations measured in textile prior to and following stressing) is indicated with a dashed line.

Changes in summed PFAS concentration after exposure to elevated temperatures were largely due to changes in 6:2 FTMAC and 6:2 FTOH concentrations. 6:2 FTMAC concentrations fell in all moisture barrier but rose in all outer shells by up to 4610 µg/kg (OS-F; Table 48). Similarly, 6:2 FTOH concentrations rose in 12 out of 13 textiles where it was observed above reporting limits prior to stressing, with a median increase of 342 µg/kg among these textiles. As with abrasion, changes in 6:2 FTMAC and 6:2 FTOH were nearly equivalent to the changes in summed PFAS concentration, and accounted for between 99.7 % and 105 % of the overall change in summed PFAS concentrations following exposure to elevated temperatures in textiles where they were identified after stressing in all textiles except MB-E where summed PFAS concentrations fell from 1251 µg/kg to 731 µg/kg while the summed concentrations of 6:2 FTMAC and 6:2 FTOH fell from 1190 µg/kg to 222 µg/kg.

Similar to the change in measured 6:2 FTOH concentration in OS-ASC following abrasion, the quantification of 6:2 FTMAC and 6:2 FTOH in OS-ASC and OS-FSC at concentrations above their reporting limits in textiles that had been exposed to elevated temperature resulted in apparently large increases of summed PFAS concentrations in these textiles. However, due to the higher reporting limits recorded for the analysis of 6:2 FTMAC and 6:2 FTOH in unstressed textiles compared with stressed textiles, it cannot be known if the concentrations of these PFAS increased in the scoured outer shells with exposure to elevated temperature. For example, 6:2 FTMAC was previously determined to be present in unstressed OS-ASC at less than the reporting limit of 326 µg/kg and was here determined to be present in OS-ASC following exposure to elevated temperatures at 68 µg/kg ± 47 µg/kg. Therefore, while for the purposes of determining summed PFAS concentrations in OS-ASC, 6:2 FTMAC was assumed to increase from zero to 68 µg/kg, 6:2 FTMAC concentrations could have in fact decreased by almost 80 % (i.e., from 325 µg/kg to 68 µg/kg).

While summed nonvolatile PFAS concentrations decreased in most outer shell textiles, summed volatile PFAS concentrations increased in all outer shell textiles with exposure to elevated temperatures (Figure 30 and Figure **31**). Conversely, most moisture barrier and thermal liner textiles had higher summed nonvolatile PFAS concentrations after exposure to elevated temperatures, while three moisture barrier textiles had lower volatile PFAS concentrations after exposure to elevated temperatures. The measured increases in volatile PFAS concentration in outer shell textiles following exposure to elevated temperatures were unexpected given that experimentally derived and predicted boiling points of 6:2 FTMAC and 6:2 FTOH (ranging from 140 °C to 220 °C and 90 °C to 174 °C, respectively [37-39]), are well below the 260 °C elevated exposure temperature. The observation of higher summed volatile PFAS concentrations after exposure to elevated temperatures could indicate their production from the degradation of fluorinated polymers as well as an increase in the fraction of PFAS that are extractable from firefighter gear textiles following exposure to elevated temperatures. Studies on the release of PFAS from fluorinated polymers at elevated temperatures have typically used much higher experimental temperatures than those used here to examine conditions relevant to municipal incineration [40]. Therefore, the extent to which fluorinated polymers in DWR treatments are degraded by exposure to air at 260 °C is unknown.

Four PFAS were quantified above reporting limits in at least one firefighter gear textile following exposure to elevated temperatures that were not observed prior to stressing (i.e., HFPO-DA, PF4OHxA, PFEESA, PFTrDA) while five PFAS were not identified in any textile following exposure to elevated temperature that had been identified in at least one unstressed textile (i.e., EtFOSE, FHxSA, FOSA, FOSAA, MeFOSE). However, these PFAS were present at relatively low concentrations and summed less than 1.5 µg/kg in any textile prior to or following exposure to elevated temperatures.

3.3. Laundering

3.3.1. PFAS Occurrence and Concentration in Laundered Firefighter Gear Textiles

PFAS concentrations were determined in 19 firefighter gear textiles following laundering (OS-F was not laundered). 15 unique PFAS were determined to be present above reporting limits across all laundered textiles with between one and 11 PFAS identified in individual laundered textiles (Figure 7). FBSA, PFBA, PFHxA, PFOS, PFPeA, 6:2 FTMAC, and 6:2 FTOH were the most widely detected with each present above reporting limits in at least 10 laundered textiles. 6:2 FTMAC and 6:2 FTOH were present at the highest concentrations of any PFAS, with 6:2 FTMAC quantified at up to 1293 µg/kg ± 42 µg/kg (OS-C; Table 37) and 6:2 FTOH up to 223 µg/kg ± 25 µg/kg (OS-C).

Following laundering, DWR-treated outer shell textiles had the highest summed concentrations of any textile class, with summed concentrations ranging from 474 µg/kg ± 13 µg/kg (OS-G; Figure 8) to 1535 µg/kg ± 49 µg/kg (OS-C), followed by moisture barrier textiles, which ranged from 39.6 µg/kg ± 3.5 µg/kg (MB-C; Table 13) to 1111 µg/kg ± 43 µg/kg (MB-E; Table 19), and thermal liner textiles, which ranged from 0.099 µg/kg ± 0.012 µg/kg (TL-E; Table 73) to 3.1 µg/kg ± 2.5 µg/kg (TL-A; Table 61). Summed PFAS concentrations in laundered scoured outer shell textiles ranged from 69 µg/kg ± 12 µg/kg (OS-FSC; Table 53) to 96.3 µg/kg ± 3.6 µg/k (OS-ASC; Table 29) which was less than intact outer shell textiles but above thermal liner textiles.

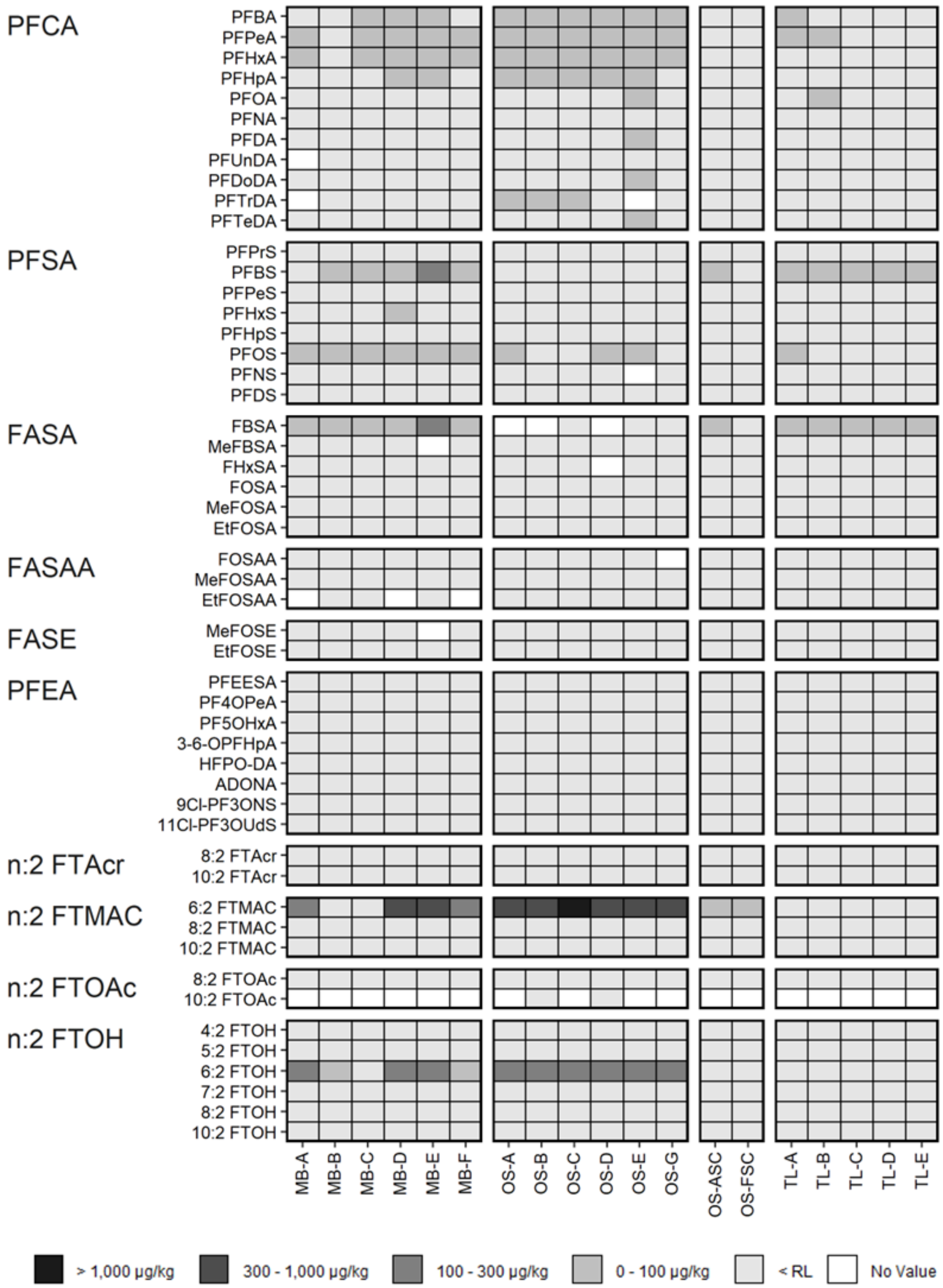

Figure 7. Mean PFAS concentrations (µg PFAS/kg textile or ppb mass ratio) determined from triplicate analysis of firefighter turnout gear textiles following laundering.

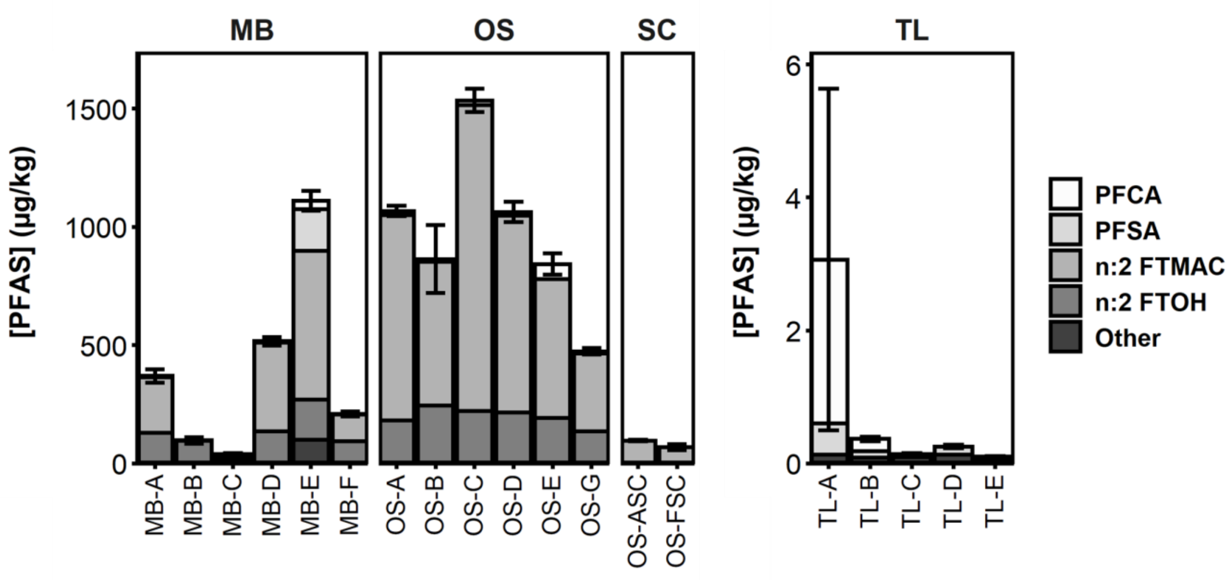

Figure 8. Summed PFAS concentrations determined from triplicate analysis of firefighter turnout gear textiles following laundering. Error bars indicate the combined standard uncertainty of summed concentrations. PFAS class is indicated by shade.

3.3.2. Changes in PFAS Occurrence and Concentration Following Laundering

Only 15 unique PFAS were quantified across laundered firefighter gear textiles and the median number of PFAS quantified in individual textiles decreased from seven prior to stressing to 5.5 following laundering. PFAS concentrations in laundered moisture barrier and thermal liner textiles were similar to or lower than in the corresponding unstressed textiles as summed PFAS concentration differed by less than 150 µg/kg in all moisture barrier textiles and less than 6 µg/kg in all thermal liners (Figure 9). Summed PFAS concentrations in laundered outer shell textiles were either similar to (OS-C, OS-E, OS-G) or lower than (OS-A, OS-B, OS-D) the concentrations in corresponding unstressed outer shell textiles. However, summed PFAS concentrations increased in both scoured outer shells by over a factor of 50. Graphical representations of the changes in PFAS occurrence and concentration with exposure to laundering are shown in Figure 21 - Figure **27**.

As with abrasion and exposure to elevated temperature, changes in summed PFAS concentration with laundering were largely driven by changes in the concentrations of 6:2 FTOH and 6:2 FTMAC. 6:2 FTMAC concentrations were lower following laundering in eight of the ten textiles where it was quantified in corresponding unstressed textiles, with concentrations falling by as much as 916 µg/kg (OS-B). Similarly, following laundering 6:2 FTOH concentrations were between 83.4 µg/kg and 178 µg/kg lower in all the outer shell textiles where it had been detected in the corresponding unstressed outer shell textiles. However, in the laundered scoured outer shell textiles, OS-ASC and OS-FSC, which did not have detectable 6:2 FTMAC concentrations prior to laundering, 6:2 FTMAC was quantified and accounted for over 99.6 % of the summed PFAS. As in OS-ASC following exposure to abrasion or elevated temperature, the quantification of 6:2 FTMAC in these textiles following laundering may be a result of the much lower reporting limits determined from the analysis of laundered textiles (i.e., ~ 70 µg/kg vs.~ 330 µg/kg).

Alternatively, the appearance of these PFAS in the scoured outer shells following laundering could indicate that laundering allowed the extraction of PFAS that were not extractable from the unstressed textiles.

While changes in overall summed PFAS concentrations with laundering were largely similar to changes in summed volatile PFAS (Figure 34), changes in summed nonvolatile PFAS concentrations were distinct in some textiles. For example, while overall summed and summed nonvolatile PFAS concentrations in MB-E fell with laundering, summed nonvolatile PFAS concentrations rose with laundering due to higher measured concentrations of FBSA (i.e., 92.1 µg/kg higher) and PFBS (142 µg/kg higher). Additionally, while the overall summed PFAS concentrations rose in OS-ASC and OS-FSC, the summed nonvolatile PFAS concentrations fell by over 75 % in both (Figure 33).

Two PFAS were present in at least one laundered textile but no unstressed textiles (i.e., PFHxS, PFTrDA) while 10 PFAS were present in at least one textile when unstressed but not in laundered textiles (i.e., EtFOSE, FHxSA, FOSA, FOSAA, MeFOSE, PFDS, PFHpS, PFNA, PFPrS, PFUnDA). However, the sum of these PFAS did not exceed 1.6 µg/kg in any textile before or after laundering and accounted for less than 0.02 % of the summed PFAS in any laundered textile and less than 15 % of the summed PFAS in any unstressed textile.

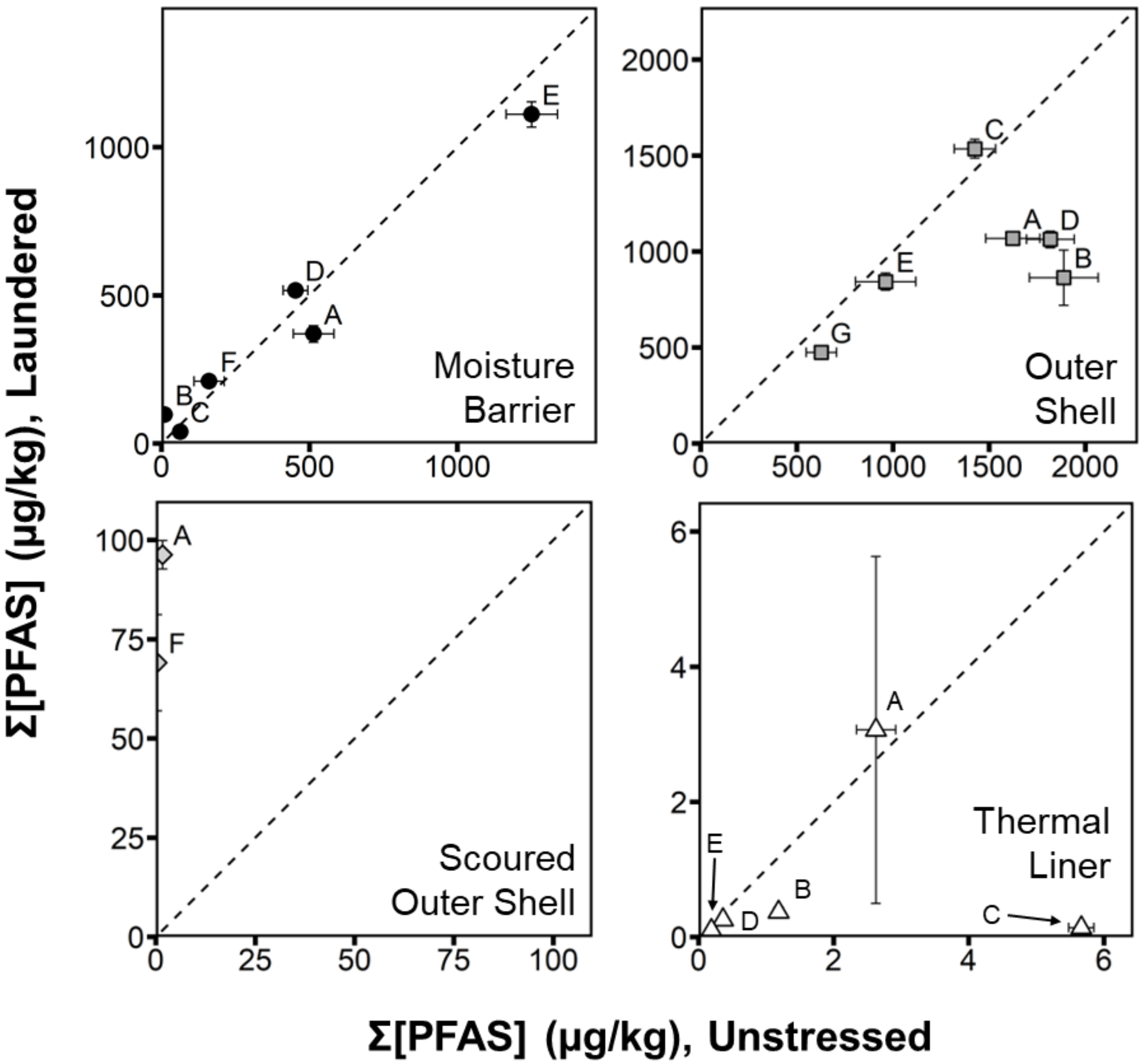

Figure 9. Summed PFAS concentrations determined by triplicate analysis of firefighter gear textiles following laundering on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Textile type is indicated in panel label and individual textiles are indicated with marker labels. A 1:1 concentration ratio (i.e., identical concentrations measured in textile prior to and following stressing) is indicated with a dashed line.

3.4. Weathering

3.4.1. PFAS Occurrence and Concentrations in Weathered Outer Shell Textiles

A total of 15 unique PFAS were identified across all weathered outer shell textiles, compared with 17 in corresponding unstressed outer shells, with a median of eight PFAS identified in individual weathered outer shell textiles (Figure 10). PFCAs with between three and 13 perfluorinated carbons were quantified above reporting limits, as were PFBS, perfluorooctane sulfonamide (FOSA), 6:2 FTMAC, and 6:2 FTOH. PFCAs with between three and six perfluorinated carbons were almost universally detected among weathered outer shell textiles, but all individual concentrations were under 100 µg/kg, while 6:2 FTMAC and 6:2 FTOH were universally present in DWR treated outer shell textiles at concentrations between 951 µg/kg to 4080 µg/kg and 590 µg/kg to 1250 µg/kg, respectively.

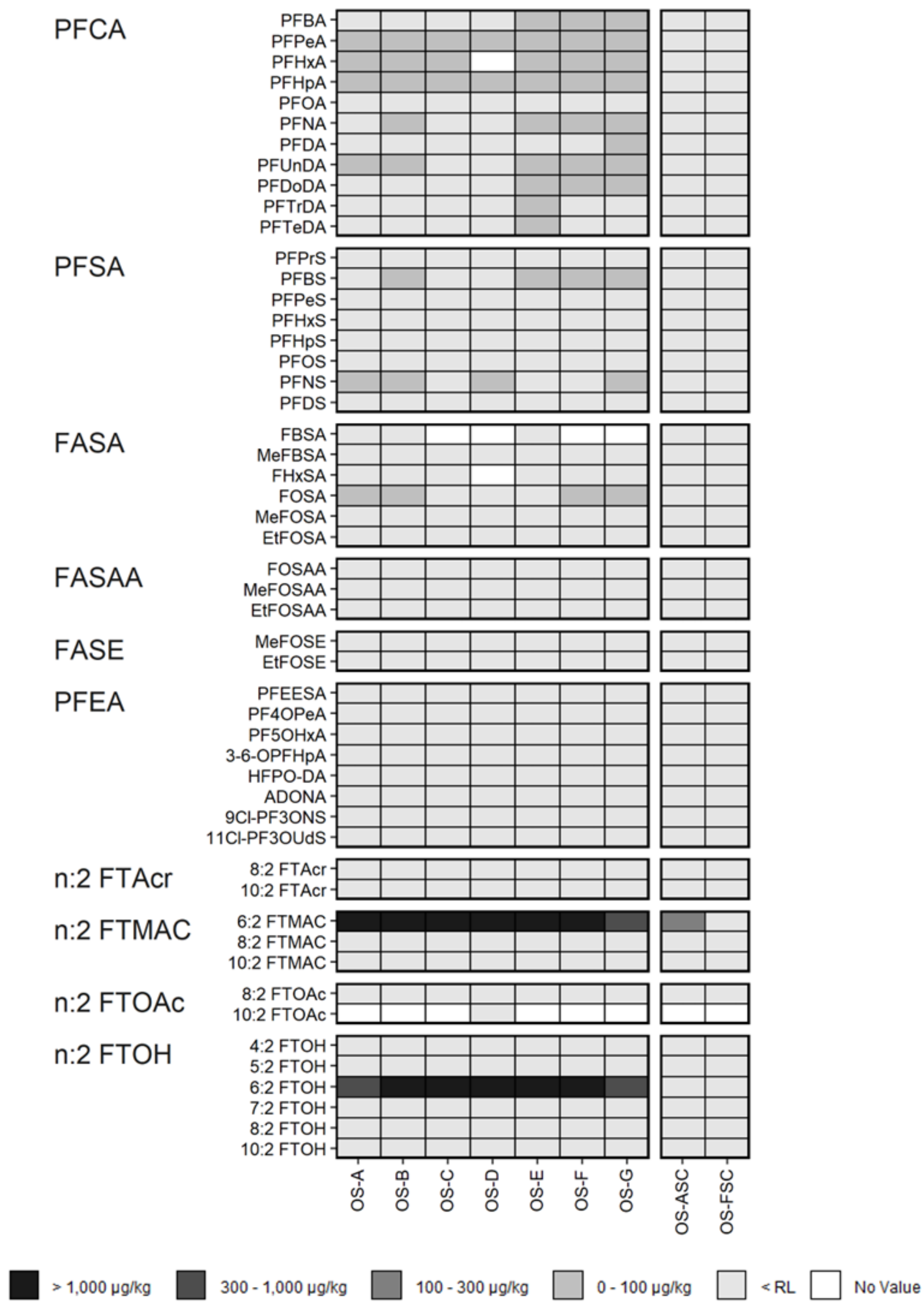

Figure 10. Mean PFAS concentrations (µg PFAS/kg textile or ppb mass ratio) determined from triplicate analysis of firefighter turnout outer shell textiles following weathering.

Summed PFAS concentrations in weathered outer shell textiles with intact water repellent treatments ranged from 1736 µg/kg ± 98 µg/kg (OS-G; Table 58) to 5300 µg/kg ± 1200 µg/kg (OS-C; Table 38), with

6:2 FTMAC and 6:2 FTOH making up between 88.7 % and 99.9 % of the summed PFAS mass (Figure 11). Among the two weathered scoured outer shell textiles, only 6:2 FTMAC was quantified above reporting limits in OS-ASC while no PFAS were in OS-FSC (Table 30 and **Table 54.** Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-FSC.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.901
PFPeA	<RL	0.028
PFHxA	<RL	0.145
PFHpA	<RL	0.547
PFOA	<RL	0.152
PFNA	<RL	0.029
PFDA	<RL	0.085
PFUnDA	<RL	0.043
PFDoDA	<RL	0.028
PFTrDA	<RL	0.083
PFTeDA	<RL	0.053
PFSA (NV)		
PFPrS	<RL	0.029
PFBS	<RL	0.025
PFPeS	<RL	0.027
PFHxS	<RL	0.065
PFHpS	<RL	0.027
PFOS	<RL	0.054
PFNS	<RL	0.027
PFDS	<RL	1.41
FASA (NV, SV)		
FBSA (NV)	<RL	0.028
MeFBSA (SV)	<RL	0.474
FHxSA (NV)	<RL	0.058
FOSA (NV)	<RL	0.058
MeFOSA (SV)	<RL	0.086
EtFOSA (SV)	<RL	0.091
FASAA (NV)		
FOSAA	<RL	0.057
MeFOSAA	<RL	0.028
EtFOSAA	<RL	0.058
FASE (SV)		
MeFOSE	<RL	0.042
EtFOSE	<RL	0.090

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.023
PF4OPeA	<RL	0.025
PF5OHxA	<RL	0.025
3-6-OPFHpA	<RL	0.025
HFPO-DA	<RL	0.045
ADONA	<RL	0.025
9Cl-PF3ONS	<RL	0.026
11Cl-PF3OUdS	<RL	0.027
n:2 FTAcr (V)		
8:2 FTAcr	<RL	13.2
10:2 FTAcr	<RL	25.4
n:2 FTMAC (V)		
6:2 FTMAC	<RL	56.6
8:2 FTMAC	<RL	58.0
10:2 FTMAC	<RL	30.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	13.0
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	65.3
5:2 FTOH	<RL	64.5
6:2 FTOH	<RL	66.4
7:2 FTOH	<RL	25.6
8:2 FTOH	<RL	64.0
10:2 FTOH	<RL	66.4
n:2 FTS (NV)		
4:2 FTS	0.18 ± 0.13	0.077
6:2 FTS	No Value	
8:2 FTS	<RL	0.130
10:2 FTS	No Value	

Table 55 Table **54**).

Three PFAS were identified in at least one weathered outer shell textile (i.e., PFNS, PFTeDA, PFTrDA) that were not identified in any unstressed outer shell textiles, while an additional five PFAS were identified in at least one unstressed outer shell textile, but not in any UV irradiated outer shell textiles (i.e., FBSA, FHxSA, FOSAA, PFDS, PFOA). These PFAS were present at summed concentrations less than 1.4 µg/kg in any outer shell textile prior to or following weathering and contributed less than 0.004 % of the summed PFAS mass in any weathered outer shell textile.

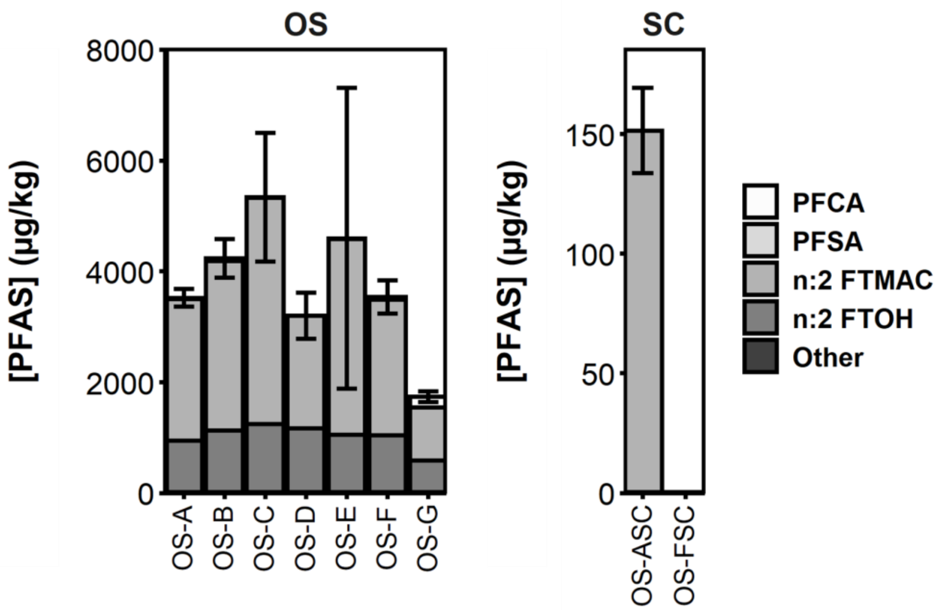

Figure 11. Summed PFAS concentrations determined from triplicate analysis of firefighter turnout gear outer shell textiles following weathering. Error bars indicate the combined standard uncertainty of summed concentrations. PFAS class is indicated by shade.

3.4.2. Change in PFAS Occurrence and Concentration in Weathered Outer Shell Textiles

Compared with unstressed textiles, summed PFAS concentrations were higher in all weathered DWR-treated outer shell textiles and one of the two scoured treated outer shell textiles (Figure 12). The median increase in summed PFAS concentrations following weathering of DWR-treated outer shell textiles was 2350 µg/kg. Virtually all the increase in summed PFAS concentrations arose from increases in 6:2 FTMAC and 6:2 FTOH, both of which rose in all DWR-treated outer shell textiles. Following weathering of DWR-treated outer shell textiles, the median increase in measured concentrations was 1530 µg/kg for 6:2 FTMAC and 771 µg/kg for 6:2 FTOH. Among DWR-treated outer shell textiles, the sum in change of 6:2 FTMAC and 6:2 FTOH concentrations was equivalent to between 84 % and 102 % of the change in summed PFAS concentration. Graphical representations of the changes in PFAS occurrence and concentration with weathering are shown in Figure 23 -Figure **25**.

As with the stressing processes discussed above, the apparent increase in summed PFAS concentrations in OS-ASC with weathering is due to the quantification of 6:2 FTMAC above reporting limits in weathered OS-ASC while it was found to be below reporting limits in unstressed OS-ASC and therefore assumed to be present at a concentration of zero. However, it cannot be known if the concentration of 6:2 FMAC in weathered OS-ASC (i.e., 151 µg/kg ± 18 µg/kg) was above the 6:2 FTMAC concentration in unstressed OS-ASC due to the higher reporting limit recorded for the analysis of unstressed OS-ASC (i.e., 326 µg/kg).

The change in summed volatile PFAS concentrations with weathering were largely similar to the changes seen in the overall summed PFAS concentrations (Figure 34) while the summed concentrations of nonvolatile PFAS fell in most DWR-treated outer shell textiles and in both scoured outer shell textiles (Figure 35).

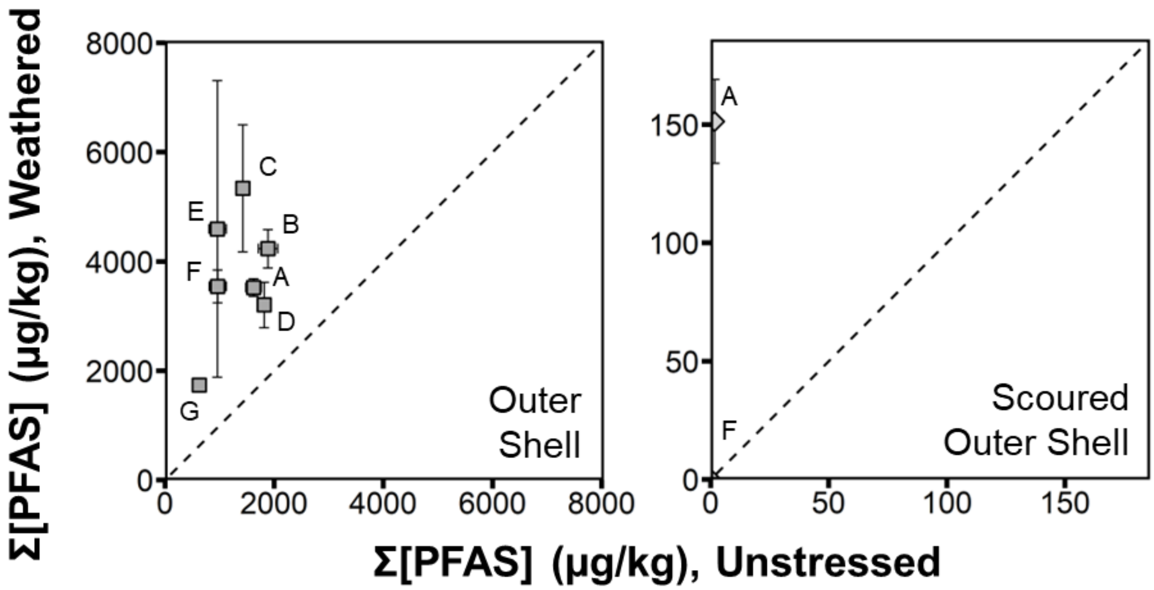

Figure 12. Summed PFAS concentrations determined by triplicate analysis of firefighter gear outer shell textiles following weathering on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Textile type is indicated in panel label and individual textiles are indicated with marker labels. A 1:1 concentration ratio (i.e., identical concentrations measured in textile prior to and following stressing) is indicated with a dashed line.

3.5. N:2 FTS Concentrations in Moisture Barrier Textile MB-E

N:2 FTS concentrations could not be quantified for some stressed textiles and are therefore not discussed above or included in summed PFAS concentrations. However, they were quantified in MB-E prior to as well as following stressing. Therefore, N:2 FTS concentrations in MB-E are discussed in this section to provide information about this PFAS class, which was present in MB-E at summed concentrations over 75 times higher than in any other unstressed textile (Figure 13, Figure **14**, and Figure **15**). Compared with 6:2 fluorotelomer sulfonate (6:2 FTS) concentrations measured in unstressed MB-E (613 µg/kg ± 15 µg/kg), 6:2 FTS concentrations were similar following abrasion (579 µg/kg ± 48; Figure 13) and exposure to elevated temperature (503 µg/kg ± 57 µg/kg) but lower (36.2 µg/kg ± 2.1 µg/kg) following laundering. Similarly, measured 4:2 fluorotelomer sulfonate (4:2 FTS) concentrations in MB-E prior to stressing (i.e., 0.85 µg/kg ± 0.27 µg/kg) were comparable to 4:2 FTS concentrations recorded following abrasion (0.828 µg/kg ± 0.091 µg/kg) and exposure to elevated temperature (0.82 ± 0.16 µg/kg), but were below the reporting limits (i.e.,< 0.139 µg/kg) following laundering.

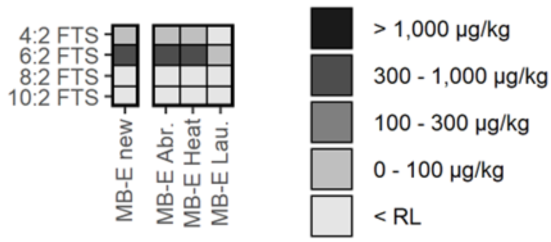

Figure 13. Average summed n:2 FTS concentrations determined from triplicate analysis of MB-E1 following exposure to abrasion (Abr.), elevated temperature (Heat), or laundering (Lau.).

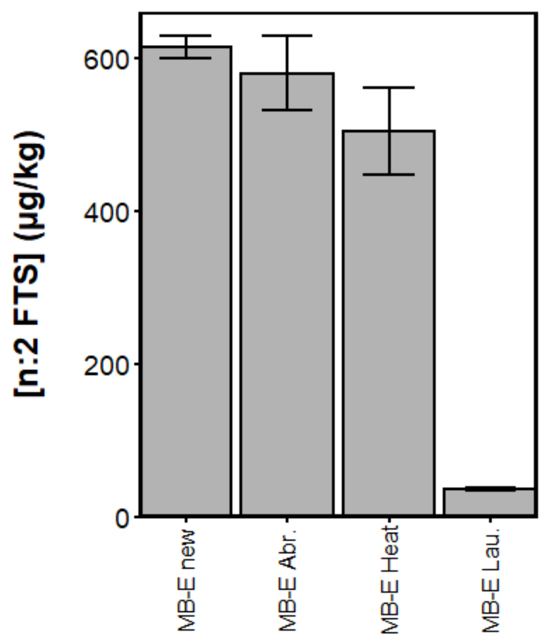

Figure 14. Summed n:2 FTS concentrations in MB-E prior to stressing (new), as well as following abrasion (Abr.), exposure to elevated temperatures (Heat), or laundering (Lau.). Error bars indicate the combined standard uncertainty of summed concentrations.

When the contribution of n:2 FTS to summed PFAS concentrations in MB-E were considered (Figure 15), similar changes occur with stressing as when n:2 FTS was excluded (Figure 3, Figure **6**, Figure 9). For example, when n:2 FTS was included, summed PFAS concentrations in MB-E were similar before and after abrasion (i.e., 1865 µg/kg ± 88 µg/kg in unstressed and 1820 µg/kg ± 73 µg/kg) and decreased by a similar amount with exposure to elevated temperatures (1236 µg/kg ± 94 µg/kg) or laundering (1147 µg/kg ± 43 µg/kg). Similarly, when n:2 FTS was not included, summed PFAS concentrations in MB-E decreased slightly with abrasion (i.e., 1251 µg/kg ± 87 µg/kg to 1240 µg/kg ± 54 µg/kg) and decreased by a similar amount with exposure to elevated temperatures (732 µg/kg ± 75 µg/kg) or laundering (1111 µg/kg ± 43 µg/kg).

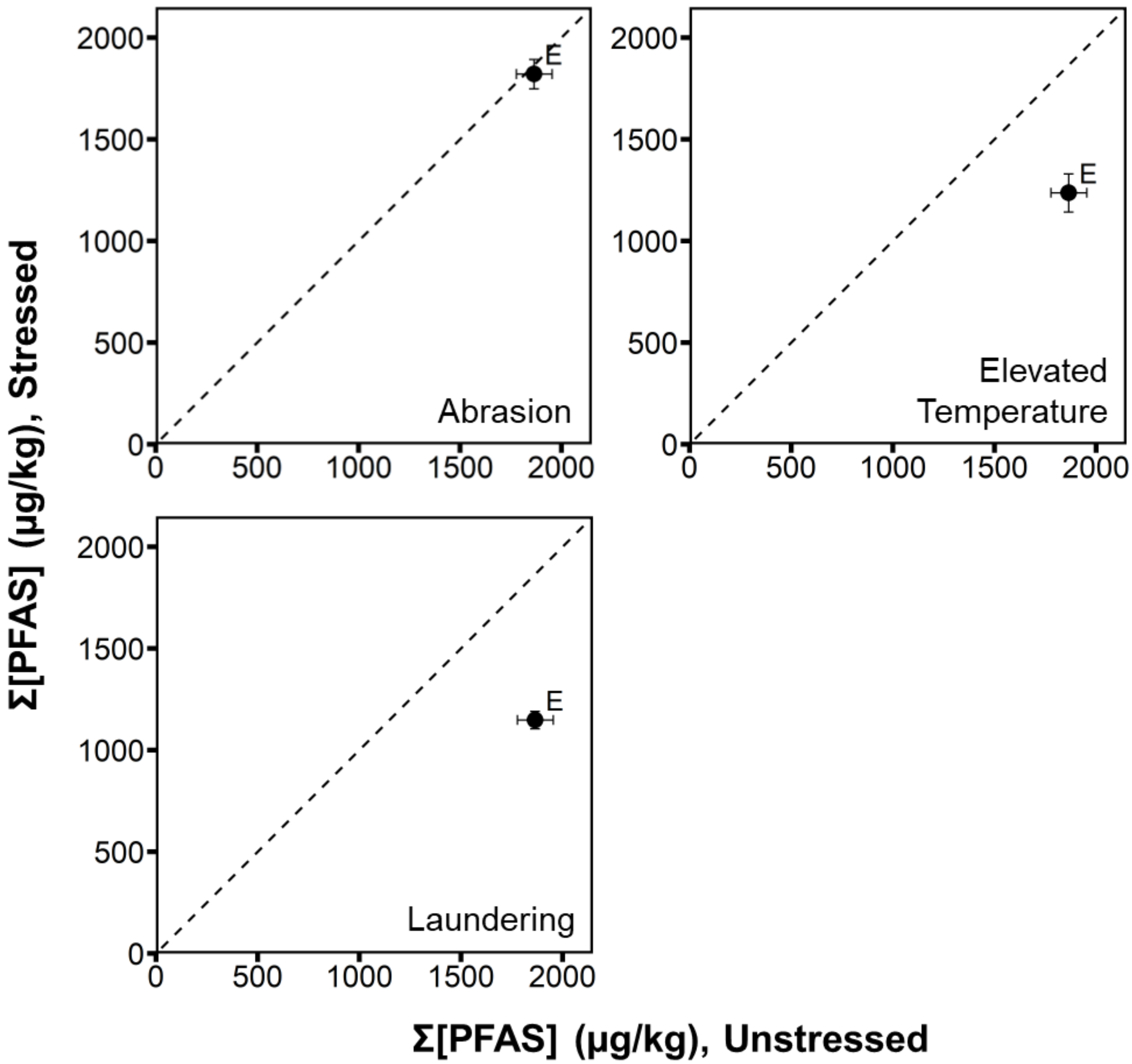

Figure 15. Summed PFAS concentrations, including n:2 FTSs, determined from triplicate analysis of MB-E following stressing on y-axis and prior to stressing MB-E on x-axis. Error bars indicate combined standard uncertainty. Stressing type is indicated in panel label. Dashed line indicates a 1:1 concentration ratio.

4. Discussion

Exposing structural firefighter turnout gear textiles to stressing changed measured individual and summed PFAS concentrations, and those changes varied between applied stresses and textile types (Table 4). While summed PFAS concentrations increased in 18 of 20 firefighter gear textiles with abrasion and in eight of nine outer shell textiles with weathering, exposure to elevated temperatures and laundering produced more varied changes. Exposure to elevated temperatures decreased summed PFAS concentrations in four of six moisture barrier textiles (median change across all six moisture barrier textiles: - 34 %) and two of five thermal liner textiles (+ 29 %), but increased concentrations in all seven DWR-treated outer shell textiles (+ 249 %). Similarly, laundering increased summed PFAS concentrations in three of six moisture barrier textiles (+ 1 %), but decreased summed PFAS concentrations in six of seven DWR-treated outer shell textiles (- 29 %) and in 4 of 5 thermal liner textiles (- 48 %). The wide variation in concentration changes suggests developing an understanding of how stresses alter PFAS concentrations in firefighter gear textiles requires accounting for the influence of multiple processes as well as differences among textile types and individual textiles.

Table 4. Median changes in summed PFAS concentrations by stressing and textile type.
++ > + 150 %, + + 25 % to + 150 %, ≈ - 25 % to + 25 %, − < - 25 %. NS – not studied.

	Abrasion	Elevated Temp.	Laundering	Weathering
Moisture Barrier	++	−	≈	NS
Outer Shell	++	++	−	++
Thermal Liner	++	+	−	NS

The largest increases in summed PFAS concentration occurred with abrasion and the exposure of outer shell textiles to elevated temperature or weathering (Table 4), and these increases were largely driven by changes in 6:2 FTMAC and 6:2 FTOH concentrations, which were the PFAS present in the highest concentrations before and after stressing. Changes in 6:2 FTMAC and 6:2 FTOH concentrations in outer shell textiles were equivalent to 98 % to 100 % of the overall summed PFAS change following abrasion and 85 % to 102 % following weathering. In both MB-A and MB-D, which had the largest absolute and relative increases in summed PFAS concentration with abrasion among moisture barrier textiles, the increase in 6:2 FTOH and 6:2 FTMAC concentrations were equivalent to 99 % of the overall summed concentration increase. Similarly, where stressing decreased summed PFAS concentrations, such as in outer shell textiles with laundering, the decreases were also largely derived from changes in the concentrations of 6:2 FTMAC and 6:2 FTOH, which accounted for at least 91 % of the summed PFAS in outer shell textiles both before and after laundering. Thermal liner textiles are an exception as no 6:2 FTMAC and 6:2 FTOH was detected prior to or after stressing. In thermal liner textiles, changes in summed PFAS concentrations were almost entirely derived from changes in PFAAs. These sum PFAS changes were below six ug/kg and did not change by more than six µg/kg for stressing processes, which is much smaller than observed in the outer shell and moisture barrier textiles).

The targeted analytical approach utilized here provides limited insight into the mechanisms underlying the observed changes in textile PFAS concentrations with stressing. For example, PFAS transformations will only be observed if the reactants and products are included in the targeted list of analyzed PFAS. Additionally, delineating the contributions of specific mechanisms is complicated by the potential simultaneous occurrence of multiple processes during textile stressing as suggested in previous examinations of PFAS concentrations in DWR-treated textiles before and after stressing [27, 29, 30]. For example, changes in PFAS concentrations from weathering may be a result of multiple processes - fluorinated polymer degradation, PFAS transformations, evaporation of volatile PFAS, and rinsing out of water soluble PFAS.

However, changes in the measured concentrations of specific PFAS subsets can provide some insight into the processes occurring during textile stressing. Abrasion resulted in overall summed PFAS concentration increases, not only among volatile PFAS as discussed above (Figure 28), but also in summed nonvolatile PFAS in most textiles (Figure 29). In the only previous study of PFAS in abraded DWR-treated textiles, Schellenberger et al. [27] quantified total fluorine by combustion ion chromatography in DWR-treated textiles that had previously been exposed to six months outdoor weathering before and after abrasion with Martindale abrader (3000 rubs at 9 Pa) and laundering with a domestic washer. This study found total fluorine concentrations fell following abrasion and laundering, which the authors indicated was likely due to removal of the outer textile layers that contained much of the applied DWR treatment. In contrast, the increased PFAS concentrations with abrasion observed here could indicate that abrasion increased the fraction of the PFAS that was released during extraction, even as a portion of the textiles was visibly abraded away.

Laundering resulted in decreased summed PFAS concentrations in most firefighter gear textiles compared to the corresponding unstressed textiles (Figure 9). Having observed decreased total fluorine concentrations in DWR-treated textiles following abrasion and laundering, Schellenberger et al. [27] identified numerous processes that could lead to reduced PFAS concentrations in laundered textiles, including wash-out of fiber fragments containing DWR treatments, wash-out of water soluble PFAS, and evaporation of volatile PFAS, as well as processes that could lead to increased PFAS concentrations such as the degradation of fluorinated polymers. In contrast, van der Veen et al. [30] reported the only previous PFAS measurements taken before and after laundering of a DWR-treated textile that had not previously been stressed and found that while PFAA concentrations were largely unchanged the concentration of 6:2 FTOH increased from 92 µg/kg to 150 µg/kg. Van der Veen et al. [30] suggested this increase may indicate an increase of 6:2 FTOH fraction that was extractable by methanol or the hydrolysis of 6:2 FTOH precursors during laundering. Each of these processes may occur to varying degrees during laundering and produce conflicting PFAS concentration changes across a range of individual textiles.

While exposure to elevated temperatures produced varied changes in summed PFAS concentrations compared with unstressed firefighter gear textiles, volatile PFAS concentrations were higher in all outer shell textiles when compared with corresponding unstressed textiles (Figure 30). There are no previous reports of PFAS concentrations in textiles following exposure to elevated temperatures, but the boiling points of both 6:2 FTMAC and 6:2 FTOH have been predicted to be under 260 °C [38, 39], while side-chain fluorinated acrylates have been found to partially decompose at temperatures under 300 °C [41]. Therefore, exposure to 260 °C could result in the simultaneous vaporization of volatile PFAS and degradation of fluorinated polymers. The observed increase in volatile PFAS concentrations in outer shell textiles following exposure to elevated temperatures suggests that other processes beyond vaporization were occurring and could be indicative of enhancement of the extractable fraction of volatile PFAS or the production of PFAS from degradation of fluorinated polymers.

Weathering of outer shell textiles resulted in increased summed volatile PFAS concentrations, relative to unstressed outer shell textiles (Figure 34), and inconsistent changes among nonvolatile PFAS (Figure 35). Additionally, visible discoloration occurred in all outer shell textiles during weathering, which was taken to indicate degradation of textiles or DWR treatments. As with other stressing processes, multiple mechanisms affecting PFAS concentrations could be occurring simultaneously during weathering. Three previous studies evaluated PFAS concentrations in DWR-treated textiles before and after weathering. Schellenberger et al. [27] exposed polyamide textiles treated with side-chain fluorinated polymers to six months outdoor exposure in Sydney, Australia and quantified 42 PFAS by extraction with methanol and analysis by LC-MS/MS and GC-MS. After weathering, PFAA concentrations had increased by as much as 7000 µg/kg but total fluorine concentrations decreased, which the authors suggested was indicative of physical processes such as the evaporation of volatile PFAS during outdoor exposure as well as the washing out of both soluble PFAS and polymer-coated textile fibers with rain [27]. Additionally, because outdoor exposure apparently produced small, nonpolymeric PFAS with similar perfluorinated chain lengths as the polymer PFAS that were originally applied as side-chain fluorinated polymers, the authors suggested that radical-based degradation of side-chain fluorinated polymers or PFAA precursors could also be occurring.

Two previous studies used an ATLAS weather-O-meter to weather outdoor clothing samples [29] or high performance outer wear textiles that had been treated with side-chain fluorinated polymer-based DWR formulations [30]. In outdoor clothing, concentration increases of up to 100 $\mu g/m^2$ (equivalent to 600 µg/kg assuming 6 m^2/kg) were observed for individual PFCAs and PFBS, while volatile PFAS concentrations increased by up to 400 $\mu g/m^2$ for multiple n:2 FTOHs and over 170 $\mu g/m^2$ for 6:2 FTMAC [29]. Similarly, in response to laboratory weathering, increased PFAA and volatile PFAS concentrations were observed in DWR-treated outer wear textiles [30]. In both studies, multiple mechanisms thought to be relevant to the measured PFAS concentration changes were proposed, including changes in the extractable fraction of PFAS, hydrolysis of fluorinated polymers forming nonpolymeric PFAS, and the conversion by reaction with radical species or hydrolysis of PFAS that were not measured by the study methods to those that were [29, 30].

As discussed above, 6:2 FTMAC or 6:2 FTOH were quantified above reporting limits in some stressed textiles but not the corresponding unstressed textile, which caused large apparent increases in the reported summed PFAS concentrations. For example, neither 6:2 FTMAC or 6:2 FTOH was quantified in scoured outer shell textiles prior to stressing, but both PFAS were repeatedly observed in scoured outer shell textiles following stressing. Because volatile PFAS reporting limits were frequently much lower for the analysis of stressed compared with unstressed textiles, the quantification of 6:2 FTMAC and 6:2 FTOH following stressing could derive from their being present at concentrations above reporting limits from the analysis of stressed textiles, but below the reporting limits from the analysis of unstressed textiles. For example, 6:2 FTMAC and 6:2 FTOH reporting limits in unstressed OS-ASC (i.e., 326 µg/kg and 183 µg/kg, respectively) were above all reported 6:2 FTMAC and 6:2 FTOH concentrations in these OS-ASC after stressing (i.e., up to 196 µg/kg ± 47 µg/kg and 129 µg/kg ± 69 µg/kg, respectively). However, the use of unstressed OS-FSC as an extraction blank suggests that, at least for OS-FSC, differences in reporting limits were not solely responsible for the apparent increases in volatile PFAS concentrations with stressing. The apparent increase in concentration of these PFAS could indicate their production during stressing or contamination from contact with other samples such as DWR-treated outer shell textiles which had 6:2 FTMAC concentrations up to 5570 µg/kg ± 330 µg/kg after stressing. However, if contamination was responsible, only moisture barrier and outer shell textiles were affected, as 6:2 FTMAC or 6:2 FTOH were not detected in thermal liner textiles. Additionally, their appearance in scoured textiles could indicate the scouring process left remnant PFAS which were not extractable from unstressed textiles but became extractable after stressing.

Ten PFAS were observed above reporting limits in at least one stressed textile but not in any unstressed textile, including four PPEAs, a class that was not observed in any unstressed textile (i.e., HFPO-DA, PFEESA, PF4OPeA, and PF5OHxA). However, these newly identified PFAS did not account for a large fraction of summed PFAS in any stressed textile as none were quantified above 1 µg/kg, except for MeFBSA in abraded MB-C (2.01 µg/kg ± 1.94 µg/kg) and abraded MB-E (8.74 µg/kg ± 1.00 µg/kg). Given their low concentrations, the detection of these PFAS in stressed but not unstressed textiles could also derive from differences in reporting limits recorded during the analysis of stressed compared with unstressed firefighter gear textiles rather than genuine increases in concentration from stressing. For example, MeFBSA reporting limits in unstressed textiles ranged from 0.825 µg/kg to 6.38 µg/kg, compared with 0.104 µg/kg to 1.25 µg/kg in stressed textiles.

The identification of PPEAs in stressed firefighter gear textiles was unexpected, as they were not detected in the corresponding unstressed textiles [22] or in textiles examined by another study of firefighter turnout gear that quantified PPEAs [20]. While this is the first report of PPEAs in firefighter turnout gear textiles, it is not clear that their quantification above reporting limits was due to changes in their concentration during stressing. For example, only HFPO-DA could be verified by a secondary multiple reaction monitoring transition, as secondary transitions were not collected for PF4OPeA, PF5OHxA, and PFEESA. Additionally, due to the high variability of the reported HPFO-DA measurements (i.e., average relative standard deviation: 50.2 %) and low measured concentrations of the other PPEAs (i.e., up to 0.068 µg/kg ± 0.007 µg/kg), contamination during storage, stressing, or extraction cannot be ruled out.

The presence of PFAAs in firefighter gear is of particular interest given the previous reporting of elevated PFAA concentrations in the serum of firefighters relative to the general population [9-14, 16, 17, 42, 43]. PFAAs were widely identified in stressed textiles, with at least one PFAA identified in 62 out of 69 stressed textiles, including PFCAs with between 3 and 13 perfluorinated carbons as well as PFSAs with between 3 and 10. However, PFAA concentrations were typically much lower than concentrations of 6:2 FTOH and 6:2 FTMAC. For example, PFOA and PFOS were not quantified above 2 µg/kg in any stressed textile. Additionally, summed PFAA concentrations changed with stressing similarly to the overall summed PFAS concentrations, which could indicate that differences in the extractable fraction of PFAS due to textile stressing were responsible for the observed changes in measured PFAA concentrations. For example, summed PFAA concentrations increased in 17 of the 18 textiles where overall summed PFAS increased with laundering and summed PFAA concentrations increased by similar ratios as overall PFAS (Figure 9 and Figure **33**). However, in outer shell textiles, PFAA concentrations were more likely to decrease while overall summed concentrations increased with abrasion or weathering. Summed PFAA concentrations in DWR-treated outer shell textiles fell in five of seven with abrasion and in four of seven with weathering, while overall summed PFAS concentrations rose in all DWR-treated outer shell textiles with abrasion or weathering. These decreases could derive from abrasive removal of textile layers that contained fluorinated polymer derived DWR treatments, loss from reaction with radical species, or the rinsing out with water spray during weathering.

This NIST Technical Note was produced to assist in determining the potential for typical use to change measured PFAS concentrations in structural firefighter gear. However, there are limitations that complicate making correlations between the observed changes in PFAS concentrations and changes in the amount of PFAS a firefighter may be exposed to from firefighting gear. The targeted analytical approach used here will only observe PFAS that are included in the targeted analyte list. Previous examinations of PFAS in firefighter gear that determined both targeted PFAS concentrations and total fluorine measurements or total oxidizable precursor assay measurements have found that targeted PFAS measurements only account for a small fraction of the total fluorine present in firefighter gear textiles and that targeted PFAS measurements may not agree with total F measurements [20, 24, 27]. Further, some PFAS could have been released from the textiles during stressing while still presenting a potential PFAS exposure source to firefighters. For example, during exposure to abrasion, fragments were observed falling from the firefighter gear textiles, which indicates that the abrasion of firefighter gear could contribute to fire station dust, which has previously been confirmed to contain PFAS [24, 44]. Additionally, firefighter gear textiles lost up to 17 % of their original mass when exposed to elevated temperatures (Table 3); if this loss of mass is indicative of the release of gaseous PFAS then is it likely a similar PFAS loss may occur when the gear is used in the field. Finally, because PFAS concentrations are reported here in terms of the stressed textile mass, the decrease in mass may result in over- or underestimated PFAS mass in garments following exposure to abrasion or elevated temperatures. However, changes in textile mass with exposure to abrasion or elevated temperatures were small relative to the changes in summed PFAS concentrations, which increased by up to 26 times in NFPA 1971 compliant textiles.

This report builds on NIST Technical Note 2248 which reported PFAS concentrations in unstressed firefighter gear textiles and found that the summed PFAS mass in a firefighter garment made of equal masses of moisture barrier, outer shell, and thermal liner textiles could vary by up to a factor of six depending on which textile was selected for each layer [22]. If a similar garment were made of the stressed textiles reported here, an even larger range of summed PFAS concentrations would be possible. A garment made from equal masses of the stressed textiles with the highest summed PFAS concentrations (i.e., abraded MB-A, OS-F exposed to elevated temperatures, and abraded TL-C; average summed PFAS: 3110 µg/kg) would contain more than 20 times the summed PFAS mass of a garment made from equal masses of the lowest concentration textiles (MB-B, OS-G, TL-E; average summed PFAS: 158 µg/kg). Additionally, a garment made from the highest concentration stressed textiles would have about 2.5 times the summed PFAS mass of one made from the highest concentration unstressed textiles (average summed PFAS: 1250 µg/kg). The observation of higher summed PFAS mass in stressed textiles suggests that measurements of PFAS in unstressed or new textiles could underestimate the PFAS concentrations that would be measured in the same textiles after use in firefighting activities. In fact, previous studies of PFAS in DWR-treated textiles undergoing outdoor aging [27] or laboratory weathering [29] both found that textiles that met European Union standards for PFAS concentrations when new sometimes failed to meet the same requirements after stressing. Further, because each textile was only stressed once in this report, it is not known if PFAS concentrations would continue to change with repeated stressing, as a previous report of PFAS concentrations in textiles subjected to outdoor aging did observe larger changes following six months of exposure compared with three months [27].

While summed PFAS concentrations were frequently higher in stressed compared with unstressed firefighter gear textiles, thermal liner textiles still had the lowest summed PFAS concentrations of any type of firefighter gear textile. This could imply lower dermal PFAS exposure to firefighters than would be expected from averaging the PFAS concentrations measured in all three textile types, as thermal liners are the closet layer to skin in assembled gear. No thermal liner textile had a summed concentration over 10.7 µg/kg ± 1.7 µg/kg (i.e., abraded TL-C) following any stressing process.

In NIST TN 2248, summed PFAS concentrations in unstressed firefighter turnout gear textiles were compared to summed PFAS concentrations determined in other reports of firefighter gear and firefighter gear textiles [20-22, 24]. It was observed that other reports which included used or older firefighter gear reported higher summed PFAS concentrations than determined in NIST TN 2248. To evaluate the extent to which stressing may contribute to the wider range of summed PFAS concentrations observed across previous reports, Figure 3 from Maizel et al. [22] is reproduced here with the overlay of summed PFAS concentrations measured in firefighter textiles after stressing (Figure 16). Summed PFAS concentrations in stressed gear were both higher and lower than in corresponding unstressed gear depending on the gear and stressing process. However, trends observed among unstressed textiles remain, for example summed concentrations generally increase from thermal liner textiles to moisture barrier textiles to outer shell textiles. Additionally, the differences in summed concentration with stressing (i.e., from decrease of 109 µg/kg to increase of 6320 µg/kg) are similar to or smaller than the range of summed PFAS concentrations observed across previous reports [20, 22, 24], which may indicate that stressing alone is insufficient to account for the observed differences.

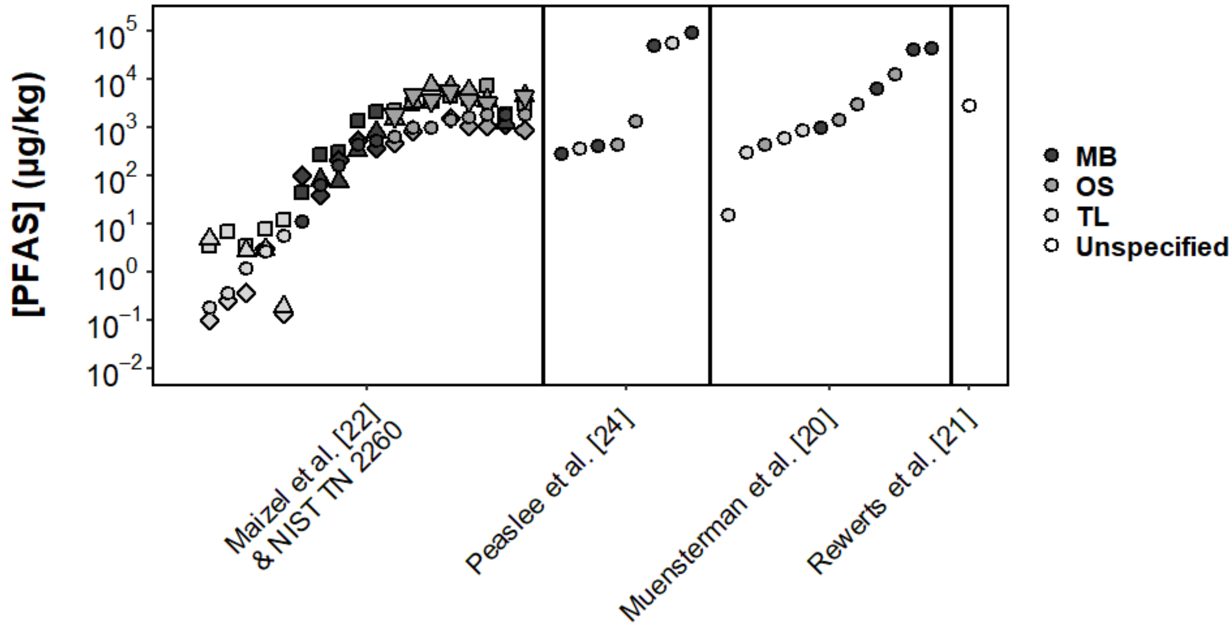

Figure 16. Summed PFAS concentrations in turnout gear textiles following abrasion (square), exposure to elevated temperatures (triangle pointing up), laundering (diamond), weathering (triangle pointing down), or prior to stressing (circle). PFAS measurements from three reports of unstressed firefighter gear [20,21,24] are also shown. Markers are ordered according to summed PFAS concentrations determined from analysis of unstressed textiles.

5. Summary

To investigate the extent to which physical stressors could change PFAS concentrations in firefighter gear, this NIST TN quantified the concentrations of 51 PFAS across 20 firefighter gear textiles following exposure to abrasion, elevated temperature, laundering, or weathering. Changes in PFAS concentration with stressing were determined by comparison with PFAS concentrations determined previously in corresponding unstressed textiles in NIST TN 2248.

Abrasion was found to increase summed PFAS concentrations for all textile types while weathering consistently increased summed PFAS concentrations in outer shell textiles. Laundering produced relatively small changes in summed PFAS concentrations across all textiles and exposure to elevated temperature increased summed PFAS in outer shell textiles but resulted in smaller changes in the remaining textile types. The largest absolute changes in PFAS concentration were observed in outer shell textiles with weathering, where the median summed PFAS concentration increased from 964 µg/kg to 3520 µg/kg. Where stressing increased summed PFAS concentrations, these changes were primarily due to increases in the concentrations of 6:2 FTMAC and 6:2 FTOH, which were also the highest concentration PFAS in unstressed turnout gear textiles, rather than the appearance of previously unobserved PFAS. As in unstressed textiles, summed PFAS concentrations tended to be highest in stressed DWR-treated outer shell textiles and lowest in stressed thermal liner textiles. While the targeted analytical approached used in this NIST TN cannot distinguish between the many processes that could contribute to altered textile PFAS concentrations with stressing, the observed changes with abrasion and weathering are consistent with changes in the fraction of PFAS that are extractable by the analytical method used in this report.

The findings of this NIST TN agree with those previously reported for PFAS in stressed DWR-treated textiles, which also observed that stressing can increase PFAS concentrations in textiles. Therefore, accurately estimating firefighter PFAS exposure from gear requires considering how PFAS concentrations may change as the gear is used.

6. Future Work

NIST is continuing to research other potential sources of PFAS exposure to firefighters such as gear worn by wildland firefighters as well as hoods and gloves worn by structural firefighters. Additionally, future work will use high-resolution mass spectrometry to identify a broader swath of PFAS than the limited number of compounds quantified here, including screening for compounds such as N-methyl perfluorobutane sulfonamido ethanol (MeFBSE) which has been identified in firefighter turnout gear [20]. Finally, to better relate the measurements made here with the actual PFAS exposure to firefighters, the capacity of simulated sweat to extract PFAS from firefighter turnout gear will be evaluated.

Table 5. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.02 ± 0.78	0.509
PFPeA	1.49 ± 0.52	0.162
PFHxA	8.45 ± 0.62	0.279
PFHpA	<RL	0.288
PFOA	<RL	0.139
PFNA	<RL	0.020
PFDA	<RL	0.131
PFUnDA	<RL	0.048
PFDoDA	<RL	0.069
PFTrDA	<RL	0.095
PFTeDA	<RL	0.134
PFSA (NV)		
PFPrS	<RL	0.028
PFBS	0.075 ± 0.021	0.060
PFPeS	<RL	0.019
PFHxS	0.082 ± 0.036	0.018
PFHpS	<RL	0.019
PFOS	<RL	0.061
PFNS	<RL	0.038
PFDS	No Value	
FASA (NV, SV)		
FBSA (NV)	0.66 ± 0.11	0.020
MeFBSA (SV)	<RL	0.138
FHxSA (NV)	0.039 ± 0.013	0.020
FOSA (NV)	0.0334 ± 0.0083	0.020
MeFOSA (SV)	<RL	0.347
EtFOSA (SV)	<RL	0.348
FASAA (NV)		
FOSAA	<RL	0.020
MeFOSAA	<RL	0.090
EtFOSAA	<RL	0.040
FASE (SV)		
MeFOSE	<RL	0.349
EtFOSE	<RL	0.721

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.018
3-6-OPFHpA	<RL	0.019
HFPO-DA	<RL	0.191
ADONA	<RL	0.018
9Cl-PF3ONS	<RL	0.036
11Cl-PF3OUdS	No Value	
n:2 FTAcr (V)		
8:2 FTAcr	<RL	27.1
10:2 FTAcr	No Value	
n:2 FTMAC (V)		
6:2 FTMAC	960 ± 47	45.2
8:2 FTMAC	<RL	46.2
10:2 FTMAC	<RL	24.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	26.3
10:2 FTOAc	<RL	13.3
n:2 FTOH (V)		
4:2 FTOH	<RL	68.7
5:2 FTOH	<RL	65.4
6:2 FTOH	1070 ± 410	25.3
7:2 FTOH	<RL	65.1
8:2 FTOH	<RL	121
10:2 FTOH	<RL	65.4
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.087
10:2 FTS	No Value	

Table 6. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-A following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.36 ± 0.28	0.719
PFPeA	0.923 ± 0.070	0.038
PFHxA	3.54 ± 0.28	0.344
PFHpA	<RL	0.156
PFOA	No Value	
PFNA	<RL	0.075
PFDA	<RL	0.040
PFUnDA	<RL	0.106
PFDoDA	<RL	0.031
PFTrDA	<RL	0.034
PFTeDA	<RL	0.022
PFSA (NV)		
PFPrS	<RL	0.044
PFBS	<RL	2.19
PFPeS	<RL	0.020
PFHxS	<RL	3.46
PFHpS	<RL	0.021
PFOS	<RL	3.64
PFNS	<RL	0.042
PFDS	<RL	0.022
FASA (NV, SV)		
FBSA (NV)	<RL	0.022
MeFBSA (SV)	<RL	0.872
FHxSA (NV)	<RL	0.022
FOSA (NV)	<RL	0.024
MeFOSA (SV)	<RL	0.417
EtFOSA (SV)	<RL	0.174
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	No Value	
EtFOSAA	No Value	
FASE (SV)		
MeFOSE	<RL	0.175
EtFOSE	No Value	
PPEA (NV)		
PFEESA	<RL	0.017
PF4OPeA	<RL	0.019
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.019
HFPO-DA	<RL	0.019
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.020
11Cl-PF3OUdS	<RL	0.020
n:2 FTAcr (V)		
8:2 FTAcr	<RL	16.6
10:2 FTAcr	<RL	16.0
n:2 FTMAC (V)		
6:2 FTMAC	357 ± 14	56.8
8:2 FTMAC	<RL	58.1
10:2 FTMAC	<RL	30.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	16.2
10:2 FTOAc	<RL	16.7
n:2 FTOH (V)		
4:2 FTOH	<RL	33.9
5:2 FTOH	<RL	82.2
6:2 FTOH	431 ± 19	82.8
7:2 FTOH	<RL	81.9
8:2 FTOH	<RL	81.0
10:2 FTOH	<RL	167
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	No Value	
10:2 FTS	No Value	

Table 7. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.893
PFPeA	0.372 ± 0.057	0.218
PFHxA	4.19 ± 0.45	0.218
PFHpA	<RL	1.16
PFOA	<RL	0.409
PFNA	<RL	0.218
PFDA	<RL	0.451
PFUnDA	No Value	
PFDoDA	<RL	0.218
PFTrDA	No Value	
PFTeDA	<RL	0.084
PFSA (NV)		
PFPrS	<RL	0.038
PFBS	<RL	0.038
PFPeS	<RL	0.039
PFHxS	<RL	0.077
PFHpS	<RL	0.039
PFOS	1.191 ± 0.058	0.202
PFNS	<RL	0.081
PFDS	<RL	0.040
FASA (NV, SV)		
FBSA (NV)	0.1532 ± 0.0061	0.084
MeFBSA (SV)	<RL	0.440
FHxSA (NV)	<RL	0.041
FOSA (NV)	<RL	0.110
MeFOSA (SV)	<RL	0.177
EtFOSA (SV)	<RL	0.439
FASAA (NV)		
FOSAA	<RL	0.218
MeFOSAA	<RL	0.218
EtFOSAA	No Value	
FASE (SV)		
MeFOSE	<RL	0.178
EtFOSE	<RL	0.176

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.042
PF4OPeA	<RL	0.198
PF5OHxA	<RL	0.076
3-6-OPFHpA	<RL	0.033
HFPO-DA	<RL	0.451
ADONA	<RL	0.034
9Cl-PF3ONS	<RL	0.033
11Cl-PF3OUdS	<RL	0.034
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.0
10:2 FTAcr	<RL	13.4
n:2 FTMAC (V)		
6:2 FTMAC	234 ± 26	59.9
8:2 FTMAC	<RL	61.3
10:2 FTMAC	<RL	32.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	13.7
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	68.6
5:2 FTOH	<RL	26.6
6:2 FTOH	129.6 ± 9.5	70.2
7:2 FTOH	<RL	27.2
8:2 FTOH	<RL	102
10:2 FTOH	<RL	69.7
n:2 FTS (NV)		
4:2 FTS	<RL	0.079
6:2 FTS	<RL	0.429
8:2 FTS	<RL	0.433
10:2 FTS	<RL	0.086

Table 8. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.889
PFPeA	<RL	0.217
PFHxA	0.355 ± 0.064	0.217
PFHpA	<RL	0.409
PFOA	<RL	0.185
PFNA	<RL	0.076
PFDA	0.1747 ± 0.0061	0.073
PFUnDA	<RL	0.068
PFDoDA	0.0678 ± 0.0064	0.064
PFTrDA	<RL	0.030
PFTeDA	<RL	0.083
PFSA (NV)		
PFPrS	<RL	0.038
PFBS	5.43 ± 0.72	0.022
PFPeS	<RL	0.027
PFHxS	<RL	0.048
PFHpS	<RL	0.024
PFOS	<RL	0.201
PFNS	<RL	0.024
PFDS	<RL	0.024
FASA (NV, SV)		
FBSA (NV)	0.461 ± 0.07	0.083
MeFBSA (SV)	<RL	0.121
FHxSA (NV)	<RL	0.025
FOSA (NV)	<RL	0.033
MeFOSA (SV)	<RL	0.303
EtFOSA (SV)	<RL	0.303
FASAA (NV)		
FOSAA	<RL	0.025
MeFOSAA	<RL	0.134
EtFOSAA	<RL	0.115
FASE (SV)		
MeFOSE	No Value	
EtFOSE	<RL	0.629

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.023
PF5OHxA	<RL	0.197
3-6-OPFHpA	<RL	0.023
HFPO-DA	<RL	0.025
ADONA	<RL	0.023
9Cl-PF3ONS	<RL	0.024
11Cl-PF3OUdS	<RL	0.024
n:2 FTAcr (V)		
8:2 FTAcr	<RL	23.9
10:2 FTAcr	<RL	11.2
n:2 FTMAC (V)		
6:2 FTMAC	<RL	39.9
8:2 FTMAC	<RL	40.8
10:2 FTMAC	<RL	21.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	23.3
10:2 FTOAc	<RL	11.7
n:2 FTOH (V)		
4:2 FTOH	<RL	60.7
5:2 FTOH	<RL	57.7
6:2 FTOH	38.4 ± 5	22.3
7:2 FTOH	<RL	57.5
8:2 FTOH	<RL	107
10:2 FTOH	<RL	57.7
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.049
10:2 FTS	<RL	0.127

Table 9. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-B following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			*PPEA (NV)*		
PFBA	<RL	0.884	**PFEESA**	<RL	0.021
PFPeA	<RL	0.047	**PF4OPeA**	<RL	0.024
PFHxA	<RL	0.422	**PF5OHxA**	<RL	0.024
PFHpA	<RL	0.192	**3-6-OPFHpA**	<RL	0.024
PFOA	<RL	0.277	**HFPO-DA**	<RL	0.024
PFNA	<RL	0.092	**ADONA**	<RL	0.024
PFDA	<RL	0.050	**9Cl-PF3ONS**	<RL	0.025
PFUnDA	<RL	0.130	**11Cl-PF3OUdS**	<RL	0.025
PFDoDA	<RL	0.039			
PFTrDA	<RL	0.042	*n:2 FTAcr (V)*		
PFTeDA	<RL	0.027	**8:2 FTAcr**	<RL	17.7
			10:2 FTAcr	<RL	17.0
PFSA (NV)					
PFPrS	<RL	0.054	*n:2 FTMAC (V)*		
PFBS	<RL	5.23	**6:2 FTMAC**	<RL	59.4
PFPeS	<RL	0.025	**8:2 FTMAC**	<RL	58.4
PFHxS	<RL	4.26	**10:2 FTMAC**	<RL	32.0
PFHpS	<RL	0.025			
PFOS	<RL	4.47	*n:2 FTOAc (V)*		
PFNS	<RL	0.051	**8:2 FTOAc**	<RL	17.3
PFDS	<RL	0.027	**10:2 FTOAc**	<RL	17.7
FASA (NV, SV)			*n:2 FTOH (V)*		
FBSA (NV)	<RL	0.027	**4:2 FTOH**	<RL	82.7
MeFBSA (SV)	<RL	0.439	**5:2 FTOH**	<RL	78.7
FHxSA (NV)	<RL	0.027	**6:2 FTOH**	<RL	35.8
FOSA (NV)	<RL	0.030	**7:2 FTOH**	<RL	36.0
MeFOSA (SV)	<RL	0.437	**8:2 FTOH**	<RL	17.6
EtFOSA (SV)	<RL	0.438	**10:2 FTOH**	<RL	90.4
FASAA (NV)			*n:2 FTS (NV)*		
FOSAA	No Value		**4:2 FTS**	No Value	
MeFOSAA	<RL	0.027	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.027	**8:2 FTS**	No Value	
			10:2 FTS	No Value	
FASE (SV)					
MeFOSE	No Value				
EtFOSE	<RL	0.433			

Table 10. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	1.09
PFPeA	<RL	0.265
PFHxA	<RL	0.265
PFHpA	<RL	1.41
PFOA	<RL	0.497
PFNA	<RL	0.265
PFDA	<RL	0.548
PFUnDA	<RL	0.265
PFDoDA	<RL	0.265
PFTrDA	<RL	0.102
PFTeDA	<RL	0.102
PFSA (NV)		
PFPrS	<RL	0.046
PFBS	0.57 ± 0.30	0.046
PFPeS	<RL	0.047
PFHxS	<RL	0.093
PFHpS	<RL	0.048
PFOS	0.330 ± 0.019	0.246
PFNS	<RL	0.098
PFDS	<RL	0.048
FASA (NV, SV)		
FBSA (NV)	0.340 ± 0.081	0.102
MeFBSA (SV)	<RL	0.453
FHxSA (NV)	<RL	0.050
FOSA (NV)	<RL	0.134
MeFOSA (SV)	<RL	0.182
EtFOSA (SV)	<RL	0.452
FASAA (NV)		
FOSAA	<RL	0.265
MeFOSAA	<RL	0.265
EtFOSAA	<RL	0.265
FASE (SV)		
MeFOSE	<RL	0.183
EtFOSE	<RL	0.181

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.051
PF4OPeA	<RL	0.241
PF5OHxA	<RL	0.093
3-6-OPFHpA	<RL	0.040
HFPO-DA	<RL	0.548
ADONA	<RL	0.041
9Cl-PF3ONS	<RL	0.041
11Cl-PF3OUdS	<RL	0.042
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.4
10:2 FTAcr	<RL	14.8
n:2 FTMAC (V)		
6:2 FTMAC	<RL	66.0
8:2 FTMAC	<RL	67.6
10:2 FTMAC	<RL	35.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.2
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	75.7
5:2 FTOH	<RL	29.3
6:2 FTOH	96 ± 14	77.4
7:2 FTOH	<RL	30.0
8:2 FTOH	<RL	113
10:2 FTOH	<RL	76.9
n:2 FTS (NV)		
4:2 FTS	<RL	0.096
6:2 FTS	<RL	0.521
8:2 FTS	<RL	0.526
10:2 FTS	<RL	0.105

Table 11. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	119.3 ± 7.5	0.819	**PFEESA**	<RL	0.014
PFPeA	1.251 ± 0.068	0.200	**PF4OPeA**	<RL	0.016
PFHxA	1.81 ± 0.18	0.200	**PF5OHxA**	<RL	0.182
PFHpA	<RL	0.277	**3-6-OPFHpA**	<RL	0.070
PFOA	<RL	0.125	**HFPO-DA**	<RL	0.017
PFNA	<RL	0.051	**ADONA**	<RL	0.015
PFDA	<RL	0.049	**9Cl-PF3ONS**	<RL	0.031
PFUnDA	<RL	0.046	**11Cl-PF3OUdS**	<RL	0.031
PFDoDA	<RL	0.200			
PFTrDA	<RL	0.077	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.077	**8:2 FTAcr**	<RL	13.6
			10:2 FTAcr	<RL	13.1
PFSA (NV)					
PFPrS	<RL	0.031	***n:2 FTMAC (V)***		
PFBS	98.9 ± 6.0	0.035	**6:2 FTMAC**	<RL	46.5
PFPeS	<RL	0.035	**8:2 FTMAC**	<RL	47.6
PFHxS	<RL	0.033	**10:2 FTMAC**	<RL	25.1
PFHpS	<RL	0.036			
PFOS	<RL	0.185	***n:2 FTOAc (V)***		
PFNS	<RL	0.074	**8:2 FTOAc**	<RL	27.0
PFDS	<RL	0.036	**10:2 FTOAc**	<RL	27.8
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	37.4 ± 2.0	0.077	**4:2 FTOH**	<RL	70.6
MeFBSA (SV)	2.0 ± 1.9	0.140	**5:2 FTOH**	<RL	67.2
FHxSA (NV)	<RL	0.038	**6:2 FTOH**	<RL	67.7
FOSA (NV)	<RL	0.101	**7:2 FTOH**	<RL	66.9
MeFOSA (SV)	<RL	0.068	**8:2 FTOH**	<RL	66.2
EtFOSA (SV)	<RL	0.218	**10:2 FTOH**	<RL	67.3
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	No Value		**4:2 FTS**	No Value	
MeFOSAA	No Value		**6:2 FTS**	No Value	
EtFOSAA	No Value		**8:2 FTS**	<RL	0.033
			10:2 FTS	<RL	0.086
FASE (SV)					
MeFOSE	2.34 ± 0.46	0.361			
EtFOSE	4.80 ± 0.54	0.067			

Table 12. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-C following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	9.93 ± 0.35	0.514
PFPeA	No Value	
PFHxA	<RL	0.245
PFHpA	0.24 ± 0.15	0.111
PFOA	<RL	0.161
PFNA	<RL	0.054
PFDA	<RL	0.029
PFUnDA	<RL	0.076
PFDoDA	<RL	0.022
PFTrDA	<RL	0.025
PFTeDA	<RL	0.015
PFSA (NV)		
PFPrS	0.0385 ± 0.0042	0.031
PFBS	70.5 ± 2.3	3.04
PFPeS	<RL	0.015
PFHxS	<RL	2.47
PFHpS	<RL	0.015
PFOS	<RL	2.60
PFNS	<RL	0.03
PFDS	<RL	0.016
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.488
FHxSA (NV)	<RL	0.015
FOSA (NV)	<RL	0.017
MeFOSA (SV)	<RL	0.486
EtFOSA (SV)	<RL	0.487
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.015
EtFOSAA	<RL	0.015
FASE (SV)		
MeFOSE	<RL	0.489
EtFOSE	<RL	0.482

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	0.01513 ± 0.00098	0.012
PF4OPeA	<RL	0.014
PF5OHxA	No Value	
3-6-OPFHpA	<RL	0.014
HFPO-DA	<RL	0.014
ADONA	<RL	0.014
9Cl-PF3ONS	<RL	0.014
11Cl-PF3OUdS	<RL	0.015
n:2 FTAcr (V)		
8:2 FTAcr	<RL	19.9
10:2 FTAcr	<RL	19.0
n:2 FTMAC (V)		
6:2 FTMAC	<RL	66.4
8:2 FTMAC	<RL	65.3
10:2 FTMAC	<RL	35.8
n:2 FTOAc (V)		
8:2 FTOAc	<RL	19.3
10:2 FTOAc	<RL	19.8
n:2 FTOH (V)		
4:2 FTOH	<RL	92.5
5:2 FTOH	<RL	88.0
6:2 FTOH	<RL	40.0
7:2 FTOH	<RL	40.3
8:2 FTOH	<RL	19.7
10:2 FTOH	<RL	101
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	<RL	0.896
8:2 FTS	<RL	0.015
10:2 FTS	No Value	

Table 13. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	6.8 ± 1.8	0.259
PFPeA	1.0 ± 1.1	0.048
PFHxA	0.29 ± 0.16	0.129
PFHpA	<RL	0.106
PFOA	<RL	0.138
PFNA	<RL	0.072
PFDA	<RL	0.135
PFUnDA	<RL	0.075
PFDoDA	<RL	0.051
PFTrDA	<RL	0.116
PFTeDA	<RL	0.024
PFSA (NV)		
PFPrS	<RL	0.067
PFBS	15.5 ± 2.6	0.027
PFPeS	<RL	0.023
PFHxS	<RL	0.046
PFHpS	<RL	0.023
PFOS	1.085 ± 0.025	0.183
PFNS	<RL	0.023
PFDS	<RL	0.031
FASA (NV, SV)		
FBSA (NV)	14.94 ± 0.94	0.024
MeFBSA (SV)	<RL	0.764
FHxSA (NV)	<RL	0.024
FOSA (NV)	<RL	0.024
MeFOSA (SV)	<RL	0.320
EtFOSA (SV)	<RL	0.321
FASAA (NV)		
FOSAA	<RL	0.416
MeFOSAA	<RL	0.129
EtFOSAA	<RL	0.129
FASE (SV)		
MeFOSE	<RL	0.765
EtFOSE	<RL	0.754

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.022
PF4OPeA	<RL	0.022
PF5OHxA	<RL	0.022
3-6-OPFHpA	<RL	0.019
HFPO-DA	<RL	0.030
ADONA	<RL	0.021
9Cl-PF3ONS	<RL	0.022
11Cl-PF3OUdS	<RL	0.023
n:2 FTAcr (V)		
8:2 FTAcr	<RL	11.9
10:2 FTAcr	<RL	11.5
n:2 FTMAC (V)		
6:2 FTMAC	<RL	51.1
8:2 FTMAC	<RL	52.3
10:2 FTMAC	<RL	27.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	11.7
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	58.6
5:2 FTOH	<RL	114
6:2 FTOH	<RL	59.9
7:2 FTOH	<RL	64.9
8:2 FTOH	<RL	61.2
10:2 FTOH	<RL	59.6
n:2 FTS (NV)		
4:2 FTS	<RL	0.120
6:2 FTS	<RL	0.247
8:2 FTS	<RL	0.249
10:2 FTS	<RL	0.048

Table 14. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.489 ± 0.046	0.133
PFPeA	0.912 ± 0.027	0.078
PFHxA	3.24 ± 0.41	0.205
PFHpA	<RL	0.346
PFOA	<RL	0.384
PFNA	<RL	0.064
PFDA	<RL	0.424
PFUnDA	<RL	0.057
PFDoDA	<RL	0.205
PFTrDA	<RL	0.079
PFTeDA	<RL	0.079
PFSA (NV)		
PFPrS	<RL	0.036
PFBS	0.1241 ± 0.0013	0.019
PFPeS	0.0429 ± 0.0094	0.023
PFHxS	<RL	0.041
PFHpS	<RL	0.037
PFOS	<RL	0.190
PFNS	<RL	0.076
PFDS	<RL	0.037
FASA (NV, SV)		
FBSA (NV)	1.070 ± 0.099	0.079
MeFBSA (SV)	<RL	0.147
FHxSA (NV)	<RL	0.039
FOSA (NV)	<RL	0.104
MeFOSA (SV)	<RL	0.071
EtFOSA (SV)	<RL	0.229
FASAA (NV)		
FOSAA	<RL	0.205
MeFOSAA	<RL	0.205
EtFOSAA	<RL	0.097
FASE (SV)		
MeFOSE	0.65 ± 0.24	0.379
EtFOSE	<RL	0.070

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.017
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.072
HFPO-DA	<RL	0.424
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.031
11Cl-PF3OUdS	<RL	0.032
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.3
10:2 FTAcr	<RL	13.8
n:2 FTMAC (V)		
6:2 FTMAC	640 ± 58	48.9
8:2 FTMAC	<RL	50.1
10:2 FTMAC	<RL	26.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	28.4
10:2 FTOAc	<RL	29.3
n:2 FTOH (V)		
4:2 FTOH	<RL	74.3
5:2 FTOH	<RL	70.7
6:2 FTOH	670 ± 270	71.3
7:2 FTOH	<RL	70.4
8:2 FTOH	<RL	69.7
10:2 FTOH	<RL	70.7
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.407
10:2 FTS	<RL	0.081

Table 15. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-D following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.2 ± 1.8	0.693
PFPeA	0.543 ± 0.045	0.037
PFHxA	1.93 ± 0.29	0.331
PFHpA	<RL	0.150
PFOA	<RL	0.217
PFNA	<RL	0.072
PFDA	<RL	0.039
PFUnDA	<RL	0.102
PFDoDA	<RL	0.030
PFTrDA	<RL	0.033
PFTeDA	<RL	0.021
PFSA (NV)		
PFPrS	<RL	0.042
PFBS	<RL	2.11
PFPeS	<RL	0.020
PFHxS	<RL	3.34
PFHpS	<RL	0.020
PFOS	<RL	3.51
PFNS	<RL	0.040
PFDS	<RL	0.021
FASA (NV, SV)		
FBSA (NV)	<RL	0.021
MeFBSA (SV)	<RL	0.393
FHxSA (NV)	<RL	0.021
FOSA (NV)	<RL	0.024
MeFOSA (SV)	<RL	0.391
EtFOSA (SV)	<RL	0.392
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.021
EtFOSAA	<RL	0.021
FASE (SV)		
MeFOSE	<RL	0.394
EtFOSE	<RL	0.388

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.017
PF4OPeA	<RL	0.019
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.019
HFPO-DA	<RL	0.019
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.019
11Cl-PF3OUdS	<RL	0.020
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.9
10:2 FTAcr	<RL	15.2
n:2 FTMAC (V)		
6:2 FTMAC	182.7 ± 8.2	53.1
8:2 FTMAC	<RL	52.2
10:2 FTMAC	<RL	28.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.4
10:2 FTOAc	<RL	15.8
n:2 FTOH (V)		
4:2 FTOH	<RL	74.0
5:2 FTOH	<RL	70.4
6:2 FTOH	146 ± 13	32.0
7:2 FTOH	<RL	32.2
8:2 FTOH	<RL	15.8
10:2 FTOH	<RL	80.9
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.020
10:2 FTS	No Value	

Table 16. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.274 ± 0.017	0.235
PFPeA	0.198 ± 0.031	0.043
PFHxA	1.96 ± 0.11	0.117
PFHpA	0.164 ± 0.013	0.096
PFOA	<RL	0.125
PFNA	<RL	0.065
PFDA	<RL	0.122
PFUnDA	<RL	0.068
PFDoDA	<RL	0.046
PFTrDA	<RL	0.105
PFTeDA	<RL	0.022
PFSA (NV)		
PFPrS	<RL	0.060
PFBS	0.398 ± 0.051	0.025
PFPeS	<RL	0.020
PFHxS	0.0730 ± 0.0099	0.042
PFHpS	<RL	0.021
PFOS	1.504 ± 0.047	0.165
PFNS	<RL	0.021
PFDS	<RL	0.028
FASA (NV, SV)		
FBSA (NV)	0.213 ± 0.029	0.022
MeFBSA (SV)	<RL	0.868
FHxSA (NV)	<RL	0.022
FOSA (NV)	<RL	0.022
MeFOSA (SV)	<RL	0.363
EtFOSA (SV)	<RL	0.364
FASAA (NV)		
FOSAA	<RL	0.376
MeFOSAA	<RL	0.117
EtFOSAA	No Value	
FASE (SV)		
MeFOSE	<RL	0.869
EtFOSE	<RL	0.856

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.019
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.017
HFPO-DA	<RL	0.027
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.020
11Cl-PF3OUdS	<RL	0.020
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.7
10:2 FTAcr	<RL	14.1
n:2 FTMAC (V)		
6:2 FTMAC	376 ± 17	62.8
8:2 FTMAC	<RL	64.3
10:2 FTMAC	<RL	33.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.4
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	72.0
5:2 FTOH	<RL	140
6:2 FTOH	136.1 ± 5.3	73.6
7:2 FTOH	<RL	79.8
8:2 FTOH	<RL	75.1
10:2 FTOH	<RL	73.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.109
6:2 FTS	<RL	0.223
8:2 FTS	<RL	0.225
10:2 FTS	<RL	0.043

Table 17. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	80 ± 14	0.139
PFPeA	0.46 ± 0.10	0.232
PFHxA	2.06 ± 0.27	1.16
PFHpA	<RL	0.360
PFOA	<RL	0.163
PFNA	<RL	0.066
PFDA	<RL	0.604
PFUnDA	<RL	0.059
PFDoDA	<RL	0.511
PFTrDA	<RL	0.391
PFTeDA	<RL	0.765
PFSA (NV)		
PFPrS	<RL	0.040
PFBS	84 ± 15	0.020
PFPeS	No Value	
PFHxS	<RL	0.042
PFHpS	<RL	0.106
PFOS	<RL	0.103
PFNS	<RL	0.107
PFDS	<RL	0.224
FASA (NV, SV)		
FBSA (NV)	27.3 ± 4.5	0.604
MeFBSA (SV)	8.7 ± 1.0	0.167
FHxSA (NV)	<RL	0.111
FOSA (NV)	<RL	0.232
MeFOSA (SV)	<RL	0.080
EtFOSA (SV)	<RL	0.260
FASAA (NV)		
FOSAA	<RL	0.022
MeFOSAA	<RL	0.118
EtFOSAA	<RL	0.604
FASE (SV)		
MeFOSE	<RL	0.430
EtFOSE	<RL	0.080

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.018
PF4OPeA	No Value	
PF5OHxA	<RL	0.105
3-6-OPFHpA	<RL	0.105
HFPO-DA	<RL	0.022
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.107
11Cl-PF3OUdS	<RL	0.108
n:2 FTAcr (V)		
8:2 FTAcr	<RL	16.3
10:2 FTAcr	<RL	15.7
n:2 FTMAC (V)		
6:2 FTMAC	752 ± 25	55.8
8:2 FTMAC	<RL	57.1
10:2 FTMAC	<RL	30.1
n:2 FTOAc (V)		
8:2 FTOAc	<RL	32.4
10:2 FTOAc	<RL	33.4
n:2 FTOH (V)		
4:2 FTOH	<RL	84.8
5:2 FTOH	<RL	80.6
6:2 FTOH	285 ± 47	81.3
7:2 FTOH	<RL	80.3
8:2 FTOH	<RL	79.5
10:2 FTOH	<RL	80.7
n:2 FTS (NV)		
4:2 FTS	0.828 ± 0.091	0.217
6:2 FTS	579 ± 48	1.15
8:2 FTS	<RL	0.043
10:2 FTS	<RL	0.112

Table 18. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-E following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			*PPEA (NV)*		
PFBA	49.0 ± 3.0	0.825	**PFEESA**	0.0676 ± 0.0069	0.021
PFPeA	0.603 ± 0.091	0.045	**PF4OPeA**	<RL	0.023
PFHxA	0.979 ± 0.085	0.407	**PF5OHxA**	<RL	0.023
PFHpA	0.74 ± 0.27	0.185	**3-6-OPFHpA**	<RL	0.023
PFOA	<RL	0.267	**HFPO-DA**	<RL	0.023
PFNA	<RL	0.089	**ADONA**	<RL	0.023
PFDA	<RL	0.048	**9Cl-PF3ONS**	<RL	0.024
PFUnDA	<RL	0.125	**11Cl-PF3OUdS**	<RL	0.024
PFDoDA	<RL	0.037			
PFTrDA	<RL	0.041	*n:2 FTAcr (V)*		
PFTeDA	<RL	0.026	**8:2 FTAcr**	<RL	20.7
			10:2 FTAcr	<RL	19.8
PFSA (NV)					
PFPrS	<RL	0.042	*n:2 FTMAC (V)*		
PFBS	452 ± 73	2.11	**6:2 FTMAC**	159 ± 13	69.1
PFPeS	<RL	0.020	**8:2 FTMAC**	<RL	70.7
PFHxS	<RL	3.34	**10:2 FTMAC**	<RL	37.3
PFHpS	0.077 ± 0.017	0.020			
PFOS	<RL	3.506	*n:2 FTOAc (V)*		
PFNS	<RL	0.040	**8:2 FTOAc**	<RL	20.1
PFDS	<RL	0.021	**10:2 FTOAc**	<RL	69.1
FASA (NV, SV)			*n:2 FTOH (V)*		
FBSA (NV)	6.0 ± 1.3	0.633	**4:2 FTOH**	<RL	96.3
MeFBSA (SV)	<RL	0.515	**5:2 FTOH**	<RL	91.6
FHxSA (NV)	<RL	0.026	**6:2 FTOH**	63.4 ± 4.3	41.7
FOSA (NV)	<RL	0.029	**7:2 FTOH**	<RL	41.9
MeFOSA (SV)	<RL	0.513	**8:2 FTOH**	<RL	20.5
EtFOSA (SV)	<RL	0.514	**10:2 FTOH**	<RL	105
FASAA (NV)			*n:2 FTS (NV)*		
FOSAA	<RL	0.243	**4:2 FTS**	0.82 ± 0.16	0.228
MeFOSAA	<RL	0.026	**6:2 FTS**	503 ± 57	1.21
EtFOSAA	<RL	0.026	**8:2 FTS**	<RL	0.025
			10:2 FTS	<RL	1.22
FASE (SV)					
MeFOSE	No Value				
EtFOSE	<RL	0.508			

Table 19. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	33.3 ± 2.3	0.300
PFPeA	0.134 ± 0.033	0.055
PFHxA	1.97 ± 0.52	0.149
PFHpA	0.36 ± 0.19	0.123
PFOA	<RL	0.159
PFNA	<RL	0.083
PFDA	<RL	0.156
PFUnDA	<RL	0.087
PFDoDA	<RL	0.058
PFTrDA	<RL	0.134
PFTeDA	<RL	0.028
PFSA (NV)		
PFPrS	<RL	0.077
PFBS	175 ± 16	0.110
PFPeS	<RL	0.026
PFHxS	<RL	0.053
PFHpS	<RL	0.026
PFOS	1.02 ± 0.18	0.115
PFNS	<RL	0.027
PFDS	<RL	0.035
FASA (NV, SV)		
FBSA (NV)	101 ± 11	0.671
MeFBSA (SV)	No Value	
FHxSA (NV)	<RL	0.028
FOSA (NV)	<RL	0.028
MeFOSA (SV)	<RL	0.291
EtFOSA (SV)	<RL	0.291
FASAA (NV)		
FOSAA	<RL	0.258
MeFOSAA	<RL	0.149
EtFOSAA	<RL	0.149
FASE (SV)		
MeFOSE	No Value	
EtFOSE	<RL	0.685

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.025
PF4OPeA	<RL	0.025
PF5OHxA	<RL	0.025
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.035
ADONA	<RL	0.025
9Cl-PF3ONS	<RL	0.026
11Cl-PF3OUdS	<RL	0.026
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.2
10:2 FTAcr	<RL	13.7
n:2 FTMAC (V)		
6:2 FTMAC	628 ± 36	61.1
8:2 FTMAC	<RL	62.5
10:2 FTMAC	<RL	32.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.0
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	70.0
5:2 FTOH	<RL	136
6:2 FTOH	170 ± 14	71.6
7:2 FTOH	<RL	77.5
8:2 FTOH	<RL	73.0
10:2 FTOH	<RL	71.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.139
6:2 FTS	36.2 ± 2.1	0.285
8:2 FTS	<RL	0.288
10:2 FTS	<RL	1.30

Table 20. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded MB-F.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.85 ± 0.14	0.137
PFPeA	1.27 ± 0.14	0.080
PFHxA	2.964 ± 0.056	0.188
PFHpA	<RL	0.354
PFOA	<RL	0.401
PFNA	<RL	0.066
PFDA	<RL	0.442
PFUnDA	<RL	0.058
PFDoDA	<RL	0.214
PFTrDA	<RL	0.082
PFTeDA	<RL	0.082
PFSA (NV)		
PFPrS	<RL	0.037
PFBS	1.309 ± 0.083	0.019
PFPeS	No Value	
PFHxS	<RL	0.075
PFHpS	<RL	0.038
PFOS	<RL	0.198
PFNS	<RL	0.079
PFDS	<RL	0.039
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.138
FHxSA (NV)	<RL	0.040
FOSA (NV)	<RL	0.108
MeFOSA (SV)	<RL	0.066
EtFOSA (SV)	<RL	0.214
FASAA (NV)		
FOSAA	<RL	0.021
MeFOSAA	<RL	0.116
EtFOSAA	<RL	0.100
FASE (SV)		
MeFOSE	<RL	0.355
EtFOSE	<RL	0.066

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.017
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.020
3-6-OPFHpA	<RL	0.020
HFPO-DA	<RL	0.442
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.033
11Cl-PF3OUdS	No Value	
n:2 FTAcr (V)		
8:2 FTAcr	<RL	8.91
10:2 FTAcr	<RL	8.60
n:2 FTMAC (V)		
6:2 FTMAC	131.9 ± 3.2	30.5
8:2 FTMAC	<RL	31.2
10:2 FTMAC	<RL	16.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	17.7
10:2 FTOAc	<RL	18.2
n:2 FTOH (V)		
4:2 FTOH	<RL	46.3
5:2 FTOH	<RL	44.1
6:2 FTOH	169 ± 15	44.4
7:2 FTOH	<RL	43.9
8:2 FTOH	<RL	43.4
10:2 FTOH	<RL	44.1
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.042
10:2 FTS	<RL	0.085

Table 21. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for MB-F following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.681
PFPeA	0.193 ± 0.064	0.036
PFHxA	3.81 ± 0.44	0.248
PFHpA	<RL	1.32
PFOA	<RL	0.466
PFNA	<RL	0.071
PFDA	<RL	0.038
PFUnDA	<RL	0.100
PFDoDA	<RL	0.030
PFTrDA	<RL	0.033
PFTeDA	<RL	0.021
PFSA (NV)		
PFPrS	<RL	0.041
PFBS	2.05 ± 0.39	0.043
PFPeS	<RL	0.019
PFHxS	<RL	0.087
PFHpS	<RL	0.020
PFOS	<RL	0.230
PFNS	<RL	0.040
PFDS	<RL	0.021
FASA (NV, SV)		
FBSA (NV)	<RL	0.021
MeFBSA (SV)	<RL	0.506
FHxSA (NV)	<RL	0.021
FOSA (NV)	<RL	0.023
MeFOSA (SV)	<RL	0.504
EtFOSA (SV)	<RL	0.505
FASAA (NV)		
FOSAA	<RL	0.248
MeFOSAA	<RL	0.248
EtFOSAA	<RL	0.248
FASE (SV)		
MeFOSE	<RL	0.507
EtFOSE	No Value	

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.016
PF4OPeA	<RL	0.018
PF5OHxA	<RL	0.018
3-6-OPFHpA	<RL	0.018
HFPO-DA	<RL	0.018
ADONA	<RL	0.038
9Cl-PF3ONS	<RL	0.019
11Cl-PF3OUdS	<RL	0.019
n:2 FTAcr (V)		
8:2 FTAcr	<RL	20.4
10:2 FTAcr	<RL	19.6
n:2 FTMAC (V)		
6:2 FTMAC	<RL	68.3
8:2 FTMAC	<RL	67.2
10:2 FTMAC	<RL	35.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	19.8
10:2 FTOAc	<RL	20.4
n:2 FTOH (V)		
4:2 FTOH	<RL	103
5:2 FTOH	<RL	209
6:2 FTOH	68.6 ± 7.9	41.2
7:2 FTOH	<RL	41.5
8:2 FTOH	<RL	20.3
10:2 FTOH	<RL	104
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.493
10:2 FTS	<RL	0.098

Table 22. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered MB-F.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.255
PFPeA	0.0752 ± 0.0051	0.047
PFHxA	1.99 ± 0.31	0.127
PFHpA	<RL	0.105
PFOA	<RL	0.136
PFNA	<RL	0.071
PFDA	<RL	0.133
PFUnDA	<RL	0.074
PFDoDA	<RL	0.050
PFTrDA	<RL	0.115
PFTeDA	<RL	0.024
PFSA (NV)		
PFPrS	<RL	0.066
PFBS	0.51 ± 0.22	0.027
PFPeS	<RL	0.022
PFHxS	<RL	0.046
PFHpS	<RL	0.022
PFOS	0.495 ± 0.098	0.180
PFNS	<RL	0.023
PFDS	<RL	0.030
FASA (NV, SV)		
FBSA (NV)	0.499 ± 0.039	0.024
MeFBSA (SV)	<RL	0.954
FHxSA (NV)	<RL	0.024
FOSA (NV)	<RL	0.024
MeFOSA (SV)	<RL	0.400
EtFOSA (SV)	<RL	0.400
FASAA (NV)		
FOSAA	<RL	0.410
MeFOSAA	<RL	0.127
EtFOSAA	No Value	
FASE (SV)		
MeFOSE	<RL	0.955
EtFOSE	<RL	0.941

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.021
PF4OPeA	<RL	0.021
PF5OHxA	<RL	0.021
3-6-OPFHpA	<RL	0.019
HFPO-DA	<RL	0.030
ADONA	<RL	0.021
9Cl-PF3ONS	<RL	0.022
11Cl-PF3OUdS	<RL	0.022
n:2 FTAcr (V)		
8:2 FTAcr	<RL	17.5
10:2 FTAcr	<RL	16.8
n:2 FTMAC (V)		
6:2 FTMAC	112.0 ± 9.6	75.1
8:2 FTMAC	<RL	76.8
10:2 FTMAC	<RL	40.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	17.2
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	86.0
5:2 FTOH	<RL	168
6:2 FTOH	94 ± 4.5	88.0
7:2 FTOH	<RL	95.3
8:2 FTOH	<RL	89.8
10:2 FTOH	<RL	87.4
n:2 FTS (NV)		
4:2 FTS	<RL	0.119
6:2 FTS	<RL	0.243
8:2 FTS	<RL	0.245
10:2 FTS	No Value	

Table 23. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	18 ± 11	0.582
PFPeA	19 ± 12	0.185
PFHxA	10.6 ± 4.4	0.319
PFHpA	1.64 ± 0.58	0.330
PFOA	<RL	0.160
PFNA	<RL	0.023
PFDA	<RL	0.150
PFUnDA	<RL	0.054
PFDoDA	<RL	0.079
PFTrDA	<RL	0.109
PFTeDA	<RL	0.154
PFSA (NV)		
PFPrS	<RL	0.032
PFBS	0.247 ± 0.085	0.068
PFPeS	<RL	0.022
PFHxS	<RL	0.021
PFHpS	<RL	0.022
PFOS	<RL	0.070
PFNS	<RL	0.044
PFDS	0.112 ± 0.015	0.045
FASA (NV, SV)		
FBSA (NV)	0.0921 ± 0.0038	0.023
MeFBSA (SV)	<RL	0.473
FHxSA (NV)	<RL	0.023
FOSA (NV)	0.068 ± 0.0058	0.023
MeFOSA (SV)	<RL	0.470
EtFOSA (SV)	<RL	0.472
FASAA (NV)		
FOSAA	<RL	0.023
MeFOSAA	<RL	0.103
EtFOSAA	<RL	0.046
FASE (SV)		
MeFOSE	<RL	0.473
EtFOSE	<RL	0.466

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.022
PF4OPeA	<RL	0.023
PF5OHxA	<RL	0.021
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.219
ADONA	<RL	0.021
9Cl-PF3ONS	<RL	0.041
11Cl-PF3OUdS	<RL	0.019
n:2 FTAcr (V)		
8:2 FTAcr	<RL	92.4
10:2 FTAcr	<RL	35.0
n:2 FTMAC (V)		
6:2 FTMAC	3000 ± 110	301
8:2 FTMAC	<RL	63.3
10:2 FTMAC	<RL	33.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	34.2
10:2 FTOAc	<RL	36.4
n:2 FTOH (V)		
4:2 FTOH	<RL	89.6
5:2 FTOH	<RL	85.3
6:2 FTOH	774 ± 75	90.2
7:2 FTOH	<RL	89.1
8:2 FTOH	<RL	88.2
10:2 FTOH	<RL	182
n:2 FTS (NV)		
4:2 FTS	<RL	3.89
6:2 FTS	No Value	
8:2 FTS	<RL	0.099
10:2 FTS	<RL	0.022

Table 24. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-A following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	2.28 ± 0.21	0.117	**PFEESA**	<RL	0.018
PFPeA	2.547 ± 0.084	0.043	**PF4OPeA**	<RL	0.020
PFHxA	7.65 ± 0.47	0.584	**PF5OHxA**	<RL	0.020
PFHpA	<RL	2.46	**3-6-OPFHpA**	<RL	0.020
PFOA	<RL	0.096	**HFPO-DA**	<RL	0.090
PFNA	<RL	0.066	**ADONA**	<RL	0.020
PFDA	<RL	0.103	**9Cl-PF3ONS**	<RL	0.021
PFUnDA	<RL	0.022	**11Cl-PF3OUdS**	<RL	0.021
PFDoDA	<RL	0.022			
PFTrDA	<RL	0.066	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.053	**8:2 FTAcr**	<RL	20.7
			10:2 FTAcr	<RL	20.0
PFSA (NV)					
PFPrS	0.0291 ± 0.0029	0.020	***n:2 FTMAC (V)***		
PFBS	0.0386 ± 0.0043	0.020	**6:2 FTMAC**	4410 ± 270	70.9
PFPeS	<RL	0.021	**8:2 FTMAC**	<RL	72.5
PFHxS	<RL	0.021	**10:2 FTMAC**	<RL	38.2
PFHpS	<RL	0.021			
PFOS	<RL	0.058	***n:2 FTOAc (V)***		
PFNS	<RL	0.022	**8:2 FTOAc**	<RL	20.2
PFDS	<RL	0.022	**10:2 FTOAc**	<RL	20.8
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	<RL	0.022	**4:2 FTOH**	<RL	42.3
MeFBSA (SV)	<RL	1.08	**5:2 FTOH**	<RL	103
FHxSA (NV)	<RL	0.022	**6:2 FTOH**	1402 ± 12	103
FOSA (NV)	<RL	0.026	**7:2 FTOH**	<RL	102
MeFOSA (SV)	<RL	0.517	**8:2 FTOH**	<RL	101
EtFOSA (SV)	<RL	0.215	**10:2 FTOH**	<RL	208
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.115	**4:2 FTS**	<RL	0.508
MeFOSAA	<RL	0.117	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.140	**8:2 FTS**	<RL	0.112
			10:2 FTS	<RL	0.024
FASE (SV)					
MeFOSE	<RL	0.216			
EtFOSE	<RL	0.511			

Table 25. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.879 ± 0.085	0.507
PFPeA	1.06 ± 0.015	0.288
PFHxA	14.33 ± 0.49	0.844
PFHpA	0.518 ± 0.053	0.158
PFOA	<RL	0.326
PFNA	<RL	0.151
PFDA	<RL	0.144
PFUnDA	<RL	0.126
PFDoDA	<RL	0.048
PFTrDA	0.075 ± 0.012	0.048
PFTeDA	<RL	0.037
PFSA (NV)		
PFPrS	<RL	0.150
PFBS	<RL	0.156
PFPeS	<RL	0.117
PFHxS	<RL	0.115
PFHpS	<RL	0.105
PFOS	0.0994 ± 0.0079	0.066
PFNS	<RL	0.052
PFDS	<RL	0.047
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.457
FHxSA (NV)	<RL	0.054
FOSA (NV)	<RL	0.079
MeFOSA (SV)	<RL	0.184
EtFOSA (SV)	<RL	0.456
FASAA (NV)		
FOSAA	<RL	0.048
MeFOSAA	<RL	0.126
EtFOSAA	<RL	0.126
FASE (SV)		
MeFOSE	<RL	0.185
EtFOSE	<RL	0.182

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.263
PF4OPeA	<RL	0.156
PF5OHxA	<RL	0.113
3-6-OPFHpA	<RL	0.084
HFPO-DA	<RL	0.163
ADONA	<RL	0.116
9Cl-PF3ONS	<RL	0.087
11Cl-PF3OUdS	<RL	0.023
n:2 FTAcr (V)		
8:2 FTAcr	<RL	12.8
10:2 FTAcr	<RL	12.3
n:2 FTMAC (V)		
6:2 FTMAC	869 ± 17	55.0
8:2 FTMAC	<RL	56.3
10:2 FTMAC	<RL	29.7
n:2 FTOAc (V)		
8:2 FTOAc	<RL	12.6
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	63.0
5:2 FTOH	<RL	24.4
6:2 FTOH	181 ± 14	64.5
7:2 FTOH	<RL	25.0
8:2 FTOH	<RL	94.0
10:2 FTOH	<RL	64.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.069
6:2 FTS	<RL	12.8
8:2 FTS	<RL	0.121
10:2 FTS	<RL	0.243

Table 26. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.813
PFPeA	1.48 ± 0.47	0.026
PFHxA	12.7 ± 3.7	0.130
PFHpA	10.0 ± 5.9	0.494
PFOA	<RL	0.137
PFNA	<RL	0.026
PFDA	<RL	0.077
PFUnDA	0.0457 ± 0.0087	0.039
PFDoDA	<RL	0.026
PFTrDA	<RL	0.075
PFTeDA	<RL	0.047
PFSA (NV)		
PFPrS	<RL	0.026
PFBS	<RL	0.023
PFPeS	<RL	0.024
PFHxS	<RL	0.058
PFHpS	<RL	0.024
PFOS	<RL	0.048
PFNS	0.043 ± 0.016	0.025
PFDS	<RL	1.27
FASA (NV, SV)		
FBSA (NV)	<RL	0.026
MeFBSA (SV)	<RL	1.06
FHxSA (NV)	<RL	0.052
FOSA (NV)	0.0661 ± 0.0092	0.052
MeFOSA (SV)	<RL	0.193
EtFOSA (SV)	<RL	0.203
FASAA (NV)		
FOSAA	<RL	0.051
MeFOSAA	<RL	0.026
EtFOSAA	<RL	0.052
FASE (SV)		
MeFOSE	<RL	0.094
EtFOSE	<RL	0.201

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.023
PF5OHxA	<RL	0.023
3-6-OPFHpA	<RL	0.023
HFPO-DA	<RL	0.041
ADONA	<RL	0.023
9Cl-PF3ONS	<RL	0.024
11Cl-PF3OUdS	<RL	0.024
n:2 FTAcr (V)		
8:2 FTAcr	<RL	22.1
10:2 FTAcr	<RL	42.6
n:2 FTMAC (V)		
6:2 FTMAC	2550 ± 120	94.9
8:2 FTMAC	<RL	97.1
10:2 FTMAC	<RL	51.2
n:2 FTOAc (V)		
8:2 FTOAc	<RL	21.8
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	109
5:2 FTOH	<RL	108
6:2 FTOH	950 ± 110	111
7:2 FTOH	<RL	42.8
8:2 FTOH	<RL	107
10:2 FTOH	<RL	111
n:2 FTS (NV)		
4:2 FTS	<RL	0.069
6:2 FTS	<RL	0.696
8:2 FTS	<RL	0.117
10:2 FTS	<RL	0.116

Table 27. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-ASC following abrasion.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.465
PFPeA	0.417 ± 0.031	0.148
PFHxA	0.59 ± 0.12	0.255
PFHpA	1.29 ± 0.15	0.263
PFOA	0.384 ± 0.043	0.127
PFNA	0.048 ± 0.016	0.018
PFDA	0.192 ± 0.016	0.120
PFUnDA	<RL	0.043
PFDoDA	<RL	0.063
PFTrDA	<RL	0.087
PFTeDA	<RL	0.123
PFSA (NV)		
PFPrS	<RL	0.026
PFBS	<RL	0.054
PFPeS	<RL	0.017
PFHxS	0.0366 ± 0.0042	0.017
PFHpS	<RL	0.018
PFOS	<RL	0.056
PFNS	<RL	0.035
PFDS	<RL	0.036
FASA (NV, SV)		
FBSA (NV)	<RL	0.018
MeFBSA (SV)	<RL	0.169
FHxSA (NV)	<RL	0.018
FOSA (NV)	<RL	0.018
MeFOSA (SV)	<RL	0.422
EtFOSA (SV)	<RL	0.423
FASAA (NV)		
FOSAA	<RL	0.018
MeFOSAA	<RL	0.082
EtFOSAA	<RL	0.036
FASE (SV)		
MeFOSE	<RL	0.425
EtFOSE	<RL	0.878

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.017
PF4OPeA	<RL	0.018
PF5OHxA	<RL	0.017
3-6-OPFHpA	<RL	0.017
HFPO-DA	<RL	0.175
ADONA	<RL	0.017
9Cl-PF3ONS	<RL	0.033
11Cl-PF3OUdS	<RL	0.015
n:2 FTAcr (V)		
8:2 FTAcr	<RL	33.1
10:2 FTAcr	<RL	15.6
n:2 FTMAC (V)		
6:2 FTMAC	<RL	55.3
8:2 FTMAC	<RL	56.6
10:2 FTMAC	<RL	29.8
n:2 FTOAc (V)		
8:2 FTOAc	<RL	32.3
10:2 FTOAc	<RL	16.2
n:2 FTOH (V)		
4:2 FTOH	<RL	84.2
5:2 FTOH	<RL	80.1
6:2 FTOH	34.8 ± 7.9	31.0
7:2 FTOH	<RL	79.7
8:2 FTOH	<RL	148
10:2 FTOH	<RL	80.1
n:2 FTS (NV)		
4:2 FTS	<RL	3.10
6:2 FTS	No Value	
8:2 FTS	<RL	0.079
10:2 FTS	<RL	0.017

Table 28. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-ASC following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.136
PFPeA	0.080 ± 0.016	0.050
PFHxA	<RL	0.682
PFHpA	<RL	2.87
PFOA	0.158 ± 0.028	0.113
PFNA	<RL	0.077
PFDA	0.13155 ± 0.00094	0.120
PFUnDA	0.046 ± 0.011	0.026
PFDoDA	0.0349 ± 0.0039	0.026
PFTrDA	<RL	0.077
PFTeDA	<RL	0.062
PFSA (NV)		
PFPrS	<RL	0.024
PFBS	0.0353 ± 0.0084	0.023
PFPeS	<RL	0.025
PFHxS	<RL	0.024
PFHpS	0.063 ± 0.026	0.025
PFOS	0.170 ± 0.079	0.068
PFNS	<RL	0.025
PFDS	0.050 ± 0.017	0.025
FASA (NV, SV)		
FBSA (NV)	<RL	0.026
MeFBSA (SV)	<RL	0.719
FHxSA (NV)	<RL	0.026
FOSA (NV)	<RL	0.030
MeFOSA (SV)	<RL	0.344
EtFOSA (SV)	<RL	0.143
FASAA (NV)		
FOSAA	<RL	0.134
MeFOSAA	<RL	0.136
EtFOSAA	<RL	0.164
FASE (SV)		
MeFOSE	<RL	0.144
EtFOSE	<RL	0.340

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.021
PF4OPeA	<RL	0.024
PF5OHxA	<RL	0.024
3-6-OPFHpA	<RL	0.024
HFPO-DA	<RL	0.105
ADONA	<RL	0.024
9Cl-PF3ONS	<RL	0.024
11Cl-PF3OUdS	<RL	0.025
n:2 FTAcr (V)		
8:2 FTAcr	<RL	13.7
10:2 FTAcr	<RL	13.3
n:2 FTMAC (V)		
6:2 FTMAC	196 ± 67	47.0
8:2 FTMAC	<RL	48.1
10:2 FTMAC	<RL	25.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	13.4
10:2 FTOAc	<RL	13.8
n:2 FTOH (V)		
4:2 FTOH	<RL	28.1
5:2 FTOH	<RL	68.1
6:2 FTOH	129 ± 35	68.6
7:2 FTOH	<RL	67.8
8:2 FTOH	<RL	67.1
10:2 FTOH	<RL	138
n:2 FTS (NV)		
4:2 FTS	2.62 ± 0.30	0.593
6:2 FTS	No Value	
8:2 FTS	<RL	0.131
10:2 FTS	<RL	0.029

Table 29. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-ASC.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	1.05
PFPeA	<RL	0.255
PFHxA	<RL	0.255
PFHpA	<RL	1.35
PFOA	<RL	0.479
PFNA	<RL	0.255
PFDA	<RL	0.528
PFUnDA	<RL	0.255
PFDoDA	<RL	0.255
PFTrDA	<RL	0.098
PFTeDA	<RL	0.098
PFSA (NV)		
PFPrS	<RL	0.044
PFBS	0.23 ± 0.27	0.044
PFPeS	<RL	0.045
PFHxS	<RL	0.090
PFHpS	<RL	0.046
PFOS	<RL	0.237
PFNS	<RL	0.095
PFDS	<RL	0.046
FASA (NV, SV)		
FBSA (NV)	0.145 ± 0.038	0.098
MeFBSA (SV)	<RL	0.455
FHxSA (NV)	<RL	0.048
FOSA (NV)	<RL	0.129
MeFOSA (SV)	<RL	0.183
EtFOSA (SV)	<RL	0.454
FASAA (NV)		
FOSAA	<RL	0.255
MeFOSAA	<RL	0.255
EtFOSAA	<RL	0.255
FASE (SV)		
MeFOSE	<RL	0.184
EtFOSE	<RL	0.182

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.049
PF4OPeA	<RL	0.232
PF5OHxA	<RL	0.089
3-6-OPFHpA	<RL	0.039
HFPO-DA	<RL	0.528
ADONA	<RL	0.040
9Cl-PF3ONS	<RL	0.039
11Cl-PF3OUdS	<RL	0.040
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.7
10:2 FTAcr	<RL	15.1
n:2 FTMAC (V)		
6:2 FTMAC	95.9 ± 3.5	67.4
8:2 FTMAC	<RL	69.0
10:2 FTMAC	<RL	36.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.5
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	77.2
5:2 FTOH	<RL	29.9
6:2 FTOH	<RL	79.0
7:2 FTOH	<RL	30.6
8:2 FTOH	<RL	115
10:2 FTOH	<RL	78.5
n:2 FTS (NV)		
4:2 FTS	<RL	0.092
6:2 FTS	<RL	0.502
8:2 FTS	<RL	0.507
10:2 FTS	<RL	0.101

Table 30. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-ASC.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	<RL	0.847	**PFEESA**	<RL	0.021
PFPeA	<RL	0.027	**PF4OPeA**	<RL	0.024
PFHxA	<RL	0.136	**PF5OHxA**	<RL	0.024
PFHpA	<RL	0.515	**3-6-OPFHpA**	<RL	0.024
PFOA	<RL	0.143	**HFPO-DA**	<RL	0.042
PFNA	<RL	0.027	**ADONA**	<RL	0.024
PFDA	<RL	0.080	**9Cl-PF3ONS**	<RL	0.025
PFUnDA	<RL	0.041	**11Cl-PF3OUdS**	<RL	0.025
PFDoDA	<RL	0.027			
PFTrDA	<RL	0.078	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.049	**8:2 FTAcr**	<RL	18.6
			10:2 FTAcr	<RL	35.8
PFSA (NV)					
PFPrS	<RL	0.027	***n:2 FTMAC (V)***		
PFBS	<RL	0.024	**6:2 FTMAC**	151 ± 18	79.9
PFPeS	<RL	0.025	**8:2 FTMAC**	<RL	81.7
PFHxS	<RL	0.061	**10:2 FTMAC**	<RL	43.1
PFHpS	<RL	0.025			
PFOS	<RL	0.050	***n:2 FTOAc (V)***		
PFNS	<RL	0.026	**8:2 FTOAc**	<RL	18.3
PFDS	<RL	1.33	**10:2 FTOAc**	No Value	
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	<RL	0.027	**4:2 FTOH**	<RL	92.1
MeFBSA (SV)	<RL	0.783	**5:2 FTOH**	<RL	91.0
FHxSA (NV)	<RL	0.054	**6:2 FTOH**	<RL	93.7
FOSA (NV)	<RL	0.054	**7:2 FTOH**	<RL	36.1
MeFOSA (SV)	<RL	0.142	**8:2 FTOH**	<RL	90.3
EtFOSA (SV)	<RL	0.150	**10:2 FTOH**	<RL	93.6
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.053	**4:2 FTS**	No Value	
MeFOSAA	<RL	0.027	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.054	**8:2 FTS**	<RL	0.122
			10:2 FTS	<RL	0.121
FASE (SV)					
MeFOSE	<RL	0.069			
EtFOSE	<RL	0.148			

Table 31. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	5.453 ± 0.081	0.382	**PFEESA**	<RL	0.014
PFPeA	5.37 ± 0.21	0.122	**PF4OPeA**	<RL	0.015
PFHxA	8.49 ± 0.50	0.21	**PF5OHxA**	<RL	0.014
PFHpA	2.58 ± 0.22	0.217	**3-6-OPFHpA**	<RL	0.014
PFOA	<RL	0.105	**HFPO-DA**	<RL	0.144
PFNA	<RL	0.015	**ADONA**	<RL	0.014
PFDA	<RL	0.098	**9Cl-PF3ONS**	<RL	0.027
PFUnDA	<RL	0.036	**11Cl-PF3OUdS**	<RL	0.012
PFDoDA	<RL	0.052			
PFTrDA	<RL	0.072	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.101	**8:2 FTAcr**	<RL	25.7
			10:2 FTAcr	<RL	12.1
PFSA (NV)					
PFPrS	<RL	0.021	***n:2 FTMAC (V)***		
PFBS	0.211 ± 0.038	0.045	**6:2 FTMAC**	2210 ± 370	42.9
PFPeS	<RL	0.014	**8:2 FTMAC**	<RL	43.9
PFHxS	<RL	0.014	**10:2 FTMAC**	<RL	23.1
PFHpS	<RL	0.014			
PFOS	0.1184 ± 0.0037	0.046	***n:2 FTOAc (V)***		
PFNS	<RL	0.029	**8:2 FTOAc**	<RL	25.0
PFDS	0.115 ± 0.059	0.03	**10:2 FTOAc**	<RL	12.6
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	0.072 ± 0.015	0.015	**4:2 FTOH**	<RL	65.3
MeFBSA (SV)	<RL	0.131	**5:2 FTOH**	<RL	62.1
FHxSA (NV)	<RL	0.015	**6:2 FTOH**	784 ± 26	24.0
FOSA (NV)	0.0440 ± 0.0094	0.015	**7:2 FTOH**	<RL	61.9
MeFOSA (SV)	<RL	0.327	**8:2 FTOH**	<RL	115
EtFOSA (SV)	<RL	0.328	**10:2 FTOH**	<RL	62.2
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.015	**4:2 FTS**	<RL	2.55
MeFOSAA	<RL	0.068	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.030	**8:2 FTS**	No Value	
			10:2 FTS	No Value	
FASE (SV)					
MeFOSE	<RL	0.329			
EtFOSE	<RL	0.681			

Table 32. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-B following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.37 ± 0.12	0.116
PFPeA	2.632 ± 0.070	0.043
PFHxA	5.789 ± 0.070	0.582
PFHpA	<RL	2.45
PFOA	<RL	0.096
PFNA	<RL	0.066
PFDA	<RL	0.103
PFUnDA	<RL	0.022
PFDoDA	<RL	0.022
PFTrDA	<RL	0.066
PFTeDA	<RL	0.053
PFSA (NV)		
PFPrS	0.0306 ± 0.0053	0.020
PFBS	<RL	0.020
PFPeS	<RL	0.021
PFHxS	<RL	0.020
PFHpS	<RL	0.021
PFOS	<RL	0.058
PFNS	<RL	0.022
PFDS	<RL	0.022
FASA (NV, SV)		
FBSA (NV)	<RL	0.022
MeFBSA (SV)	<RL	1.01
FHxSA (NV)	<RL	0.022
FOSA (NV)	<RL	0.026
MeFOSA (SV)	<RL	0.482
EtFOSA (SV)	<RL	0.201
FASAA (NV)		
FOSAA	<RL	0.114
MeFOSAA	<RL	0.116
EtFOSAA	<RL	0.140
FASE (SV)		
MeFOSE	<RL	0.202
EtFOSE	<RL	0.477
PPEA (NV)		
PFEESA	<RL	0.018
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.020
3-6-OPFHpA	<RL	0.020
HFPO-DA	<RL	0.090
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.021
11Cl-PF3OUdS	<RL	0.021
n:2 FTAcr (V)		
8:2 FTAcr	<RL	19.4
10:2 FTAcr	<RL	18.8
n:2 FTMAC (V)		
6:2 FTMAC	3410 ± 860	66.5
8:2 FTMAC	<RL	68.1
10:2 FTMAC	<RL	35.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	18.9
10:2 FTOAc	<RL	19.5
n:2 FTOH (V)		
4:2 FTOH	<RL	39.7
5:2 FTOH	<RL	96.2
6:2 FTOH	1000 ± 160	97.0
7:2 FTOH	<RL	95.8
8:2 FTOH	<RL	94.8
10:2 FTOH	<RL	196
n:2 FTS (NV)		
4:2 FTS	<RL	0.507
6:2 FTS	No Value	
8:2 FTS	<RL	0.112
10:2 FTS	<RL	0.024

Table 33. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.03 ± 0.19	0.457
PFPeA	1.25 ± 0.28	0.26
PFHxA	8.1 ± 1.6	0.761
PFHpA	0.69 ± 0.16	0.142
PFOA	<RL	0.294
PFNA	<RL	0.136
PFDA	<RL	0.130
PFUnDA	<RL	0.114
PFDoDA	<RL	0.044
PFTrDA	0.077 ± 0.029	0.044
PFTeDA	<RL	0.033
PFSA (NV)		
PFPrS	<RL	0.135
PFBS	<RL	0.141
PFPeS	<RL	0.105
PFHxS	<RL	0.104
PFHpS	<RL	0.095
PFOS	<RL	0.060
PFNS	<RL	0.047
PFDS	<RL	0.042
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.385
FHxSA (NV)	<RL	0.049
FOSA (NV)	<RL	0.071
MeFOSA (SV)	<RL	0.155
EtFOSA (SV)	<RL	0.385
FASAA (NV)		
FOSAA	<RL	0.044
MeFOSAA	<RL	0.114
EtFOSAA	<RL	0.114
FASE (SV)		
MeFOSE	<RL	0.156
EtFOSE	<RL	0.154

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.237
PF4OPeA	<RL	0.141
PF5OHxA	<RL	0.102
3-6-OPFHpA	<RL	0.076
HFPO-DA	<RL	0.147
ADONA	<RL	0.104
9Cl-PF3ONS	<RL	0.078
11Cl-PF3OUdS	<RL	0.020
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.9
10:2 FTAcr	<RL	15.3
n:2 FTMAC (V)		
6:2 FTMAC	610 ± 100	143
8:2 FTMAC	<RL	69.9
10:2 FTMAC	<RL	36.8
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.7
10:2 FTOAc	<RL	42.8
n:2 FTOH (V)		
4:2 FTOH	<RL	78.3
5:2 FTOH	<RL	30.3
6:2 FTOH	250 ± 100	80.1
7:2 FTOH	<RL	31.0
8:2 FTOH	<RL	117
10:2 FTOH	<RL	79.6
n:2 FTS (NV)		
4:2 FTS	<RL	0.062
6:2 FTS	No Value	
8:2 FTS	<RL	0.109
10:2 FTS	<RL	0.220

Table 34. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.743
PFPeA	1.80 ± 0.72	0.023
PFHxA	15.6 ± 4.3	0.119
PFHpA	26.4 ± 7.6	0.452
PFOA	<RL	0.126
PFNA	0.0580 ± 0.0018	0.024
PFDA	<RL	0.070
PFUnDA	0.0462 ± 0.0017	0.036
PFDoDA	<RL	0.023
PFTrDA	<RL	0.068
PFTeDA	<RL	0.043
PFSA (NV)		
PFPrS	<RL	0.024
PFBS	0.067 ± 0.031	0.021
PFPeS	<RL	0.022
PFHxS	<RL	0.053
PFHpS	<RL	0.022
PFOS	<RL	0.044
PFNS	0.0326 ± 0.0077	0.022
PFDS	<RL	1.16
FASA (NV, SV)		
FBSA (NV)	<RL	0.023
MeFBSA (SV)	<RL	1.08
FHxSA (NV)	<RL	0.048
FOSA (NV)	0.064 ± 0.015	0.048
MeFOSA (SV)	<RL	0.196
EtFOSA (SV)	<RL	0.207
FASAA (NV)		
FOSAA	<RL	0.047
MeFOSAA	<RL	0.023
EtFOSAA	<RL	0.048
FASE (SV)		
MeFOSE	<RL	0.095
EtFOSE	<RL	0.204

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.021
PF5OHxA	<RL	0.021
3-6-OPFHpA	<RL	0.021
HFPO-DA	<RL	0.037
ADONA	<RL	0.021
9Cl-PF3ONS	<RL	0.022
11Cl-PF3OUdS	<RL	0.022
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.6
10:2 FTAcr	<RL	29.9
n:2 FTMAC (V)		
6:2 FTMAC	3060 ± 340	66.7
8:2 FTMAC	<RL	68.2
10:2 FTMAC	<RL	35.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.3
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	76.8
5:2 FTOH	<RL	75.9
6:2 FTOH	1130 ± 100	78.2
7:2 FTOH	<RL	30.1
8:2 FTOH	<RL	75.3
10:2 FTOH	<RL	78.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.063
6:2 FTS	1.26 ± 0.13	0.636
8:2 FTS	<RL	0.107
10:2 FTS	<RL	0.106

Table 35. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	16 ± 4.4	0.405	**PFEESA**	<RL	0.015
PFPeA	16.3 ± 5.0	0.129	**PF4OPeA**	<RL	0.016
PFHxA	14.1 ± 2.9	0.222	**PF5OHxA**	<RL	0.014
PFHpA	3.53 ± 0.3	0.230	**3-6-OPFHpA**	<RL	0.015
PFOA	<RL	0.111	**HFPO-DA**	<RL	0.152
PFNA	<RL	0.016	**ADONA**	<RL	0.014
PFDA	<RL	0.104	**9Cl-PF3ONS**	<RL	0.029
PFUnDA	<RL	0.038	**11Cl-PF3OUdS**	<RL	0.013
PFDoDA	<RL	0.055			
PFTrDA	<RL	0.076	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.107	**8:2 FTAcr**	<RL	26.5
			10:2 FTAcr	<RL	12.5
PFSA (NV)					
PFPrS	<RL	0.022	***n:2 FTMAC (V)***		
PFBS	0.207 ± 0.077	0.047	**6:2 FTMAC**	3200 ± 320	44.2
PFPeS	<RL	0.015	**8:2 FTMAC**	<RL	45.2
PFHxS	<RL	0.015	**10:2 FTMAC**	<RL	23.8
PFHpS	<RL	0.015			
PFOS	0.0565 ± 0.0019	0.049	***n:2 FTOAc (V)***		
PFNS	<RL	0.031	**8:2 FTOAc**	<RL	25.8
PFDS	<RL	0.031	**10:2 FTOAc**	<RL	13.0
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	0.183 ± 0.010	0.016	**4:2 FTOH**	<RL	67.2
MeFBSA (SV)	<RL	0.134	**5:2 FTOH**	<RL	63.9
FHxSA (NV)	<RL	0.016	**6:2 FTOH**	1220 ± 190	24.7
FOSA (NV)	0.0591 ± 0.0022	0.016	**7:2 FTOH**	<RL	63.7
MeFOSA (SV)	<RL	0.336	**8:2 FTOH**	<RL	118
EtFOSA (SV)	<RL	0.337	**10:2 FTOH**	<RL	64.0
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.016	**4:2 FTS**	No Value	
MeFOSAA	<RL	0.072	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.032	**8:2 FTS**	<RL	0.069
			10:2 FTS	No Value	
FASE (SV)					
MeFOSE	<RL	0.338			
EtFOSE	<RL	0.699			

Table 36. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-C following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	2.39 ± 0.15	0.124	**PFEESA**	<RL	0.019
PFPeA	3.33 ± 0.10	0.045	**PF4OPeA**	<RL	0.021
PFHxA	4.99 ± 0.42	0.619	**PF5OHxA**	<RL	0.021
PFHpA	<RL	2.60	**3-6-OPFHpA**	<RL	0.021
PFOA	<RL	0.102	**HFPO-DA**	<RL	0.096
PFNA	<RL	0.070	**ADONA**	<RL	0.021
PFDA	<RL	0.109	**9Cl-PF3ONS**	<RL	0.022
PFUnDA	<RL	0.024	**11Cl-PF3OUdS**	<RL	0.022
PFDoDA	<RL	0.024			
PFTrDA	<RL	0.070	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.056	**8:2 FTAcr**	<RL	16.5
			10:2 FTAcr	<RL	15.9
PFSA (NV)					
PFPrS	0.0232 ± 0.0038	0.021	***n:2 FTMAC (V)***		
PFBS	0.130 ± 0.036	0.021	**6:2 FTMAC**	5570 ± 330	56.5
PFPeS	<RL	0.022	**8:2 FTMAC**	<RL	57.8
PFHxS	<RL	0.022	**10:2 FTMAC**	<RL	30.4
PFHpS	<RL	0.023			
PFOS	<RL	0.062	***n:2 FTOAc (V)***		
PFNS	<RL	0.023	**8:2 FTOAc**	<RL	16.1
PFDS	<RL	0.023	**10:2 FTOAc**	<RL	16.6
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	<RL	0.024	**4:2 FTOH**	<RL	33.7
MeFBSA (SV)	<RL	0.856	**5:2 FTOH**	<RL	81.7
FHxSA (NV)	<RL	0.024	**6:2 FTOH**	1360 ± 110	82.3
FOSA (NV)	<RL	0.027	**7:2 FTOH**	<RL	81.4
MeFOSA (SV)	<RL	0.409	**8:2 FTOH**	<RL	80.5
EtFOSA (SV)	<RL	0.171	**10:2 FTOH**	<RL	166
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.122	**4:2 FTS**	<RL	0.539
MeFOSAA	<RL	0.124	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.149	**8:2 FTS**	<RL	0.119
			10:2 FTS	<RL	0.026
FASE (SV)					
MeFOSE	<RL	0.171			
EtFOSE	<RL	0.405			

Table 37. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.20 ± 0.11	0.551
PFPeA	2.53 ± 0.23	0.313
PFHxA	13.04 ± 0.59	0.918
PFHpA	1.81 ± 0.17	0.172
PFOA	<RL	0.354
PFNA	<RL	0.164
PFDA	<RL	0.156
PFUnDA	<RL	0.137
PFDoDA	<RL	0.053
PFTrDA	0.116 ± 0.031	0.053
PFTeDA	<RL	0.040
PFSA (NV)		
PFPrS	<RL	0.163
PFBS	<RL	0.170
PFPeS	<RL	0.127
PFHxS	<RL	0.125
PFHpS	<RL	0.114
PFOS	<RL	0.072
PFNS	<RL	0.057
PFDS	<RL	0.051
FASA (NV, SV)		
FBSA (NV)	<RL	0.077
MeFBSA (SV)	<RL	0.411
FHxSA (NV)	<RL	0.059
FOSA (NV)	<RL	0.085
MeFOSA (SV)	<RL	0.165
EtFOSA (SV)	<RL	0.410
FASAA (NV)		
FOSAA	<RL	0.053
MeFOSAA	<RL	0.137
EtFOSAA	<RL	0.137
FASE (SV)		
MeFOSE	<RL	0.166
EtFOSE	<RL	0.164
PPEA (NV)		
PFEESA	<RL	0.286
PF4OPeA	<RL	0.169
PF5OHxA	<RL	0.123
3-6-OPFHpA	<RL	0.092
HFPO-DA	<RL	0.177
ADONA	<RL	0.126
9Cl-PF3ONS	<RL	0.094
11Cl-PF3OUdS	<RL	0.024
n:2 FTAcr (V)		
8:2 FTAcr	<RL	12.7
10:2 FTAcr	<RL	12.2
n:2 FTMAC (V)		
6:2 FTMAC	1293 ± 42	54.6
8:2 FTMAC	<RL	55.8
10:2 FTMAC	<RL	29.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	12.5
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	62.5
5:2 FTOH	<RL	24.2
6:2 FTOH	223 ± 25	64.0
7:2 FTOH	<RL	24.8
8:2 FTOH	<RL	93.2
10:2 FTOH	<RL	63.5
n:2 FTS (NV)		
4:2 FTS	<RL	0.075
6:2 FTS	<RL	13.9
8:2 FTS	<RL	0.131
10:2 FTS	<RL	0.265

Table 38. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.774
PFPeA	0.67 ± 0.15	0.024
PFHxA	5.80 ± 0.83	0.124
PFHpA	4.5 ± 1.5	0.470
PFOA	<RL	0.131
PFNA	<RL	0.025
PFDA	<RL	0.073
PFUnDA	<RL	0.037
PFDoDA	<RL	0.024
PFTrDA	<RL	0.071
PFTeDA	<RL	0.045
PFSA (NV)		
PFPrS	<RL	0.025
PFBS	<RL	0.022
PFPeS	<RL	0.023
PFHxS	<RL	0.056
PFHpS	<RL	0.023
PFOS	<RL	0.046
PFNS	<RL	0.023
PFDS	<RL	1.21
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.935
FHxSA (NV)	<RL	0.050
FOSA (NV)	<RL	0.050
MeFOSA (SV)	<RL	0.170
EtFOSA (SV)	<RL	0.179
FASAA (NV)		
FOSAA	<RL	0.049
MeFOSAA	<RL	0.024
EtFOSAA	<RL	0.050
FASE (SV)		
MeFOSE	<RL	0.083
EtFOSE	<RL	0.177

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.022
PF5OHxA	<RL	0.022
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.039
ADONA	<RL	0.022
9Cl-PF3ONS	<RL	0.023
11Cl-PF3OUdS	<RL	0.023
n:2 FTAcr (V)		
8:2 FTAcr	<RL	18.7
10:2 FTAcr	<RL	36.0
n:2 FTMAC (V)		
6:2 FTMAC	4100 ± 1100	80.2
8:2 FTMAC	<RL	82.0
10:2 FTMAC	<RL	43.2
n:2 FTOAc (V)		
8:2 FTOAc	<RL	18.4
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	92.4
5:2 FTOH	<RL	91.3
6:2 FTOH	1250 ± 350	94.0
7:2 FTOH	<RL	36.2
8:2 FTOH	<RL	90.6
10:2 FTOH	<RL	93.9
n:2 FTS (NV)		
4:2 FTS	<RL	0.066
6:2 FTS	17 ± 20	0.663
8:2 FTS	<RL	0.112
10:2 FTS	<RL	0.110

Table 39. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.99 ± 0.22	0.400
PFPeA	2.42 ± 0.18	0.127
PFHxA	4.099 ± 0.088	0.219
PFHpA	<RL	0.227
PFOA	<RL	0.110
PFNA	<RL	0.016
PFDA	<RL	0.103
PFUnDA	<RL	0.037
PFDoDA	<RL	0.054
PFTrDA	<RL	0.075
PFTeDA	<RL	0.106
PFSA (NV)		
PFPrS	<RL	0.022
PFBS	<RL	0.047
PFPeS	<RL	0.015
PFHxS	<RL	0.015
PFHpS	<RL	0.015
PFOS	<RL	0.048
PFNS	<RL	0.030
PFDS	0.0958 ± 0.0025	0.031
FASA (NV, SV)		
FBSA (NV)	0.0228 ± 0.0034	0.016
MeFBSA (SV)	<RL	0.141
FHxSA (NV)	<RL	0.016
FOSA (NV)	0.0470 ± 0.0056	0.016
MeFOSA (SV)	<RL	0.353
EtFOSA (SV)	<RL	0.354
FASAA (NV)		
FOSAA	<RL	0.016
MeFOSAA	<RL	0.071
EtFOSAA	<RL	0.031
FASE (SV)		
MeFOSE	<RL	0.355
EtFOSE	<RL	0.734

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.015
PF4OPeA	<RL	0.016
PF5OHxA	<RL	0.014
3-6-OPFHpA	<RL	0.015
HFPO-DA	<RL	0.151
ADONA	<RL	0.014
9Cl-PF3ONS	<RL	0.028
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	27.9
10:2 FTAcr	<RL	13.1
n:2 FTMAC (V)		
6:2 FTMAC	5440 ± 560	46.6
8:2 FTMAC	<RL	47.7
10:2 FTMAC	<RL	25.1
n:2 FTOAc (V)		
8:2 FTOAc	<RL	27.2
10:2 FTOAc	<RL	13.7
n:2 FTOH (V)		
4:2 FTOH	<RL	70.9
5:2 FTOH	<RL	67.5
6:2 FTOH	1710 ± 320	26.1
7:2 FTOH	<RL	67.2
8:2 FTOH	<RL	125
10:2 FTOH	<RL	67.5
n:2 FTS (NV)		
4:2 FTS	<RL	2.67
6:2 FTS	No Value	
8:2 FTS	No Value	
10:2 FTS	No Value	

Table 40. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-D following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.77 ± 0.77	0.116
PFPeA	1.888 ± 0.097	0.043
PFHxA	5.79 ± 0.20	0.582
PFHpA	<RL	2.45
PFOA	<RL	0.096
PFNA	<RL	0.066
PFDA	<RL	0.103
PFUnDA	<RL	0.022
PFDoDA	<RL	0.022
PFTrDA	<RL	0.066
PFTeDA	<RL	0.053
PFSA (NV)		
PFPrS	0.1176 ± 0.0050	0.020
PFBS	<RL	0.020
PFPeS	<RL	0.021
PFHxS	<RL	0.020
PFHpS	<RL	0.021
PFOS	<RL	0.058
PFNS	<RL	0.022
PFDS	<RL	0.022
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.797
FHxSA (NV)	No Value	
FOSA (NV)	<RL	0.026
MeFOSA (SV)	<RL	0.381
EtFOSA (SV)	<RL	0.159
FASAA (NV)		
FOSAA	<RL	0.114
MeFOSAA	<RL	0.116
EtFOSAA	<RL	0.140
FASE (SV)		
MeFOSE	<RL	0.160
EtFOSE	<RL	0.377

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.018
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.020
3-6-OPFHpA	<RL	0.020
HFPO-DA	<RL	0.090
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.021
11Cl-PF3OUdS	<RL	0.021
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.3
10:2 FTAcr	<RL	14.7
n:2 FTMAC (V)		
6:2 FTMAC	2670 ± 250	52.3
8:2 FTMAC	<RL	53.5
10:2 FTMAC	<RL	28.2
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.9
10:2 FTOAc	<RL	15.3
n:2 FTOH (V)		
4:2 FTOH	<RL	31.2
5:2 FTOH	<RL	75.6
6:2 FTOH	881 ± 18	76.2
7:2 FTOH	<RL	75.3
8:2 FTOH	<RL	74.5
10:2 FTOH	<RL	154
n:2 FTS (NV)		
4:2 FTS	<RL	0.507
6:2 FTS	No Value	
8:2 FTS	<RL	0.112
10:2 FTS	<RL	0.024

Table 41. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.02 ± 0.33	0.482
PFPeA	1.16 ± 0.10	0.274
PFHxA	11.08 ± 0.50	0.803
PFHpA	0.729 ± 0.017	0.150
PFOA	<RL	0.310
PFNA	<RL	0.143
PFDA	<RL	0.137
PFUnDA	<RL	0.120
PFDoDA	<RL	0.046
PFTrDA	<RL	0.046
PFTeDA	<RL	0.035
PFSA (NV)		
PFPrS	<RL	0.142
PFBS	<RL	0.148
PFPeS	<RL	0.111
PFHxS	<RL	0.109
PFHpS	<RL	0.100
PFOS	0.090 ± 0.012	0.063
PFNS	<RL	0.049
PFDS	<RL	0.044
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.366
FHxSA (NV)	No Value	
FOSA (NV)	<RL	0.075
MeFOSA (SV)	<RL	0.147
EtFOSA (SV)	<RL	0.365
FASAA (NV)		
FOSAA	<RL	0.046
MeFOSAA	<RL	0.120
EtFOSAA	<RL	0.120
FASE (SV)		
MeFOSE	<RL	0.148
EtFOSE	<RL	0.146

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.250
PF4OPeA	<RL	0.148
PF5OHxA	<RL	0.108
3-6-OPFHpA	<RL	0.080
HFPO-DA	<RL	0.155
ADONA	<RL	0.110
9Cl-PF3ONS	<RL	0.082
11Cl-PF3OUdS	<RL	0.021
n:2 FTAcr (V)		
8:2 FTAcr	<RL	12.3
10:2 FTAcr	<RL	11.8
n:2 FTMAC (V)		
6:2 FTMAC	833.9 ± 9.9	115
8:2 FTMAC	<RL	54.0
10:2 FTMAC	<RL	28.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	12.1
10:2 FTOAc	<RL	34.2
n:2 FTOH (V)		
4:2 FTOH	<RL	60.5
5:2 FTOH	<RL	23.4
6:2 FTOH	215 ± 42	61.9
7:2 FTOH	<RL	24.0
8:2 FTOH	<RL	90.2
10:2 FTOH	<RL	61.5
n:2 FTS (NV)		
4:2 FTS	<RL	0.066
6:2 FTS	<RL	12.2
8:2 FTS	<RL	0.115
10:2 FTS	<RL	0.232

Table 42. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.772
PFPeA	0.622 ± 0.067	0.024
PFHxA	No Value	
PFHpA	3.6 ± 1.3	0.469
PFOA	<RL	0.130
PFNA	<RL	0.025
PFDA	<RL	0.073
PFUnDA	<RL	0.037
PFDoDA	<RL	0.024
PFTrDA	<RL	0.071
PFTeDA	<RL	0.045
PFSA (NV)		
PFPrS	<RL	0.025
PFBS	<RL	0.022
PFPeS	<RL	0.023
PFHxS	<RL	0.055
PFHpS	<RL	0.023
PFOS	<RL	0.046
PFNS	0.0252 ± 0.0012	0.023
PFDS	<RL	1.21
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	1.24
FHxSA (NV)	No Value	
FOSA (NV)	<RL	0.050
MeFOSA (SV)	<RL	0.227
EtFOSA (SV)	<RL	0.240
FASAA (NV)		
FOSAA	<RL	0.049
MeFOSAA	<RL	0.024
EtFOSAA	<RL	0.050
FASE (SV)		
MeFOSE	<RL	0.111
EtFOSE	<RL	0.237

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.022
PF5OHxA	<RL	0.022
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.038
ADONA	<RL	0.022
9Cl-PF3ONS	<RL	0.023
11Cl-PF3OUdS	<RL	0.023
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.6
10:2 FTAcr	<RL	28.1
n:2 FTMAC (V)		
6:2 FTMAC	2040 ± 120	170
8:2 FTMAC	<RL	64.1
10:2 FTMAC	<RL	33.8
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.4
10:2 FTOAc	<RL	50.8
n:2 FTOH (V)		
4:2 FTOH	<RL	72.3
5:2 FTOH	<RL	71.4
6:2 FTOH	1160 ± 400	73.5
7:2 FTOH	<RL	28.3
8:2 FTOH	<RL	70.8
10:2 FTOH	<RL	73.4
n:2 FTS (NV)		
4:2 FTS	<RL	0.066
6:2 FTS	No Value	
8:2 FTS	<RL	0.112
10:2 FTS	<RL	0.110

Table 43. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	33.0 ± 4.4	0.411
PFPeA	35.1 ± 5.2	0.131
PFHxA	46.3 ± 3.7	0.226
PFHpA	6.3 ± 0.6	0.233
PFOA	0.539 ± 0.064	0.113
PFNA	0.226 ± 0.033	0.016
PFDA	0.441 ± 0.075	0.106
PFUnDA	0.080 ± 0.026	0.038
PFDoDA	0.081 ± 0.021	0.056
PFTrDA	<RL	0.077
PFTeDA	<RL	0.109
PFSA (NV)		
PFPrS	<RL	0.023
PFBS	0.100 ± 0.014	0.048
PFPeS	<RL	0.015
PFHxS	<RL	0.015
PFHpS	<RL	0.016
PFOS	<RL	0.05
PFNS	<RL	0.031
PFDS	<RL	0.032
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.148
FHxSA (NV)	No Value	
FOSA (NV)	0.034 ± 0.013	0.016
MeFOSA (SV)	<RL	0.370
EtFOSA (SV)	<RL	0.371
FASAA (NV)		
FOSAA	<RL	0.016
MeFOSAA	<RL	0.073
EtFOSAA	<RL	0.032
FASE (SV)		
MeFOSE	<RL	0.372
EtFOSE	<RL	0.769

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.015
PF4OPeA	<RL	0.016
PF5OHxA	<RL	0.015
3-6-OPFHpA	<RL	0.015
HFPO-DA	<RL	0.155
ADONA	<RL	0.015
9Cl-PF3ONS	<RL	0.029
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	29.1
10:2 FTAcr	<RL	13.7
n:2 FTMAC (V)		
6:2 FTMAC	1850 ± 150	48.6
8:2 FTMAC	<RL	49.7
10:2 FTMAC	<RL	26.2
n:2 FTOAc (V)		
8:2 FTOAc	<RL	28.3
10:2 FTOAc	<RL	14.3
n:2 FTOH (V)		
4:2 FTOH	<RL	73.9
5:2 FTOH	<RL	70.3
6:2 FTOH	1016 ± 97	195
7:2 FTOH	<RL	70.1
8:2 FTOH	<RL	130
10:2 FTOH	<RL	70.4
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	0.626 ± 0.072	0.07
10:2 FTS	No Value	

Table 44. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-E following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.387 ± 0.072	0.131
PFPeA	3.278 ± 0.047	0.048
PFHxA	6.94 ± 0.19	0.656
PFHpA	<RL	2.76
PFOA	<RL	0.108
PFNA	<RL	0.074
PFDA	<RL	0.116
PFUnDA	<RL	0.025
PFDoDA	<RL	0.025
PFTrDA	<RL	0.074
PFTeDA	<RL	0.059
PFSA (NV)		
PFPrS	0.0859 ± 0.0075	0.023
PFBS	0.060 ± 0.013	0.022
PFPeS	<RL	0.024
PFHxS	<RL	0.023
PFHpS	<RL	0.024
PFOS	<RL	0.065
PFNS	<RL	0.024
PFDS	<RL	0.024
FASA (NV, SV)		
FBSA (NV)	<RL	0.025
MeFBSA (SV)	<RL	0.749
FHxSA (NV)	<RL	0.025
FOSA (NV)	<RL	0.029
MeFOSA (SV)	<RL	0.358
EtFOSA (SV)	<RL	0.149
FASAA (NV)		
FOSAA	<RL	0.129
MeFOSAA	<RL	0.131
EtFOSAA	<RL	0.157
FASE (SV)		
MeFOSE	<RL	0.150
EtFOSE	<RL	0.354

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.023
PF5OHxA	<RL	0.023
3-6-OPFHpA	<RL	0.023
HFPO-DA	<RL	0.101
ADONA	<RL	0.023
9Cl-PF3ONS	<RL	0.024
11Cl-PF3OUdS	<RL	0.024
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.4
10:2 FTAcr	<RL	13.9
n:2 FTMAC (V)		
6:2 FTMAC	2289 ± 98	49.1
8:2 FTMAC	<RL	50.3
10:2 FTMAC	<RL	26.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.0
10:2 FTOAc	<RL	14.4
n:2 FTOH (V)		
4:2 FTOH	<RL	29.3
5:2 FTOH	<RL	71.1
6:2 FTOH	1050 ± 19	71.6
7:2 FTOH	<RL	70.8
8:2 FTOH	<RL	70.0
10:2 FTOH	<RL	144
n:2 FTS (NV)		
4:2 FTS	<RL	0.571
6:2 FTS	No Value	
8:2 FTS	<RL	0.126
10:2 FTS	0.0577 ± 0.0076	0.027

Table 45. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	3.43 ± 0.30	0.328
PFPeA	4.61 ± 0.21	0.186
PFHxA	50.25 ± 0.46	0.546
PFHpA	4.51 ± 0.21	0.102
PFOA	0.377 ± 0.053	0.211
PFNA	<RL	0.098
PFDA	0.246 ± 0.031	0.093
PFUnDA	<RL	0.081
PFDoDA	0.118 ± 0.012	0.031
PFTrDA	No Value	
PFTeDA	0.049 ± 0.022	0.024
PFSA (NV)		
PFPrS	<RL	0.097
PFBS	<RL	0.101
PFPeS	<RL	0.076
PFHxS	<RL	0.074
PFHpS	<RL	0.068
PFOS	0.149 ± 0.017	0.043
PFNS	No Value	
PFDS	<RL	0.030
FASA (NV, SV)		
FBSA (NV)	<RL	0.046
MeFBSA (SV)	<RL	0.364
FHxSA (NV)	<RL	0.035
FOSA (NV)	<RL	0.051
MeFOSA (SV)	<RL	0.146
EtFOSA (SV)	<RL	0.363
FASAA (NV)		
FOSAA	<RL	0.031
MeFOSAA	<RL	0.081
EtFOSAA	<RL	0.081
FASE (SV)		
MeFOSE	<RL	0.147
EtFOSE	<RL	0.145

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.17
PF4OPeA	<RL	0.101
PF5OHxA	<RL	0.073
3-6-OPFHpA	<RL	0.054
HFPO-DA	<RL	0.106
ADONA	<RL	0.075
9Cl-PF3ONS	<RL	0.056
11Cl-PF3OUdS	<RL	0.015
n:2 FTAcr (V)		
8:2 FTAcr	<RL	11.2
10:2 FTAcr	<RL	10.8
n:2 FTMAC (V)		
6:2 FTMAC	587 ± 45	48.2
8:2 FTMAC	<RL	49.3
10:2 FTMAC	<RL	26.0
n:2 FTOAc (V)		
8:2 FTOAc	<RL	11.1
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	55.2
5:2 FTOH	<RL	21.4
6:2 FTOH	192.1 ± 4.4	56.5
7:2 FTOH	<RL	21.9
8:2 FTOH	<RL	82.3
10:2 FTOH	<RL	56.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.045
6:2 FTS	<RL	8.27
8:2 FTS	0.344 ± 0.069	0.078
10:2 FTS	No Value	

Table 46. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.06 ± 0.17	0.754
PFPeA	1.43 ± 0.10	0.024
PFHxA	7.49 ± 0.23	0.121
PFHpA	2.57 ± 0.49	0.458
PFOA	<RL	0.127
PFNA	0.067 ± 0.023	0.024
PFDA	<RL	0.071
PFUnDA	0.0484 ± 0.0069	0.036
PFDoDA	0.0445 ± 0.0075	0.024
PFTrDA	0.0759 ± 0.0050	0.069
PFTeDA	0.083 ± 0.018	0.044
PFSA (NV)		
PFPrS	<RL	0.024
PFBS	0.108 ± 0.016	0.021
PFPeS	<RL	0.022
PFHxS	<RL	0.054
PFHpS	<RL	0.023
PFOS	<RL	0.045
PFNS	<RL	0.023
PFDS	<RL	1.18
FASA (NV, SV)		
FBSA (NV)	<RL	0.024
MeFBSA (SV)	<RL	0.934
FHxSA (NV)	<RL	0.048
FOSA (NV)	<RL	0.048
MeFOSA (SV)	<RL	0.17
EtFOSA (SV)	<RL	0.179
FASAA (NV)		
FOSAA	<RL	0.047
MeFOSAA	<RL	0.024
EtFOSAA	<RL	0.048
FASE (SV)		
MeFOSE	<RL	0.083
EtFOSE	<RL	0.177

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.021
PF5OHxA	<RL	0.021
3-6-OPFHpA	<RL	0.021
HFPO-DA	<RL	0.038
ADONA	<RL	0.021
9Cl-PF3ONS	<RL	0.022
11Cl-PF3OUdS	<RL	0.022
n:2 FTAcr (V)		
8:2 FTAcr	<RL	23.1
10:2 FTAcr	<RL	44.4
n:2 FTMAC (V)		
6:2 FTMAC	3500 ± 2700	98.9
8:2 FTMAC	<RL	101
10:2 FTMAC	<RL	53.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	22.7
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	114
5:2 FTOH	<RL	113
6:2 FTOH	1050 ± 120	116
7:2 FTOH	<RL	44.7
8:2 FTOH	<RL	112
10:2 FTOH	<RL	116
n:2 FTS (NV)		
4:2 FTS	0.77 ± 0.68	0.064
6:2 FTS	No Value	
8:2 FTS	2.76 ± 0.24	0.109
10:2 FTS	No Value	

Table 47. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-F.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	17.9 ± 1.9	0.384
PFPeA	19.3 ± 2.4	0.122
PFHxA	40.3 ± 1.4	0.211
PFHpA	6.03 ± 0.21	0.218
PFOA	0.423 ± 0.033	0.105
PFNA	0.202 ± 0.015	0.015
PFDA	0.381 ± 0.0071	0.099
PFUnDA	0.0766 ± 0.004	0.036
PFDoDA	0.081 ± 0.021	0.052
PFTrDA	<RL	0.072
PFTeDA	<RL	0.101
PFSA (NV)		
PFPrS	<RL	0.021
PFBS	1.61 ± 0.15	0.045
PFPeS	<RL	0.014
PFHxS	0.09 ± 0.11	0.014
PFHpS	<RL	0.015
PFOS	0.182 ± 0.066	0.046
PFNS	<RL	0.029
PFDS	<RL	0.030
FASA (NV, SV)		
FBSA (NV)	0.226 ± 0.022	0.015
MeFBSA (SV)	<RL	0.149
FHxSA (NV)	<RL	0.015
FOSA (NV)	0.0297 ± 0.0032	0.015
MeFOSA (SV)	<RL	0.372
EtFOSA (SV)	<RL	0.373
FASAA (NV)		
FOSAA	<RL	0.015
MeFOSAA	<RL	0.068
EtFOSAA	<RL	0.030
FASE (SV)		
MeFOSE	<RL	0.374
EtFOSE	<RL	0.774

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.014
PF4OPeA	<RL	0.015
PF5OHxA	<RL	0.014
3-6-OPFHpA	<RL	0.014
HFPO-DA	<RL	0.145
ADONA	<RL	0.014
9Cl-PF3ONS	<RL	0.027
11Cl-PF3OUdS	<RL	0.012
n:2 FTAcr (V)		
8:2 FTAcr	<RL	29.3
10:2 FTAcr	<RL	13.8
n:2 FTMAC (V)		
6:2 FTMAC	2140 ± 750	48.9
8:2 FTMAC	<RL	50
10:2 FTMAC	<RL	26.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	28.5
10:2 FTOAc	<RL	14.4
n:2 FTOH (V)		
4:2 FTOH	<RL	74.4
5:2 FTOH	<RL	70.8
6:2 FTOH	1270 ± 560	27.4
7:2 FTOH	<RL	70.5
8:2 FTOH	<RL	131
10:2 FTOH	<RL	70.8
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	0.327 ± 0.075	0.065
10:2 FTS	No Value	

Table 48 Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-F following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	2.64 ± 0.22	0.115
PFPeA	3.36 ± 0.16	0.042
PFHxA	7.87 ± 0.72	0.577
PFHpA	<RL	2.42
PFOA	<RL	0.095
PFNA	<RL	0.065
PFDA	<RL	0.102
PFUnDA	<RL	0.022
PFDoDA	<RL	0.022
PFTrDA	<RL	0.065
PFTeDA	<RL	0.052
PFSA (NV)		
PFPrS	<RL	0.020
PFBS	0.99 ± 0.11	0.020
PFPeS	<RL	0.021
PFHxS	<RL	0.020
PFHpS	<RL	0.021
PFOS	<RL	0.057
PFNS	<RL	0.021
PFDS	<RL	0.021
FASA (NV, SV)		
FBSA (NV)	<RL	0.022
MeFBSA (SV)	<RL	0.795
FHxSA (NV)	<RL	0.022
FOSA (NV)	<RL	0.025
MeFOSA (SV)	<RL	0.380
EtFOSA (SV)	<RL	0.159
FASAA (NV)		
FOSAA	<RL	0.113
MeFOSAA	<RL	0.115
EtFOSAA	<RL	0.138
FASE (SV)		
MeFOSE	<RL	0.159
EtFOSE	<RL	0.376
PPEA (NV)		
PFEESA	<RL	0.018
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.020
3-6-OPFHpA	<RL	0.020
HFPO-DA	<RL	0.089
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.021
11Cl-PF3OUdS	<RL	0.021
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.2
10:2 FTAcr	<RL	14.7
n:2 FTMAC (V)		
6:2 FTMAC	5250 ± 110	52.2
8:2 FTMAC	<RL	53.4
10:2 FTMAC	<RL	28.1
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.9
10:2 FTOAc	<RL	15.3
n:2 FTOH (V)		
4:2 FTOH	<RL	31.1
5:2 FTOH	<RL	75.5
6:2 FTOH	2026 ± 58	76.1
7:2 FTOH	<RL	75.2
8:2 FTOH	<RL	74.4
10:2 FTOH	<RL	153
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.111
10:2 FTS	<RL	0.024

Table 49. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-F.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.487
PFPeA	0.4569 ± 0.0052	0.277
PFHxA	4.69 ± 0.30	0.811
PFHpA	0.2312 ± 0.0099	0.152
PFOA	<RL	0.313
PFNA	<RL	0.145
PFDA	<RL	0.138
PFUnDA	<RL	0.121
PFDoDA	<RL	0.046
PFTrDA	<RL	0.046
PFTeDA	<RL	0.035
PFSA (NV)		
PFPrS	<RL	0.144
PFBS	<RL	0.150
PFPeS	<RL	0.112
PFHxS	<RL	0.111
PFHpS	<RL	0.101
PFOS	0.2103 ± 0.0073	0.064
PFNS	<RL	0.050
PFDS	0.065 ± 0.019	0.045
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.467
FHxSA (NV)	No Value	
FOSA (NV)	<RL	0.076
MeFOSA (SV)	<RL	0.188
EtFOSA (SV)	<RL	0.465
FASAA (NV)		
FOSAA	<RL	0.046
MeFOSAA	<RL	0.121
EtFOSAA	<RL	0.121
FASE (SV)		
MeFOSE	<RL	0.189
EtFOSE	<RL	0.186

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.253
PF4OPeA	<RL	0.150
PF5OHxA	<RL	0.109
3-6-OPFHpA	<RL	0.081
HFPO-DA	<RL	0.157
ADONA	<RL	0.111
9Cl-PF3ONS	<RL	0.083
11Cl-PF3OUdS	<RL	0.022
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.5
10:2 FTAcr	<RL	13.9
n:2 FTMAC (V)		
6:2 FTMAC	1007 ± 48	62.1
8:2 FTMAC	<RL	63.6
10:2 FTMAC	<RL	33.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.3
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	71.2
5:2 FTOH	<RL	27.6
6:2 FTOH	137.9 ± 7.4	72.8
7:2 FTOH	<RL	28.2
8:2 FTOH	<RL	106
10:2 FTOH	<RL	72.3
n:2 FTS (NV)		
4:2 FTS	<RL	0.066
6:2 FTS	No Value	
8:2 FTS	<RL	0.116
10:2 FTS	<RL	0.234

Table 50. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-F.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	3.75 ± 0.47	0.793
PFPeA	7.11 ± 0.88	0.025
PFHxA	26.7 ± 2.7	0.127
PFHpA	18.3 ± 2.1	0.482
PFOA	<RL	0.134
PFNA	0.158 ± 0.028	0.025
PFDA	<RL	0.075
PFUnDA	0.090 ± 0.016	0.038
PFDoDA	0.064 ± 0.021	0.025
PFTrDA	<RL	0.073
PFTeDA	<RL	0.046
PFSA (NV)		
PFPrS	<RL	0.025
PFBS	0.058 ± 0.028	0.022
PFPeS	<RL	0.023
PFHxS	<RL	0.057
PFHpS	<RL	0.024
PFOS	<RL	0.047
PFNS	<RL	0.024
PFDS	<RL	1.24
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	1.24
FHxSA (NV)	<RL	0.051
FOSA (NV)	0.05524 ± 0.00095	0.051
MeFOSA (SV)	<RL	0.225
EtFOSA (SV)	<RL	0.237
FASAA (NV)		
FOSAA	<RL	0.050
MeFOSAA	<RL	0.025
EtFOSAA	<RL	0.051
FASE (SV)		
MeFOSE	<RL	0.109
EtFOSE	<RL	0.235

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.022
PF5OHxA	<RL	0.022
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.040
ADONA	<RL	0.022
9Cl-PF3ONS	<RL	0.023
11Cl-PF3OUdS	<RL	0.024
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.8
10:2 FTAcr	<RL	28.5
n:2 FTMAC (V)		
6:2 FTMAC	2440 ± 290	63.6
8:2 FTMAC	<RL	65.1
10:2 FTMAC	<RL	34.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.6
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	73.3
5:2 FTOH	<RL	72.5
6:2 FTOH	1042 ± 76	74.6
7:2 FTOH	<RL	28.7
8:2 FTOH	<RL	71.9
10:2 FTOH	<RL	74.5
n:2 FTS (NV)		
4:2 FTS	<RL	0.068
6:2 FTS	9.8 ± 2.6	0.679
8:2 FTS	1.06 ± 0.34	0.115
10:2 FTS	0.69 ± 0.17	0.113

Table 51. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-FSC.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.534
PFPeA	<RL	0.170
PFHxA	<RL	0.293
PFHpA	<RL	0.302
PFOA	<RL	0.146
PFNA	<RL	0.021
PFDA	<RL	0.137
PFUnDA	<RL	0.050
PFDoDA	<RL	0.072
PFTrDA	<RL	0.100
PFTeDA	<RL	0.141
PFSA (NV)		
PFPrS	<RL	0.030
PFBS	<RL	0.063
PFPeS	<RL	0.020
PFHxS	0.0295 ± 0.0022	0.019
PFHpS	<RL	0.020
PFOS	<RL	0.064
PFNS	<RL	0.040
PFDS	<RL	0.041
FASA (NV, SV)		
FBSA (NV)	<RL	0.021
MeFBSA (SV)	<RL	0.140
FHxSA (NV)	<RL	0.021
FOSA (NV)	0.035 ± 0.011	0.021
MeFOSA (SV)	<RL	0.350
EtFOSA (SV)	<RL	0.351
FASAA (NV)		
FOSAA	<RL	0.021
MeFOSAA	<RL	0.095
EtFOSAA	<RL	0.042
FASE (SV)		
MeFOSE	<RL	0.352
EtFOSE	<RL	0.728

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.021
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.020
HFPO-DA	<RL	0.201
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.038
11Cl-PF3OUdS	<RL	0.017
n:2 FTAcr (V)		
8:2 FTAcr	<RL	27.6
10:2 FTAcr	<RL	13.0
n:2 FTMAC (V)		
6:2 FTMAC	<RL	46.1
8:2 FTMAC	<RL	47.2
10:2 FTMAC	<RL	24.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	26.9
10:2 FTOAc	<RL	13.5
n:2 FTOH (V)		
4:2 FTOH	<RL	70.2
5:2 FTOH	<RL	66.7
6:2 FTOH	<RL	25.8
7:2 FTOH	<RL	66.5
8:2 FTOH	<RL	123
10:2 FTOH	<RL	66.8
n:2 FTS (NV)		
4:2 FTS	<RL	3.57
6:2 FTS	No Value	
8:2 FTS	<RL	0.091
10:2 FTS	No Value	

Table 52. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-FSC following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.985
PFPeA	<RL	0.241
PFHxA	<RL	0.241
PFHpA	<RL	1.28
PFOA	<RL	0.112
PFNA	<RL	0.077
PFDA	<RL	0.120
PFUnDA	<RL	0.026
PFDoDA	<RL	0.026
PFTrDA	<RL	0.077
PFTeDA	<RL	0.061
PFSA (NV)		
PFPrS	<RL	0.023
PFBS	<RL	0.023
PFPeS	<RL	0.025
PFHxS	<RL	0.024
PFHpS	<RL	0.025
PFOS	<RL	0.068
PFNS	<RL	0.025
PFDS	<RL	0.025
FASA (NV, SV)		
FBSA (NV)	<RL	0.093
MeFBSA (SV)	<RL	0.635
FHxSA (NV)	<RL	0.045
FOSA (NV)	<RL	0.122
MeFOSA (SV)	<RL	0.304
EtFOSA (SV)	<RL	0.127
FASAA (NV)		
FOSAA	<RL	0.134
MeFOSAA	<RL	0.136
EtFOSAA	<RL	0.163
FASE (SV)		
MeFOSE	<RL	0.127
EtFOSE	<RL	0.300

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.021
PF4OPeA	<RL	0.046
PF5OHxA	<RL	0.219
3-6-OPFHpA	<RL	0.084
HFPO-DA	<RL	0.497
ADONA	<RL	0.023
9Cl-PF3ONS	<RL	0.024
11Cl-PF3OUdS	<RL	0.025
n:2 FTAcr (V)		
8:2 FTAcr	<RL	12.1
10:2 FTAcr	<RL	11.7
n:2 FTMAC (V)		
6:2 FTMAC	80 ± 13	41.5
8:2 FTMAC	<RL	42.5
10:2 FTMAC	<RL	22.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	11.8
10:2 FTOAc	<RL	12.2
n:2 FTOH (V)		
4:2 FTOH	<RL	24.8
5:2 FTOH	<RL	60.1
6:2 FTOH	87.5 ± 8.3	60.5
7:2 FTOH	<RL	59.8
8:2 FTOH	<RL	59.2
10:2 FTOH	<RL	122
n:2 FTS (NV)		
4:2 FTS	<RL	0.087
6:2 FTS	0.519 ± 0.049	0.473
8:2 FTS	<RL	0.131
10:2 FTS	<RL	0.028

Table 53. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-FSC.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.991
PFPeA	<RL	0.242
PFHxA	<RL	0.242
PFHpA	<RL	1.28
PFOA	<RL	0.454
PFNA	<RL	0.242
PFDA	<RL	0.500
PFUnDA	<RL	0.242
PFDoDA	<RL	0.242
PFTrDA	<RL	0.093
PFTeDA	<RL	0.093
PFSA (NV)		
PFPrS	<RL	0.042
PFBS	<RL	0.042
PFPeS	<RL	0.043
PFHxS	<RL	0.085
PFHpS	<RL	0.043
PFOS	<RL	0.225
PFNS	<RL	0.09
PFDS	<RL	0.044
FASA (NV, SV)		
FBSA (NV)	<RL	0.093
MeFBSA (SV)	<RL	0.448
FHxSA (NV)	<RL	0.046
FOSA (NV)	<RL	0.122
MeFOSA (SV)	<RL	0.180
EtFOSA (SV)	<RL	0.447
FASAA (NV)		
FOSAA	<RL	0.242
MeFOSAA	<RL	0.242
EtFOSAA	<RL	0.242
FASE (SV)		
MeFOSE	<RL	0.181
EtFOSE	<RL	0.179

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.047
PF4OPeA	<RL	0.22
PF5OHxA	<RL	0.085
3-6-OPFHpA	<RL	0.037
HFPO-DA	<RL	0.50
ADONA	<RL	0.037
9Cl-PF3ONS	<RL	0.037
11Cl-PF3OUdS	<RL	0.038
n:2 FTAcr (V)		
8:2 FTAcr	<RL	16.5
10:2 FTAcr	<RL	15.8
n:2 FTMAC (V)		
6:2 FTMAC	69 ± 12	70.6
8:2 FTMAC	<RL	72.2
10:2 FTMAC	<RL	38.0
n:2 FTOAc (V)		
8:2 FTOAc	<RL	16.2
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	80.9
5:2 FTOH	<RL	31.3
6:2 FTOH	<RL	82.7
7:2 FTOH	<RL	32.1
8:2 FTOH	<RL	121
10:2 FTOH	<RL	82.2
n:2 FTS (NV)		
4:2 FTS	<RL	0.087
6:2 FTS	<RL	0.476
8:2 FTS	<RL	0.480
10:2 FTS	<RL	0.096

Table 54. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-FSC.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.901
PFPeA	<RL	0.028
PFHxA	<RL	0.145
PFHpA	<RL	0.547
PFOA	<RL	0.152
PFNA	<RL	0.029
PFDA	<RL	0.085
PFUnDA	<RL	0.043
PFDoDA	<RL	0.028
PFTrDA	<RL	0.083
PFTeDA	<RL	0.053
PFSA (NV)		
PFPrS	<RL	0.029
PFBS	<RL	0.025
PFPeS	<RL	0.027
PFHxS	<RL	0.065
PFHpS	<RL	0.027
PFOS	<RL	0.054
PFNS	<RL	0.027
PFDS	<RL	1.41
FASA (NV, SV)		
FBSA (NV)	<RL	0.028
MeFBSA (SV)	<RL	0.474
FHxSA (NV)	<RL	0.058
FOSA (NV)	<RL	0.058
MeFOSA (SV)	<RL	0.086
EtFOSA (SV)	<RL	0.091
FASAA (NV)		
FOSAA	<RL	0.057
MeFOSAA	<RL	0.028
EtFOSAA	<RL	0.058
FASE (SV)		
MeFOSE	<RL	0.042
EtFOSE	<RL	0.090

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.023
PF4OPeA	<RL	0.025
PF5OHxA	<RL	0.025
3-6-OPFHpA	<RL	0.025
HFPO-DA	<RL	0.045
ADONA	<RL	0.025
9Cl-PF3ONS	<RL	0.026
11Cl-PF3OUdS	<RL	0.027
n:2 FTAcr (V)		
8:2 FTAcr	<RL	13.2
10:2 FTAcr	<RL	25.4
n:2 FTMAC (V)		
6:2 FTMAC	<RL	56.6
8:2 FTMAC	<RL	58.0
10:2 FTMAC	<RL	30.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	13.0
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	65.3
5:2 FTOH	<RL	64.5
6:2 FTOH	<RL	66.4
7:2 FTOH	<RL	25.6
8:2 FTOH	<RL	64.0
10:2 FTOH	<RL	66.4
n:2 FTS (NV)		
4:2 FTS	0.18 ± 0.13	0.077
6:2 FTS	No Value	
8:2 FTS	<RL	0.130
10:2 FTS	No Value	

Table 55. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded OS-G.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	5.88 ± 0.26	0.388
PFPeA	6.36 ± 0.25	0.123
PFHxA	12.9 ± 1.2	0.212
PFHpA	4.0 ± 0.3	0.220
PFOA	<RL	0.106
PFNA	<RL	0.015
PFDA	<RL	0.100
PFUnDA	<RL	0.036
PFDoDA	<RL	0.053
PFTrDA	<RL	0.073
PFTeDA	<RL	0.102
PFSA (NV)		
PFPrS	<RL	0.021
PFBS	<RL	0.045
PFPeS	<RL	0.015
PFHxS	0.02682 ± 0.00053	0.014
PFHpS	<RL	0.015
PFOS	<RL	0.047
PFNS	<RL	0.029
PFDS	<RL	0.030
FASA (NV, SV)		
FBSA (NV)	0.0283 ± 0.0043	0.015
MeFBSA (SV)	<RL	0.159
FHxSA (NV)	<RL	0.015
FOSA (NV)	<RL	0.015
MeFOSA (SV)	<RL	0.400
EtFOSA (SV)	<RL	0.401
FASAA (NV)		
FOSAA	<RL	0.015
MeFOSAA	<RL	0.069
EtFOSAA	<RL	0.030
FASE (SV)		
MeFOSE	<RL	0.402
EtFOSE	<RL	0.831

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.014
PF4OPeA	<RL	0.015
PF5OHxA	<RL	0.014
3-6-OPFHpA	<RL	0.015
HFPO-DA	<RL	0.146
ADONA	<RL	0.014
9Cl-PF3ONS	<RL	0.027
11Cl-PF3OUdS	<RL	0.012
n:2 FTAcr (V)		
8:2 FTAcr	<RL	31.5
10:2 FTAcr	<RL	14.8
n:2 FTMAC (V)		
6:2 FTMAC	1450 ± 180	52.5
8:2 FTMAC	<RL	53.7
10:2 FTMAC	<RL	28.3
n:2 FTOAc (V)		
8:2 FTOAc	<RL	30.6
10:2 FTOAc	<RL	15.4
n:2 FTOH (V)		
4:2 FTOH	<RL	79.9
5:2 FTOH	<RL	76.0
6:2 FTOH	690 ± 80	29.4
7:2 FTOH	<RL	75.7
8:2 FTOH	<RL	140
10:2 FTOH	<RL	76.1
n:2 FTS (NV)		
4:2 FTS	<RL	2.59
6:2 FTS	No Value	
8:2 FTS	<RL	0.066
10:2 FTS	<RL	0.015

Table 56. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for OS-G following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	3.88 ± 0.59	0.079
PFPeA	1.97 ± 0.32	0.043
PFHxA	11.15 ± 0.82	0.108
PFHpA	0.94 ± 0.40	0.204
PFOA	0.51 ± 0.31	0.092
PFNA	0.36 ± 0.28	0.038
PFDA	0.30 ± 0.21	0.036
PFUnDA	<RL	0.023
PFDoDA	<RL	0.023
PFTrDA	0.104 ± 0.077	0.015
PFTeDA	0.060 ± 0.041	0.030
PFSA (NV)		
PFPrS	<RL	0.020
PFBS	0.092 ± 0.020	0.011
PFPeS	<RL	0.014
PFHxS	<RL	0.021
PFHpS	<RL	0.012
PFOS	<RL	0.046
PFNS	<RL	0.012
PFDS	<RL	0.012
FASA (NV, SV)		
FBSA (NV)	<RL	0.013
MeFBSA (SV)	<RL	0.772
FHxSA (NV)	<RL	0.013
FOSA (NV)	<RL	0.016
MeFOSA (SV)	<RL	0.369
EtFOSA (SV)	<RL	0.154
FASAA (NV)		
FOSAA	<RL	0.012
MeFOSAA	<RL	0.067
EtFOSAA	<RL	0.057
FASE (SV)		
MeFOSE	<RL	0.155
EtFOSE	<RL	0.365

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.010
PF4OPeA	<RL	0.012
PF5OHxA	0.028 ± 0.014	0.011
3-6-OPFHpA	<RL	0.011
HFPO-DA	0.80 ± 0.64	0.013
ADONA	<RL	0.011
9Cl-PF3ONS	<RL	0.012
11Cl-PF3OUdS	<RL	0.012
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.6
10:2 FTAcr	<RL	14.1
n:2 FTMAC (V)		
6:2 FTMAC	900 ± 160	49.8
8:2 FTMAC	<RL	51.0
10:2 FTMAC	<RL	26.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.2
10:2 FTOAc	<RL	14.6
n:2 FTOH (V)		
4:2 FTOH	<RL	29.7
5:2 FTOH	<RL	72.1
6:2 FTOH	541 ± 96	72.7
7:2 FTOH	<RL	71.8
8:2 FTOH	<RL	71.1
10:2 FTOH	<RL	147
n:2 FTS (NV)		
4:2 FTS	<RL	0.513
6:2 FTS	No Value	
8:2 FTS	<RL	0.024
10:2 FTS	<RL	0.025

Table 57. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered OS-G.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.994 ± 0.018	0.930
PFPeA	0.964 ± 0.052	0.227
PFHxA	6.77 ± 0.40	0.227
PFHpA	<RL	1.20
PFOA	<RL	0.426
PFNA	<RL	0.227
PFDA	<RL	0.470
PFUnDA	<RL	0.227
PFDoDA	<RL	0.227
PFTrDA	<RL	0.087
PFTeDA	<RL	0.087
PFSA (NV)		
PFPrS	<RL	0.039
PFBS	<RL	0.039
PFPeS	<RL	0.040
PFHxS	<RL	0.080
PFHpS	<RL	0.041
PFOS	<RL	0.211
PFNS	<RL	0.084
PFDS	<RL	0.041
FASA (NV, SV)		
FBSA (NV)	<RL	0.087
MeFBSA (SV)	<RL	0.468
FHxSA (NV)	<RL	0.043
FOSA (NV)	<RL	0.115
MeFOSA (SV)	<RL	0.188
EtFOSA (SV)	<RL	0.467
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.227
EtFOSAA	<RL	0.227
FASE (SV)		
MeFOSE	<RL	0.189
EtFOSE	<RL	0.187

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.044
PF4OPeA	<RL	0.207
PF5OHxA	<RL	0.079
3-6-OPFHpA	<RL	0.035
HFPO-DA	<RL	0.470
ADONA	<RL	0.035
9Cl-PF3ONS	<RL	0.035
11Cl-PF3OUdS	<RL	0.036
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.2
10:2 FTAcr	<RL	14.6
n:2 FTMAC (V)		
6:2 FTMAC	329 ± 10	64.9
8:2 FTMAC	<RL	66.4
10:2 FTMAC	<RL	35.0
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.9
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	74.4
5:2 FTOH	<RL	28.8
6:2 FTOH	136.4 ± 8.7	76.1
7:2 FTOH	<RL	29.5
8:2 FTOH	<RL	111
10:2 FTOH	<RL	75.6
n:2 FTS (NV)		
4:2 FTS	<RL	0.082
6:2 FTS	1.33 ± 0.47	0.447
8:2 FTS	<RL	0.451
10:2 FTS	<RL	0.090

Table 58. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for weathered OS-G.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	6.09 ± 0.89	0.787
PFPeA	18.2 ± 1.4	0.025
PFHxA	76.8 ± 3.7	0.126
PFHpA	93.82 ± 0.40	0.478
PFOA	<RL	0.133
PFNA	0.071 ± 0.026	0.025
PFDA	0.084 ± 0.021	0.074
PFUnDA	0.0574 ± 0.0083	0.038
PFDoDA	0.053 ± 0.012	0.025
PFTrDA	<RL	0.072
PFTeDA	<RL	0.046
PFSA (NV)		
PFPrS	<RL	0.025
PFBS	0.118 ± 0.045	0.022
PFPeS	<RL	0.023
PFHxS	<RL	0.056
PFHpS	<RL	0.024
PFOS	<RL	0.047
PFNS	0.0445 ± 0.0049	0.024
PFDS	<RL	1.23
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	1.01
FHxSA (NV)	<RL	0.050
FOSA (NV)	0.061 ± 0.01	0.050
MeFOSA (SV)	<RL	0.184
EtFOSA (SV)	<RL	0.194
FASAA (NV)		
FOSAA	<RL	0.049
MeFOSAA	<RL	0.025
EtFOSAA	<RL	0.050
FASE (SV)		
MeFOSE	<RL	0.090
EtFOSE	<RL	0.192

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.02
PF4OPeA	<RL	0.022
PF5OHxA	<RL	0.022
3-6-OPFHpA	<RL	0.022
HFPO-DA	<RL	0.039
ADONA	<RL	0.022
9Cl-PF3ONS	<RL	0.023
11Cl-PF3OUdS	<RL	0.023
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.3
10:2 FTAcr	<RL	29.5
n:2 FTMAC (V)		
6:2 FTMAC	951 ± 81	65.7
8:2 FTMAC	<RL	67.3
10:2 FTMAC	<RL	35.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.1
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	75.8
5:2 FTOH	<RL	74.9
6:2 FTOH	590 ± 56	77.1
7:2 FTOH	<RL	29.7
8:2 FTOH	<RL	74.3
10:2 FTOH	<RL	77.0
n:2 FTS (NV)		
4:2 FTS	<RL	0.067
6:2 FTS	9.42 ± 0.35	0.673
8:2 FTS	<RL	0.114
10:2 FTS	<RL	0.112

Table 59. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded TL-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	3.57 ± 0.95	0.091
PFPeA	0.739 ± 0.086	0.053
PFHxA	0.689 ± 0.075	0.125
PFHpA	<RL	0.236
PFOA	0.737 ± 0.089	0.107
PFNA	0.0639 ± 0.009	0.044
PFDA	0.087 ± 0.021	0.042
PFUnDA	<RL	0.039
PFDoDA	<RL	0.037
PFTrDA	0.041 ± 0.017	0.017
PFTeDA	<RL	0.035
PFSA (NV)		
PFPrS	<RL	0.026
PFBS	1.05 ± 0.13	0.013
PFPeS	<RL	0.016
PFHxS	<RL	0.028
PFHpS	<RL	0.014
PFOS	No Value	
PFNS	<RL	0.014
PFDS	<RL	0.014
FASA (NV, SV)		
FBSA (NV)	0.8 ± 0.13	0.015
MeFBSA (SV)	No Value	
FHxSA (NV)	<RL	0.015
FOSA (NV)	0.0243 ± 0.0045	0.019
MeFOSA (SV)	No Value	
EtFOSA (SV)	No Value	
FASAA (NV)		
FOSAA	<RL	0.014
MeFOSAA	<RL	0.077
EtFOSAA	<RL	0.066
FASE (SV)		
MeFOSE	No Value	
EtFOSE	No Value	

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.012
PF4OPeA	<RL	0.013
PF5OHxA	<RL	0.013
3-6-OPFHpA	<RL	0.013
HFPO-DA	<RL	0.015
ADONA	<RL	0.013
9Cl-PF3ONS	<RL	0.014
11Cl-PF3OUdS	<RL	0.014
n:2 FTAcr (V)		
8:2 FTAcr	<RL	11.8
10:2 FTAcr	<RL	11.4
n:2 FTMAC (V)		
6:2 FTMAC	<RL	40.5
8:2 FTMAC	<RL	41.5
10:2 FTMAC	<RL	21.9
n:2 FTOAc (V)		
8:2 FTOAc	<RL	23.5
10:2 FTOAc	<RL	24.2
n:2 FTOH (V)		
4:2 FTOH	<RL	61.6
5:2 FTOH	<RL	58.6
6:2 FTOH	<RL	59.0
7:2 FTOH	<RL	58.3
8:2 FTOH	<RL	57.7
10:2 FTOH	<RL	58.6
n:2 FTS (NV)		
4:2 FTS	<RL	0.281
6:2 FTS	No Value	
8:2 FTS	<RL	0.028
10:2 FTS	<RL	0.073

Table 60. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for TL-A following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.553
PFPeA	<RL	0.029
PFHxA	<RL	0.264
PFHpA	<RL	0.120
PFOA	<RL	0.173
PFNA	<RL	0.058
PFDA	<RL	0.031
PFUnDA	<RL	0.081
PFDoDA	<RL	0.024
PFTrDA	<RL	0.026
PFTeDA	<RL	0.017
PFSA (NV)		
PFPrS	<RL	0.034
PFBS	2.88 ± 0.14	1.68
PFPeS	<RL	0.016
PFHxS	<RL	2.66
PFHpS	<RL	0.016
PFOS	<RL	2.80
PFNS	<RL	0.032
PFDS	<RL	0.017
FASA (NV, SV)		
FBSA (NV)	<RL	0.017
MeFBSA (SV)	<RL	0.481
FHxSA (NV)	<RL	0.017
FOSA (NV)	<RL	0.019
MeFOSA (SV)	<RL	0.479
EtFOSA (SV)	<RL	0.480
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.017
EtFOSAA	<RL	0.017
FASE (SV)		
MeFOSE	<RL	0.482
EtFOSE	<RL	0.475

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.013
PF4OPeA	<RL	0.015
PF5OHxA	<RL	0.015
3-6-OPFHpA	<RL	0.015
HFPO-DA	<RL	0.015
ADONA	<RL	0.015
9Cl-PF3ONS	<RL	0.016
11Cl-PF3OUdS	<RL	0.016
n:2 FTAcr (V)		
8:2 FTAcr	<RL	94.2
10:2 FTAcr	<RL	35.7
n:2 FTMAC (V)		
6:2 FTMAC	<RL	307
8:2 FTMAC	<RL	64.5
10:2 FTMAC	<RL	34.0
n:2 FTOAc (V)		
8:2 FTOAc	<RL	34.9
10:2 FTOAc	<RL	37.1
n:2 FTOH (V)		
4:2 FTOH	<RL	91.4
5:2 FTOH	<RL	87.0
6:2 FTOH	<RL	92.0
7:2 FTOH	<RL	90.9
8:2 FTOH	<RL	89.9
10:2 FTOH	<RL	185
n:2 FTS (NV)		
4:2 FTS	<RL	0.028
6:2 FTS	<RL	0.964
8:2 FTS	<RL	0.016
10:2 FTS	No Value	

Table 61. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered TL-A.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	2.3 ± 2.6	0.199	**PFEESA**	<RL	0.017
PFPeA	0.21 ± 0.21	0.037	**PF4OPeA**	<RL	0.017
PFHxA	<RL	0.099	**PF5OHxA**	<RL	0.017
PFHpA	<RL	0.082	**3-6-OPFHpA**	<RL	0.015
PFOA	<RL	0.106	**HFPO-DA**	<RL	0.023
PFNA	<RL	0.055	**ADONA**	<RL	0.016
PFDA	<RL	0.103	**9Cl-PF3ONS**	<RL	0.017
PFUnDA	<RL	0.058	**11Cl-PF3OUdS**	<RL	0.017
PFDoDA	<RL	0.039			
PFTrDA	<RL	0.089	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.018	**8:2 FTAcr**	<RL	14.9
			10:2 FTAcr	<RL	14.3
PFSA (NV)					
PFPrS	<RL	0.051	***n:2 FTMAC (V)***		
PFBS	0.331 ± 0.073	0.021	**6:2 FTMAC**	<RL	63.8
PFPeS	<RL	0.017	**8:2 FTMAC**	<RL	65.3
PFHxS	<RL	0.035	**10:2 FTMAC**	<RL	34.4
PFHpS	<RL	0.017			
PFOS	0.142 ± 0.011	0.140	***n:2 FTOAc (V)***		
PFNS	<RL	0.018	**8:2 FTOAc**	<RL	14.6
PFDS	<RL	0.024	**10:2 FTOAc**	No Value	
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	0.131 ± 0.026	0.018	**4:2 FTOH**	<RL	73.1
MeFBSA (SV)	<RL	0.851	**5:2 FTOH**	<RL	142
FHxSA (NV)	<RL	0.018	**6:2 FTOH**	<RL	74.8
FOSA (NV)	<RL	0.018	**7:2 FTOH**	<RL	81
MeFOSA (SV)	<RL	0.356	**8:2 FTOH**	<RL	76.3
EtFOSA (SV)	<RL	0.357	**10:2 FTOH**	<RL	74.3
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	<RL	0.319	**4:2 FTS**	<RL	0.092
MeFOSAA	<RL	0.099	**6:2 FTS**	<RL	0.189
EtFOSAA	<RL	0.099	**8:2 FTS**	<RL	0.191
			10:2 FTS	<RL	0.037
FASE (SV)					
MeFOSE	<RL	0.852			
EtFOSE	<RL	0.839			

Table 62. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded TL-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.54 ± 0.28	0.088
PFPeA	0.22 ± 0.18	0.052
PFHxA	0.45 ± 0.25	0.121
PFHpA	<RL	0.229
PFOA	0.49 ± 0.2	0.103
PFNA	0.21 ± 0.15	0.042
PFDA	0.28 ± 0.10	0.041
PFUnDA	0.079 ± 0.046	0.038
PFDoDA	0.123 ± 0.017	0.036
PFTrDA	0.063 ± 0.022	0.017
PFTeDA	0.085 ± 0.0043	0.034
PFSA (NV)		
PFPrS	0.0343 ± 0.005	0.026
PFBS	0.69 ± 0.23	0.012
PFPeS	<RL	0.015
PFHxS	<RL	0.027
PFHpS	<RL	0.013
PFOS	0.096 ± 0.016	0.052
PFNS	<RL	0.014
PFDS	<RL	0.014
FASA (NV, SV)		
FBSA (NV)	0.151 ± 0.043	0.014
MeFBSA (SV)	<RL	0.142
FHxSA (NV)	<RL	0.014
FOSA (NV)	0.02528 ± 0.00033	0.018
MeFOSA (SV)	<RL	0.068
EtFOSA (SV)	<RL	0.221
FASAA (NV)		
FOSAA	<RL	0.014
MeFOSAA	<RL	0.075
EtFOSAA	<RL	0.064
FASE (SV)		
MeFOSE	<RL	0.367
EtFOSE	<RL	0.068

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.011
PF4OPeA	<RL	0.013
PF5OHxA	<RL	0.013
3-6-OPFHpA	<RL	0.013
HFPO-DA	<RL	0.014
ADONA	<RL	0.013
9Cl-PF3ONS	<RL	0.013
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	13.8
10:2 FTAcr	<RL	13.3
n:2 FTMAC (V)		
6:2 FTMAC	<RL	47.2
8:2 FTMAC	<RL	48.3
10:2 FTMAC	<RL	25.5
n:2 FTOAc (V)		
8:2 FTOAc	<RL	27.4
10:2 FTOAc	<RL	28.2
n:2 FTOH (V)		
4:2 FTOH	<RL	71.7
5:2 FTOH	<RL	68.3
6:2 FTOH	<RL	68.8
7:2 FTOH	<RL	68.0
8:2 FTOH	<RL	67.3
10:2 FTOH	<RL	68.3
n:2 FTS (NV)		
4:2 FTS	<RL	0.273
6:2 FTS	No Value	
8:2 FTS	<RL	0.027
10:2 FTS	<RL	0.071

Table 63. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for TL-B following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.544
PFPeA	<RL	0.029
PFHxA	<RL	0.260
PFHpA	<RL	0.118
PFOA	<RL	0.171
PFNA	<RL	0.057
PFDA	<RL	0.031
PFUnDA	<RL	0.080
PFDoDA	<RL	0.024
PFTrDA	<RL	0.026
PFTeDA	<RL	0.016
PFSA (NV)		
PFPrS	<RL	0.033
PFBS	2.77 ± 0.53	1.66
PFPeS	<RL	0.015
PFHxS	<RL	2.62
PFHpS	<RL	0.016
PFOS	<RL	2.75
PFNS	<RL	0.032
PFDS	<RL	0.017
FASA (NV, SV)		
FBSA (NV)	<RL	0.016
MeFBSA (SV)	<RL	0.403
FHxSA (NV)	<RL	0.016
FOSA (NV)	<RL	0.018
MeFOSA (SV)	<RL	0.401
EtFOSA (SV)	<RL	0.402
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.016
EtFOSAA	<RL	0.016
FASE (SV)		
MeFOSE	<RL	0.403
EtFOSE	<RL	0.397

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.013
PF4OPeA	<RL	0.015
PF5OHxA	<RL	0.015
3-6-OPFHpA	<RL	0.015
HFPO-DA	<RL	0.015
ADONA	<RL	0.015
9Cl-PF3ONS	<RL	0.015
11Cl-PF3OUdS	<RL	0.015
n:2 FTAcr (V)		
8:2 FTAcr	<RL	78.7
10:2 FTAcr	<RL	29.8
n:2 FTMAC (V)		
6:2 FTMAC	<RL	257
8:2 FTMAC	<RL	53.9
10:2 FTMAC	<RL	28.4
n:2 FTOAc (V)		
8:2 FTOAc	<RL	29.2
10:2 FTOAc	<RL	31.0
n:2 FTOH (V)		
4:2 FTOH	<RL	76.4
5:2 FTOH	<RL	72.7
6:2 FTOH	<RL	76.9
7:2 FTOH	<RL	76.0
8:2 FTOH	<RL	75.2
10:2 FTOH	<RL	155
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	0.038 ± 0.016	0.016
10:2 FTS	No Value	

Table 64. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered TL-B.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.188
PFPeA	0.055 ± 0.008	0.035
PFHxA	<RL	0.094
PFHpA	<RL	0.077
PFOA	0.130 ± 0.021	0.100
PFNA	<RL	0.052
PFDA	<RL	0.098
PFUnDA	<RL	0.054
PFDoDA	<RL	0.037
PFTrDA	<RL	0.085
PFTeDA	<RL	0.017
PFSA (NV)		
PFPrS	<RL	0.049
PFBS	0.097 ± 0.016	0.020
PFPeS	<RL	0.016
PFHxS	<RL	0.034
PFHpS	<RL	0.017
PFOS	<RL	0.133
PFNS	<RL	0.017
PFDS	<RL	0.022
FASA (NV, SV)		
FBSA (NV)	0.085 ± 0.018	0.017
MeFBSA (SV)	<RL	0.877
FHxSA (NV)	<RL	0.017
FOSA (NV)	<RL	0.017
MeFOSA (SV)	<RL	0.367
EtFOSA (SV)	<RL	0.368
FASAA (NV)		
FOSAA	<RL	0.302
MeFOSAA	<RL	0.094
EtFOSAA	<RL	0.094
FASE (SV)		
MeFOSE	<RL	0.878
EtFOSE	<RL	0.865

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.016
PF4OPeA	<RL	0.016
PF5OHxA	<RL	0.016
3-6-OPFHpA	<RL	0.014
HFPO-DA	<RL	0.022
ADONA	<RL	0.016
9Cl-PF3ONS	<RL	0.016
11Cl-PF3OUdS	<RL	0.016
n:2 FTAcr (V)		
8:2 FTAcr	<RL	12.9
10:2 FTAcr	<RL	12.4
n:2 FTMAC (V)		
6:2 FTMAC	<RL	55.3
8:2 FTMAC	<RL	56.6
10:2 FTMAC	<RL	29.8
n:2 FTOAc (V)		
8:2 FTOAc	<RL	12.7
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	63.3
5:2 FTOH	<RL	123
6:2 FTOH	<RL	64.8
7:2 FTOH	<RL	70.2
8:2 FTOH	<RL	66.1
10:2 FTOH	<RL	64.4
n:2 FTS (NV)		
4:2 FTS	<RL	0.088
6:2 FTS	<RL	0.179
8:2 FTS	<RL	0.181
10:2 FTS	<RL	0.035

Table 65. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded TL-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.16 ± 0.21	0.083
PFPeA	0.49 ± 0.18	0.049
PFHxA	1.49 ± 0.79	0.114
PFHpA	0.818 ± 0.097	0.216
PFOA	2.2 ± 1.2	0.098
PFNA	1.00 ± 0.65	0.04
PFDA	0.95 ± 0.38	0.039
PFUnDA	0.181 ± 0.091	0.036
PFDoDA	0.34 ± 0.11	0.034
PFTrDA	0.0566 ± 0.0029	0.016
PFTeDA	0.104 ± 0.037	0.032
PFSA (NV)		
PFPrS	0.065 ± 0.017	0.024
PFBS	1.257 ± 0.077	0.012
PFPeS	<RL	0.015
PFHxS	<RL	0.025
PFHpS	<RL	0.013
PFOS	0.178 ± 0.029	0.049
PFNS	<RL	0.013
PFDS	<RL	0.013
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.104
FHxSA (NV)	No Value	
FOSA (NV)	0.059 ± 0.014	0.017
MeFOSA (SV)	<RL	0.05
EtFOSA (SV)	<RL	0.162
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.071
EtFOSAA	0.25 ± 0.11	0.061
FASE (SV)		
MeFOSE	<RL	0.268
EtFOSE	<RL	0.050

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.011
PF4OPeA	<RL	0.012
PF5OHxA	<RL	0.012
3-6-OPFHpA	<RL	0.012
HFPO-DA	0.178 ± 0.047	0.013
ADONA	<RL	0.012
9Cl-PF3ONS	<RL	0.012
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	10.1
10:2 FTAcr	<RL	9.75
n:2 FTMAC (V)		
6:2 FTMAC	<RL	34.6
8:2 FTMAC	<RL	35.4
10:2 FTMAC	<RL	18.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	20.0
10:2 FTOAc	<RL	20.7
n:2 FTOH (V)		
4:2 FTOH	<RL	52.5
5:2 FTOH	<RL	50.0
6:2 FTOH	<RL	50.3
7:2 FTOH	<RL	49.8
8:2 FTOH	<RL	49.2
10:2 FTOH	<RL	50.0
n:2 FTS (NV)		
4:2 FTS	0.467 ± 0.071	0.257
6:2 FTS	No Value	
8:2 FTS	0.58 ± 0.35	0.026
10:2 FTS	0.548 ± 0.055	0.067

Table 66. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for TL-C following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.465
PFPeA	<RL	0.025
PFHxA	<RL	0.222
PFHpA	<RL	0.101
PFOA	<RL	0.146
PFNA	<RL	0.048
PFDA	<RL	0.026
PFUnDA	<RL	0.068
PFDoDA	<RL	0.020
PFTrDA	<RL	0.022
PFTeDA	<RL	0.014
PFSA (NV)		
PFPrS	<RL	0.028
PFBS	<RL	1.42
PFPeS	<RL	0.013
PFHxS	<RL	2.24
PFHpS	<RL	0.013
PFOS	<RL	2.35
PFNS	<RL	0.027
PFDS	<RL	0.014
FASA (NV, SV)		
FBSA (NV)	<RL	0.014
MeFBSA (SV)	<RL	0.406
FHxSA (NV)	<RL	0.014
FOSA (NV)	<RL	0.016
MeFOSA (SV)	<RL	0.404
EtFOSA (SV)	<RL	0.405
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.014
EtFOSAA	<RL	0.014
FASE (SV)		
MeFOSE	<RL	0.406
EtFOSE	<RL	0.400

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.011
PF4OPeA	<RL	0.013
PF5OHxA	<RL	0.013
3-6-OPFHpA	<RL	0.013
HFPO-DA	<RL	0.013
ADONA	<RL	0.013
9Cl-PF3ONS	<RL	0.013
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	79.1
10:2 FTAcr	<RL	30.0
n:2 FTMAC (V)		
6:2 FTMAC	<RL	258
8:2 FTMAC	<RL	54.2
10:2 FTMAC	<RL	28.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	29.3
10:2 FTOAc	<RL	31.2
n:2 FTOH (V)		
4:2 FTOH	<RL	76.8
5:2 FTOH	<RL	73.1
6:2 FTOH	<RL	77.3
7:2 FTOH	<RL	76.4
8:2 FTOH	<RL	75.6
10:2 FTOH	<RL	156
n:2 FTS (NV)		
4:2 FTS	<RL	0.023
6:2 FTS	<RL	0.811
8:2 FTS	0.194 ± 0.012	0.013
10:2 FTS	No Value	

Table 67. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered TL-C.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.217
PFPeA	<RL	0.040
PFHxA	<RL	0.108
PFHpA	<RL	0.089
PFOA	<RL	0.115
PFNA	<RL	0.060
PFDA	<RL	0.113
PFUnDA	<RL	0.063
PFDoDA	<RL	0.042
PFTrDA	<RL	0.098
PFTeDA	<RL	0.020
PFSA (NV)		
PFPrS	<RL	0.056
PFBS	0.04 ± 0.01	0.023
PFPeS	<RL	0.019
PFHxS	<RL	0.039
PFHpS	<RL	0.019
PFOS	<RL	0.153
PFNS	<RL	0.019
PFDS	<RL	0.026
FASA (NV, SV)		
FBSA (NV)	0.096 ± 0.011	0.020
MeFBSA (SV)	<RL	0.904
FHxSA (NV)	<RL	0.020
FOSA (NV)	<RL	0.020
MeFOSA (SV)	<RL	0.379
EtFOSA (SV)	<RL	0.379
FASAA (NV)		
FOSAA	<RL	0.349
MeFOSAA	<RL	0.108
EtFOSAA	<RL	0.108
FASE (SV)		
MeFOSE	<RL	0.905
EtFOSE	<RL	0.892

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.018
PF4OPeA	<RL	0.018
PF5OHxA	<RL	0.018
3-6-OPFHpA	<RL	0.016
HFPO-DA	<RL	0.025
ADONA	<RL	0.018
9Cl-PF3ONS	<RL	0.019
11Cl-PF3OUdS	<RL	0.019
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.4
10:2 FTAcr	<RL	14.8
n:2 FTMAC (V)		
6:2 FTMAC	<RL	66.2
8:2 FTMAC	<RL	67.7
10:2 FTMAC	<RL	35.7
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.2
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	75.8
5:2 FTOH	<RL	148
6:2 FTOH	<RL	77.6
7:2 FTOH	<RL	84.0
8:2 FTOH	<RL	79.2
10:2 FTOH	<RL	77.1
n:2 FTS (NV)		
4:2 FTS	<RL	0.101
6:2 FTS	<RL	0.207
8:2 FTS	<RL	0.209
10:2 FTS	No Value	

Table 68. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded TL-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	1.29 ± 0.22	0.085
PFPeA	0.63 ± 0.17	0.050
PFHxA	0.61 ± 0.14	0.116
PFHpA	0.44 ± 0.10	0.220
PFOA	0.419 ± 0.090	0.099
PFNA	0.293 ± 0.093	0.041
PFDA	0.253 ± 0.095	0.039
PFUnDA	0.121 ± 0.053	0.036
PFDoDA	0.113 ± 0.047	0.034
PFTrDA	0.098 ± 0.029	0.016
PFTeDA	0.071 ± 0.035	0.032
PFSA (NV)		
PFPrS	0.0299 ± 0.0026	0.025
PFBS	0.62 ± 0.13	0.012
PFPeS	<RL	0.015
PFHxS	<RL	0.026
PFHpS	<RL	0.013
PFOS	0.0831 ± 0.0052	0.050
PFNS	<RL	0.013
PFDS	<RL	0.013
FASA (NV, SV)		
FBSA (NV)	0.125 ± 0.014	0.014
MeFBSA (SV)	<RL	0.144
FHxSA (NV)	<RL	0.014
FOSA (NV)	0.0457 ± 0.0031	0.018
MeFOSA (SV)	<RL	0.069
EtFOSA (SV)	<RL	0.224
FASAA (NV)		
FOSAA	<RL	0.013
MeFOSAA	<RL	0.072
EtFOSAA	<RL	0.062
FASE (SV)		
MeFOSE	<RL	0.371
EtFOSE	<RL	0.069

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.011
PF4OPeA	<RL	0.013
PF5OHxA	<RL	0.012
3-6-OPFHpA	<RL	0.012
HFPO-DA	0.60 ± 0.21	0.014
ADONA	<RL	0.012
9Cl-PF3ONS	<RL	0.013
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	13.9
10:2 FTAcr	<RL	13.4
n:2 FTMAC (V)		
6:2 FTMAC	<RL	47.7
8:2 FTMAC	<RL	48.8
10:2 FTMAC	<RL	25.7
n:2 FTOAc (V)		
8:2 FTOAc	<RL	27.7
10:2 FTOAc	<RL	28.5
n:2 FTOH (V)		
4:2 FTOH	<RL	72.4
5:2 FTOH	<RL	68.9
6:2 FTOH	<RL	69.4
7:2 FTOH	<RL	68.6
8:2 FTOH	<RL	67.9
10:2 FTOH	<RL	69.0
n:2 FTS (NV)		
4:2 FTS	1.04 ± 0.18	0.262
6:2 FTS	No Value	
8:2 FTS	<RL	0.026
10:2 FTS	<RL	0.068

Table 69. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for TL-D following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)	PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)			***PPEA (NV)***		
PFBA	<RL	0.530	**PFEESA**	<RL	0.013
PFPeA	<RL	0.028	**PF4OPeA**	<RL	0.014
PFHxA	<RL	0.253	**PF5OHxA**	<RL	0.014
PFHpA	<RL	0.115	**3-6-OPFHpA**	<RL	0.014
PFOA	<RL	0.166	**HFPO-DA**	<RL	0.014
PFNA	<RL	0.055	**ADONA**	<RL	0.014
PFDA	<RL	0.030	**9Cl-PF3ONS**	<RL	0.015
PFUnDA	<RL	0.078	**11Cl-PF3OUdS**	<RL	0.015
PFDoDA	<RL	0.023			
PFTrDA	<RL	0.025	***n:2 FTAcr (V)***		
PFTeDA	<RL	0.016	**8:2 FTAcr**	<RL	82.2
			10:2 FTAcr	<RL	31.1
PFSA (NV)					
PFPrS	<RL	0.032	***n:2 FTMAC (V)***		
PFBS	<RL	1.62	**6:2 FTMAC**	<RL	268
PFPeS	<RL	0.015	**8:2 FTMAC**	<RL	56.3
PFHxS	<RL	2.55	**10:2 FTMAC**	<RL	29.7
PFHpS	<RL	0.015			
PFOS	<RL	2.68	***n:2 FTOAc (V)***		
PFNS	<RL	0.031	**8:2 FTOAc**	<RL	30.5
PFDS	<RL	0.016	**10:2 FTOAc**	<RL	32.4
FASA (NV, SV)			***n:2 FTOH (V)***		
FBSA (NV)	<RL	0.016	**4:2 FTOH**	<RL	79.8
MeFBSA (SV)	<RL	0.420	**5:2 FTOH**	<RL	75.9
FHxSA (NV)	<RL	0.016	**6:2 FTOH**	<RL	80.3
FOSA (NV)	<RL	0.018	**7:2 FTOH**	<RL	79.3
MeFOSA (SV)	<RL	0.418	**8:2 FTOH**	<RL	78.5
EtFOSA (SV)	<RL	0.419	**10:2 FTOH**	<RL	162
FASAA (NV)			***n:2 FTS (NV)***		
FOSAA	No Value		**4:2 FTS**	No Value	
MeFOSAA	<RL	0.016	**6:2 FTS**	No Value	
EtFOSAA	<RL	0.016	**8:2 FTS**	<RL	0.015
			10:2 FTS	No Value	
FASE (SV)					
MeFOSE	<RL	0.421			
EtFOSE	<RL	0.414			

Table 70. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered TL-D.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.236
PFPeA	<RL	0.044
PFHxA	<RL	0.117
PFHpA	<RL	0.097
PFOA	<RL	0.125
PFNA	<RL	0.066
PFDA	<RL	0.123
PFUnDA	<RL	0.068
PFDoDA	<RL	0.046
PFTrDA	<RL	0.106
PFTeDA	<RL	0.022
PFSA (NV)		
PFPrS	<RL	0.061
PFBS	0.120 ± 0.024	0.025
PFPeS	<RL	0.020
PFHxS	<RL	0.042
PFHpS	<RL	0.021
PFOS	<RL	0.167
PFNS	<RL	0.021
PFDS	<RL	0.028
FASA (NV, SV)		
FBSA (NV)	0.134 ± 0.011	0.022
MeFBSA (SV)	<RL	0.836
FHxSA (NV)	<RL	0.022
FOSA (NV)	<RL	0.022
MeFOSA (SV)	<RL	0.350
EtFOSA (SV)	<RL	0.351
FASAA (NV)		
FOSAA	<RL	0.379
MeFOSAA	<RL	0.117
EtFOSAA	<RL	0.117
FASE (SV)		
MeFOSE	<RL	0.837
EtFOSE	<RL	0.825

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.020
PF4OPeA	<RL	0.020
PF5OHxA	<RL	0.020
3-6-OPFHpA	<RL	0.017
HFPO-DA	<RL	0.027
ADONA	<RL	0.020
9Cl-PF3ONS	<RL	0.020
11Cl-PF3OUdS	<RL	0.021
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.9
10:2 FTAcr	<RL	15.3
n:2 FTMAC (V)		
6:2 FTMAC	<RL	68.1
8:2 FTMAC	<RL	69.7
10:2 FTMAC	<RL	36.7
n:2 FTOAc (V)		
8:2 FTOAc	<RL	15.6
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	78.1
5:2 FTOH	<RL	152
6:2 FTOH	<RL	79.9
7:2 FTOH	<RL	86.5
8:2 FTOH	<RL	81.5
10:2 FTOH	<RL	79.4
n:2 FTS (NV)		
4:2 FTS	<RL	0.110
6:2 FTS	<RL	0.225
8:2 FTS	<RL	0.227
10:2 FTS	<RL	0.044

Table 71. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for abraded TL-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	0.433 ± 0.090	0.084
PFPeA	0.311 ± 0.096	0.049
PFHxA	0.424 ± 0.030	0.115
PFHpA	<RL	0.217
PFOA	0.393 ± 0.033	0.098
PFNA	0.208 ± 0.050	0.040
PFDA	0.210 ± 0.030	0.039
PFUnDA	0.093 ± 0.032	0.036
PFDoDA	0.1085 ± 0.0087	0.034
PFTrDA	0.0521 ± 0.0053	0.016
PFTeDA	0.0464 ± 0.0052	0.032
PFSA (NV)		
PFPrS	<RL	0.024
PFBS	0.1095 ± 0.0040	0.012
PFPeS	<RL	0.015
PFHxS	<RL	0.025
PFHpS	<RL	0.013
PFOS	<RL	0.049
PFNS	<RL	0.013
PFDS	<RL	0.013
FASA (NV, SV)		
FBSA (NV)	No Value	
MeFBSA (SV)	<RL	0.156
FHxSA (NV)	<RL	0.013
FOSA (NV)	<RL	0.017
MeFOSA (SV)	<RL	0.075
EtFOSA (SV)	<RL	0.243
FASAA (NV)		
FOSAA	<RL	0.013
MeFOSAA	<RL	0.071
EtFOSAA	<RL	0.061
FASE (SV)		
MeFOSE	<RL	0.403
EtFOSE	<RL	0.075

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.011
PF4OPeA	<RL	0.012
PF5OHxA	<RL	0.012
3-6-OPFHpA	<RL	0.012
HFPO-DA	0.425 ± 0.084	0.013
ADONA	<RL	0.012
9Cl-PF3ONS	<RL	0.012
11Cl-PF3OUdS	<RL	0.013
n:2 FTAcr (V)		
8:2 FTAcr	<RL	15.2
10:2 FTAcr	<RL	14.7
n:2 FTMAC (V)		
6:2 FTMAC	<RL	52.1
8:2 FTMAC	<RL	53.3
10:2 FTMAC	<RL	28.1
n:2 FTOAc (V)		
8:2 FTOAc	<RL	30.2
10:2 FTOAc	<RL	31.1
n:2 FTOH (V)		
4:2 FTOH	<RL	79.1
5:2 FTOH	<RL	75.2
6:2 FTOH	<RL	75.8
7:2 FTOH	<RL	74.9
8:2 FTOH	<RL	74.2
10:2 FTOH	<RL	75.3
n:2 FTS (NV)		
4:2 FTS	0.635 ± 0.050	0.258
6:2 FTS	No Value	
8:2 FTS	<RL	0.026
10:2 FTS	<RL	0.067

Table 72. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for TL-E following exposure to elevated temperature.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.595
PFPeA	0.69 ± 0.46	0.032
PFHxA	1.03 ± 0.15	0.285
PFHpA	0.45 ± 0.27	0.129
PFOA	0.83 ± 0.10	0.187
PFNA	0.65 ± 0.25	0.062
PFDA	0.33 ± 0.15	0.033
PFUnDA	<RL	0.088
PFDoDA	0.088 ± 0.085	0.026
PFTrDA	0.048 ± 0.023	0.029
PFTeDA	<RL	0.018
PFSA (NV)		
PFPrS	<RL	0.036
PFBS	<RL	1.81
PFPeS	<RL	0.017
PFHxS	<RL	2.87
PFHpS	0.071 ± 0.034	0.017
PFOS	<RL	3.01
PFNS	<RL	0.035
PFDS	<RL	0.018
FASA (NV, SV)		
FBSA (NV)	<RL	0.018
MeFBSA (SV)	<RL	0.446
FHxSA (NV)	<RL	0.018
FOSA (NV)	<RL	0.020
MeFOSA (SV)	<RL	0.444
EtFOSA (SV)	<RL	0.445
FASAA (NV)		
FOSAA	No Value	
MeFOSAA	<RL	0.018
EtFOSAA	<RL	0.018
FASE (SV)		
MeFOSE	<RL	0.446
EtFOSE	<RL	0.440

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.014
PF4OPeA	<RL	0.016
PF5OHxA	<RL	0.016
3-6-OPFHpA	<RL	0.016
HFPO-DA	0.67 ± 0.61	0.016
ADONA	<RL	0.016
9Cl-PF3ONS	<RL	0.017
11Cl-PF3OUdS	<RL	0.017
n:2 FTAcr (V)		
8:2 FTAcr	<RL	87.5
10:2 FTAcr	<RL	33.1
n:2 FTMAC (V)		
6:2 FTMAC	<RL	285
8:2 FTMAC	<RL	59.9
10:2 FTMAC	<RL	31.6
n:2 FTOAc (V)		
8:2 FTOAc	<RL	32.4
10:2 FTOAc	<RL	34.5
n:2 FTOH (V)		
4:2 FTOH	<RL	84.9
5:2 FTOH	<RL	80.7
6:2 FTOH	<RL	85.4
7:2 FTOH	<RL	84.4
8:2 FTOH	<RL	83.5
10:2 FTOH	<RL	172
n:2 FTS (NV)		
4:2 FTS	No Value	
6:2 FTS	No Value	
8:2 FTS	<RL	0.017
10:2 FTS	No Value	

Table 73. Measured PFAS concentrations (µg-PFAS / kg-textile; mean ± standard deviation of triplicate measurements) and reporting limits (RL) for laundered TL-E.

PFAS	Concentration (µg/kg)	RL (µg/kg)
PFCA (NV)		
PFBA	<RL	0.233
PFPeA	<RL	0.043
PFHxA	<RL	0.116
PFHpA	<RL	0.096
PFOA	<RL	0.124
PFNA	<RL	0.065
PFDA	<RL	0.121
PFUnDA	<RL	0.067
PFDoDA	<RL	0.045
PFTrDA	<RL	0.104
PFTeDA	<RL	0.021
PFSA (NV)		
PFPrS	<RL	0.060
PFBS	0.050 ± 0.012	0.025
PFPeS	<RL	0.020
PFHxS	<RL	0.042
PFHpS	<RL	0.020
PFOS	<RL	0.164
PFNS	<RL	0.021
PFDS	<RL	0.028
FASA (NV, SV)		
FBSA (NV)	0.0490 ± 0.0031	0.021
MeFBSA (SV)	<RL	0.814
FHxSA (NV)	<RL	0.021
FOSA (NV)	<RL	0.021
MeFOSA (SV)	<RL	0.341
EtFOSA (SV)	<RL	0.342
FASAA (NV)		
FOSAA	<RL	0.373
MeFOSAA	<RL	0.116
EtFOSAA	<RL	0.116
FASE (SV)		
MeFOSE	<RL	0.815
EtFOSE	<RL	0.803

PFAS	Concentration (µg/kg)	RL (µg/kg)
PPEA (NV)		
PFEESA	<RL	0.019
PF4OPeA	<RL	0.019
PF5OHxA	<RL	0.019
3-6-OPFHpA	<RL	0.017
HFPO-DA	<RL	0.027
ADONA	<RL	0.019
9Cl-PF3ONS	<RL	0.020
11Cl-PF3OUdS	<RL	0.020
n:2 FTAcr (V)		
8:2 FTAcr	<RL	14.7
10:2 FTAcr	<RL	14.1
n:2 FTMAC (V)		
6:2 FTMAC	<RL	63.0
8:2 FTMAC	<RL	64.5
10:2 FTMAC	<RL	34.0
n:2 FTOAc (V)		
8:2 FTOAc	<RL	14.5
10:2 FTOAc	No Value	
n:2 FTOH (V)		
4:2 FTOH	<RL	72.2
5:2 FTOH	<RL	141
6:2 FTOH	<RL	73.9
7:2 FTOH	<RL	80.1
8:2 FTOH	<RL	75.4
10:2 FTOH	<RL	73.4
n:2 FTS (NV)		
4:2 FTS	<RL	0.108
6:2 FTS	<RL	0.222
8:2 FTS	<RL	0.223
10:2 FTS	<RL	0.043

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Appendix A. Experimental Details

A.1. Materials

A.1.1. Firefighter Turnout Gear Textiles

Table 74 shows the area density (kg/m^2) and an example image of each textile prior to stressing.

Table 74. Area densities (mean ± standard deviation of triplicate measurements; kg/m^2) and images of firefighter turnout gear textiles prior to stressing.

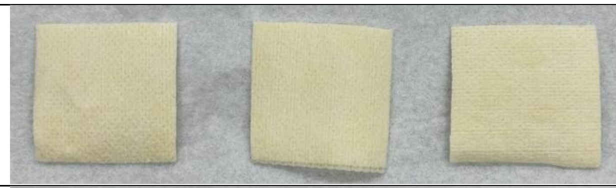
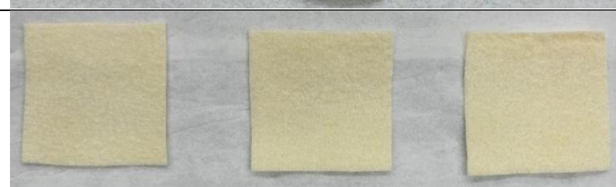
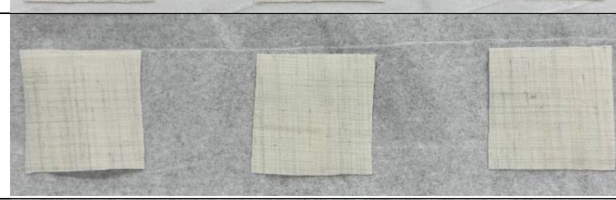
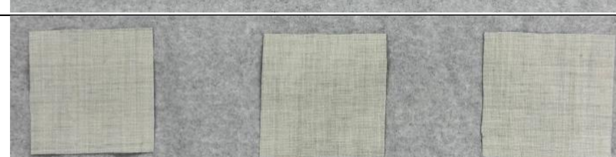
Textile	Area Density (kg/m^2)	Image
MB-A	0.1672 ± 0.0026	
MB-B	0.1533 ± 0.0015	
MB-C	0.2540 ± 0.0011	
MB-D	0.2049 ± 0.0037	
MB-E	0.1675 ± 0.0012	
MB-F	0.2128 ± 0.0031	

Table 74. (Continued)

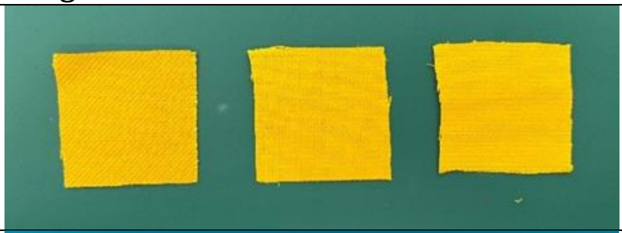
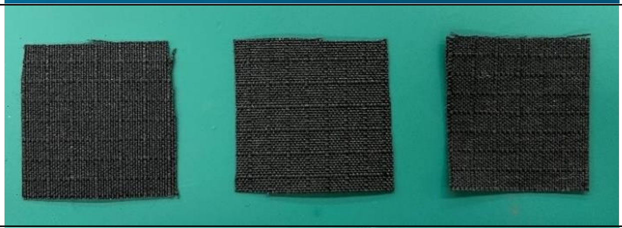
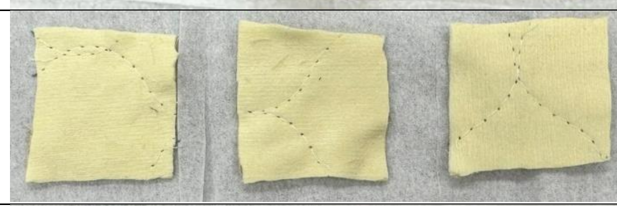
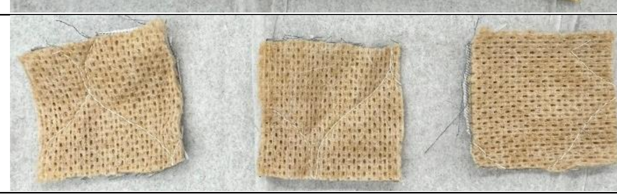
Textile	Area Density (kg/m^2)	Image
OS-A	0.2244 ± 0.0070	
OS-ASC	0.2093 ± 0.0027	
OS-B	0.2635 ± 0.0055	
OS-C	0.2333 ± 0.0093	
OS-D	0.2619 ± 0.0085	
OS-E	0.2461 ± 0.0114	
OS-F	0.2574 ± 0.0016	

Table 74. (Continued)

Textile	Area Density (kg/m^2)	Image
OS-FSC	0.2178 ± 0.0073	
OS-G	0.2779 ± 0.0046	
TL-A	0.3428 ± 0.0087	
TL-B	0.3813 ± 0.0147	
TL-C	0.3727 ± 0.0019	
TL-D	0.3533 ± 0.0043	
TL-E	0.3412 ± 0.0106	

A.1.2. PFAS Analytical Standards and NIST Reference Materials

The selection of PFAS for inclusion in this study was based on previous reports in the scientific literature, the professional experience of NIST researchers related to PFAS and firefighter gear, as well as conversations with subject matter experts outside NIST. Analytical standards were obtained for 55 PFAS including 11 PFCAs, eight PFSAs, six perfluoroalkane sulfonamides (FASA), three per- and polyfluoroalkane sulfonamido acetic acids (FASAA), two perfluoroalkane sulfonamido ethanols (FASE), eight PPEAs, six n:2 FTOHs, two n:2 fluorotelomer acrylates (n:2 FTAcr), three n:2 fluorotelomer methacrylates (n:2 FTMAC), two n:2 fluorotelomer acetates (n:2 FTOAc), two n:2 fluorotelomer acrylates (n:2 FTAcr), and four n:2 fluorotelomer sulfonates (n:2 FTS).

Analytical standards (Table 75) and isotopically labeled standards (Table 76) for nonvolatile PFAS as well as semivolatile PFAS (Table 77 and Table **78**) were obtained from Wellington Laboratories (Guelph, Ontario, Canada). Analytical standards and isotopically labeled standards for volatile PFAS (Table 79 and

NIST Reference Materials (RMs) 8446 Perfluorinated Carboxylic Acids and Perfluorooctane Sulfonamide in Methanol (8446) and 8447 Perfluorinated Sulfonic Acids in Methanol (8447) were obtained for use as quality control samples (Table 81 andTable **82**).

Table 80) were obtained from Wellington Laboratories and Synquest Laboratories (Alachua, FL).

Table 75. Analytical standard solutions obtained from Wellington Laboratories for use in nonvolatile PFAS analysis, with full analyte names, CAS RN, and abbreviations (bold), as well as analyte concentrations with expanded maximum combined percent relative uncertainty. PFHxS, PFOS, MeFOSAA, and EtFOSAA in PFAC30PAR were present as a mixture of structural isomers.

Standard	Contents	Concentration
PFAC30-PAR	Perfluoro-n-butanoic acid (375-22-4; **PFBA**), Perfluoro-n-pentanoic acid (2706-90-3; **PFPeA**), Perfluoro-n-hexanoic acid (307-24-4; **PFHxA**), Perfluoro-n-heptanoic acid (375-85-9; **PFHpA**), Perfluoro-n-octanoic acid (335-67-1; PFOA), Perfluoro-n-nonanoic acid (375-95-1; **PFNA**), Perfluoro-n-decanoic acid (335-76-2; **PFDA**), Perfluoro-n-undecanoic acid (2058-94-8; **PFUnDA**), Perfluoro-n-dodecanoic acid (307-55-1; **PFDoDA**), Perfluoro-n-tridecanoic acid (72629-94-8; **PFTrDA**), Perfluoro-n-tetradecanoic acid (0376-06-07; **PFTeDA**), Perfluoro-1-butanesulfonamide (30334-69-1; **FBSA**), Perfluoro-1-hexanesulfonamide (41997-13-1; **FHxSA**), Perfluoro-1-octanesulfonamide (754-91-6; **FOSA**), Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid (13252-13-6; HFPO-DA), N-methylperfluoro-1-octanesulfonamidoacetic acid (2355-31-9; **N-MeFOSAA**), N-ethylperfluoro-1-octanesulfonamidoacetic acid (2991-50-6, N-EtFOSAA), Potassium perfluorobutanesulfonate (29420-49-3; **PFBS**), Sodium perfluoropentanesulfonate (630402-22-1; **PFPeS**), Potassium perfluorohexanesulfonate (3871-99-6; **PFHxS**), Sodium perfluoroheptanesulfonate (21934-50-9; **PFHpS**), Potassium perfluorooctanesulfonate (2795-39-3; **PFOS**), Sodium perfluorononanesulfonate (98789-57-2; **PFNS**), Sodium perfluorodecanesulfonate (2806-15-7; **PFDS**), Sodium 1H,1H,2H,2H,-perfluoro-1-hexanesulfonate (27619-93-8; **4:2 FTS**), Sodium 1H,1H,2H,2H,-perfluoro-1-octanesulfonate (27619-94-9; **6:2 FTS**), Sodium 1H,1H,2H,2H,-perfluoro-1-decanesulfonate (27619-96-1; **8:2 FTS),** Sodium dodecafluoro-3H-4,8-dioxanonatoate; **NaDONA**), Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate (73606-19-6; **9Cl-PF3ONS**), Potassium 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate (83329-89-9; **11Cl-PF3OUdS**)	(1.00 µg/mL ± 0.05 µg/mL) in methanol/isopropanol (6%) /water (< 1%)
PFAC-MXG	Perfluoro-4-oxapentenoic acid (377-73-1; **PF4OPeA**), Perfluoro-5-oxahexanoic acid (863090-89-5; **PF5OHxA**), Perfluoro-3,6-dioxaheptanoic acid (151772-58-6; **3,6-OPFHpA**), Potassium perfluoro(2-ethoxyethane)sulfonic acid (**PFEESA**)	(2.0 µg/mL ± 0.1 µg/mL) in methanol/water (<1%)
L-PFPrS	Sodium perfluoropropanesulfonate (359868-82-9; **PFPrS**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
FOSAA	Perfluorooctane sulfonamidoacetic acid (2806-24-6; **FOSAA**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol/water (<1%)
10:2FTS	Sodium 1H,1H,2H,2H,-perfluoro-1-dodecanesulfonate (**10:2 FTS**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol

Table 76. Isotopically labeled internal and injection standard solutions obtained from Wellington Laboratories for use in nonvolatile and semivolatile PFAS analysis, with full analyte names, and analyte concentrations with expanded maximum combined percent relative uncertainty where provided.

Standard	Contents	Concentration
MPFAC-24ES	Perfluoro-n-[13C4]-butanoic acid, Perfluoro-n-[13C5]-pentanoic acid, Perfluoro-n-[1,2,3,4,6-13C5]-hexanoic acid, Perfluoro-n-[1,2,3,4-13C4]-heptanoic acid, Perfluoro-n-[13C8]-octanoic acid, Perfluoro-n-[13C9]-nonanoic acid, Perfluoro-n-[1,2,3,4,5,6-13C5]decanoic acid, Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid, Perfluoro-n-[1,2-13C2]dodecanoic acid, Perfluoro-n-[1,2-13C2]tetradecanoic acid, Sodium perfluoro-1-[2,3,4-13C3]-butanesulfonate, Sodium perfluoro-1-[1,2,3-13C3]-hexanesulfonate, Sodium perfluoro-1-[13C8]-octanesulfonate, Perfluoro-1-[13C8]octanesulfonamide, N-methyl-d3-perlfuoro-1-octanesulfonamid acetic acid, N-ethyl-d5-perfluoro-1-octanesulfonamido acetic acid, Sodium 1H, 1H, 2H, 2H-perfluoro-1-[1,2-13C2]-hexane sulfonate, Sodium 1H, 1H, 2H, 2H-perfluoro-1-[1,2-13C2]-octane sulfonate, Sodium 1H, 1H, 2H, 2H-perlfuoro-1-[1,2-13C2]-decane sulfonate	(1.00 µg/mL ± 0.05 µg/mL) in methanol/ isopropanol (2%)/water (<1%)
M3HFPO-DA	Tetrafluoro(heptafluoropropoxy)[$^{13}C_3$]-propanoic acid	(50.0 µg/mL ± 2.5 µg/mL) in methanol
MPFAC-C-IS	Perfluoro-n-[2,3,4-13C3]-butanoic acid (**PFBA-INJ**), Perfluoro-n-[1,2,3,4-13C4]-octanoic acid (**PFOA -INJ**), Perfluoro-n-[1,2-13C2]decanoic acid (**PFDA -INJ)**, Sodium perfluoro-1-[1,2,3,4-13C4]-octanesulfonate (**PFOS -INJ**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol/ water (<1%)

Table 77. Analytical standard solutions purchased from Wellington Laboratories for use in semivolatile PFAS analysis including full analyte names, CAS RN, abbreviations (bold), and analyte concentrations with expanded maximum combined percent relative uncertainty where provided.

Standard	Contents	Concentration
N-MeFBSA-M	Nonafluoro-N-methylbutancesulfonamide (6829-12-4; **MeFBSA**)	(50 µg/mL ± 2.5 µg/mL) in methanol
N-MeFOSA-M	Heptadecafluoro-N-methyloctancesulfonamide (31506-32-8; **MeFOSA**)	(50 µg/mL ± 2.5 µg/mL) in methanol
N-EtFOSA-M	Heptadecafluoro-N-ethyloctancesulfonamide (4151-50-2; **EtFOSA**)	(50 µg/mL ± 2.5 µg/mL in methanol
N-MeFOSE-M	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol (24448-09-7; **MeFOSE**)	(50 µg/mL ± 2.5 µg/mL) in methanol
N-EtFOSE-M	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol (1691-99-2; **EtFOSE**)	(50 µg/mL ± 2.5 µg/mL) in methanol

Table 78. Isotopically labeled internal standard solutions obtained from Wellington Laboratories for use in semivolatile PFAS analysis, with full analyte names, and analyte concentrations with expanded maximum combined percent relative uncertainty where provided.

Standard	Contents	Concentration
d-N-MeFOSA-M	N-methy-d3-perflouro-1-octanesulfonamide	(50 µg/mL ± 2.5 µg/mL) in methanol
d-N-EtFOSA	N-ethyl-d5-perfluoro-1-octanesulfonamide	(50 µg/mL ± 2.5 µg/mL) in methanol
d7-N-MeFOSE-M	2-(N-methyl-d3-perfluoro-1-octanesulfonamido)ethan-d4-ol	(50 µg/mL ± 2.5 µg/mL) in methanol
d9-N-EtFOSE-M	2-(N-ethyl-d5-perfluoro-1-octanesulfonamido)ethan-d4-ol	(50 µg/mL ± 2.5 µg/mL) in methanol

Table 79. Analytical standards solutions obtained for volatile PFAS analysis with supplier (WL = Wellington Laboratories, S = Synquest Laboratories), full analyte names, CAS RN, abbreviations (bold), and analyte concentrations with expanded maximum combined percent relative uncertainty where provided.

Standard	Contents	Concentration
8:2FTAcr (W)	1H, 1H, 2H, 2H-Perfluorodecyl acrylate (27905-45-9; **8:2 FTAcr**)	(50.0 µg/mL ± 2.5 µg/mL) in isooctane
10:2 FTAcr (W)	1H, 1H, 2H, 2H-Pefluorododecyl acrylate (17741-60-5; **10:2 FTAcr**)	(47.9 µg/mL ± 2.4 µg/mL) in isooctane
FBET (W)	2-Perflourobutyl ethanol (2043-47-2; **4:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
5:2sFTOH (W)	1-Perfluoropentyl ethanol (914637-05-1; **5:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
FHET (W)	2-Perfluorohexyl ethanol (647-42-7; **6:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
7:2sFTOH (W)	1-Perfluoroheptyl ethanol (24015-83-6; **7:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
FOET (W)	2-Perfluorooctyl ethanol (678-39-7; **8:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
FDET (W)	2-Perfluorodecyl ethanol (865-86-1; **10:2 FTOH**)	(50.0 µg/mL ± 2.5 µg/mL) in methanol
8:2 FTOAc (W)	1H, 1H, 2H, 2H-Perfluorodecyl acetate (37858-04-1; **8:2 FTOAc**)	(48.5 µg/mL ± 2.4 µg/mL) in isooctane
10:2FTOAc (W)	1H, 1H, 2H, 2H-Perfluorododecyl acetate (37858-05-2; **10:2 FTOAc**)	(50.0 µg/mL ± 2.5 µg/mL) in isooctane
8:2 FTAcr (W)	1H, 1H, 2H, 2H-Perfluorodecyl acrylate (27905-45-9; **8:2 FTAcr**)	(50.0 µg/mL ± 2.5 µg/mL) in isooctane
10:2 FTAcr (W)	1H, 1H, 2H, 2H-Perfluorododecyl acrylate (17741-60-5; **10:2 FTAcr**)	(47.9 µg/mL ± 2.4 µg/mL) in isooctane
2324-3-46 (S)	1H, 1H, 2H, 2H-Perfluorooctyl methacrylate (2144-53-8; **6:2 FTMAC**)	(97 % Purity)
2324-3-42 (S)	1H, 1H, 2H, 2H-Perfluorodecyl methacrylate (1996-88-9; **8:2 FTMAC**)	(97 % Purity)
2324-3-Y5 (S)	1H, 1H, 2H, 2H-Perfluorododecyl methacrylate (2144-54-9; **10:2 FTMAC**)	(97 % Purity)

NIST Reference Materials (RMs) 8446 Perfluorinated Carboxylic Acids and Perfluorooctane Sulfonamide in Methanol (8446) and 8447 Perfluorinated Sulfonic Acids in Methanol (8447) were obtained for use as quality control samples (Table 81 andTable **82**).

Table 80. Isotopically labeled standard solutions purchased from Wellington Laboratories for volatile PFAS analysis, including full analyte names, and analyte concentrations with expanded maximum combined percent relative uncertainty where provided.

Standard	Contents	Concentration
MFBET	2-Perfluorobutyl-[1,1,2,2-$^{2}H_4$]-ethanol	(48.5 µg/mL ± 2.4 µg/mL) in methanol
MFHET	2-Perfluorohexyl-[1,1-$^{2}H_2$]-[1,2-$^{13}C_2$]-ethanol	(50 µg/mL ± 2.5 µg/mL) in methanol
MFOET	2-Perfluorooctyl-[1,1-$^{2}H_2$]-[1,2-$^{13}C_2$]-ethanol	(50 µg/mL ± 2.5 µg/mL) in methanol
MFDET	2-Perfluorodecyl-[1,1-$^{2}H_2$]-[1,2-$^{13}C_2$]-ethanol	(50 µg/mL ± 2.5 µg/mL) in methanol

Table 81. Reference mass fractions for NIST Reference Material 8446 including mean value and expanded uncertainty with 95 % confidence.

PFAS	Mass Fraction (mg/kg)
PFHxA	59.1 ± 1.4
PFHpA	76.0 ± 7.2
PFOA	54.8 ± 2.2
PFNA	63.0 ± 1.4
PFDA	58.1 ± 4.0
PFUdA	62.8 ± 6.5
PFDoDA	59.5 ± 7.0
PFTrDA	62.9 ± 2.8
PFTeDA	58.0 ± 3.8
PFBA	43 ± 11
PFPeA	60.9 ± 0.9
FOSA	66.9 ± 1.7

Table 82. Reference mass fractions NIST Reference Material 8447 including mean value and expanded uncertainty with 95 % confidence.

PFAS	Mass Fraction (mg/kg)
PFBS	42.3 ± 2.3
PFHxS	55.2 ± 1.7
PFOS	56.6 ± 2.5

A.1.3. Method Reproducibility Material (OS-FRM)

As described in NIST TN 2248, 400 cuttings of outer shell textile OS-F were prepared and designated OS-FRM. Once PFAS concentrations in OS-FRM were determined (Table 83), a single section of OS-FRM was extracted and analyzed with each batch of 11 textile samples for nonvolatile, semivolatile, and volatile PFAS analysis.

Table 83. PFAS concentrations (mean ± standard deviation) determined from analysis of twelve replicates of OS-FRM. Measured concentrations that were below the reporting limit in individual replicates were not included in average and standard deviation calculations.

PFAS	(µg/kg)
Nonvolatile PFAS	
PFBA	11.69 ± 0.48
PFPeA	12.81 ± 0.73
PFHxA	38.1 ± 3.2
PFHpA	5.37 ± 0.43
PFOA	0.369 ± 0.075
PFNA	0.214 ± 0.048
PFDA	0.316 ± 0.051
PFBS	1.38 ± 0.29
FBSA	0.333 ± 0.018
FHxSA	0.0345 ± 0.005
Semivolatile PFAS	
MeFOSE	0.53 ± 0.12
Volatile PFAS	
6:2 FTOH	273 ± 39
6:2 FTMAC	613 ± 107

A.2. PFAS Analysis

PFAS analytical methods, including quality control limits, for GC-MS analysis of volatile PFAS as well as LC-MS/MS analysis of semivolatile and nonvolatile PFAS were performed as described in NIST TN 2248 [22].

A.3. Quality Control Results

With each analytical sequence a range of quality control (QC) results were obtained. Reporting limits determined with each measurement (Section A.3.4), NIST RM 8446 and 8447 recovery (Section A.3.5), as well as OS-FRM recovery (Section A.3.6) are detailed below.

A.3.4. Reporting Limits

Reporting limits determined for each PFAS measurement in stressed firefighter gear textiles are above in Tables 5 - 73. Histograms of the reporting limits for measurements made with each of the three analytical methods are shown in Figure 17. Most of the determined reporting limits for nonvolatile (2084 out of 2194) and semivolatile (265 out of 328) PFAS measurements were < 0.5 µg/kg. Reporting limits for volatile PFAS were much higher; out of a total of 858 reported volatile GC measurements, no reporting limit was under 8.6 µg/kg and 71 were over 100 µg/kg.

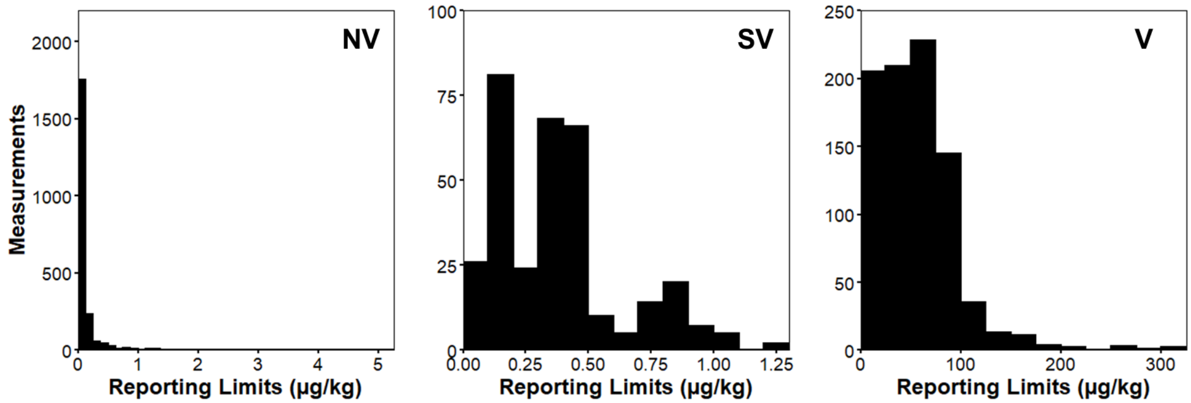


Figure 17. Histograms of reporting limits for individual measurements of (NV) PFAS determined with nonvolatile analytical method (binwidth = 0.125 µg/kg), (SV) PFAS determined with semivolatile analytical method (binwidth = 0.1µg/kg), and (V) PFAS determined with volatile analytical method (binwidth = 25 µg/kg).

A.3.5. NIST Reference Materials 8446 and 8447

Nonvolatile PFAS concentrations in extracts of firefighter turnout gear textiles were determined across 16 analytical sequences. Gravimetric dilutions of NIST RMs 8446 Perfluorinated Carboxylic Acids and Perfluorooctane Sulfonamide in Methanol as well as 8447 Perfluorinated Sulfonic Acids in Methanol were prepared and analyzed with each sequence and measured concentrations were between 80.4 % - 119 % of the reference values for all analytes (Figure 18). The recovery of all NIST RM 8446 and 8447 analytes suggests that calibration regressions determined with each nonvolatile analytical sequence were consistent and accurate.

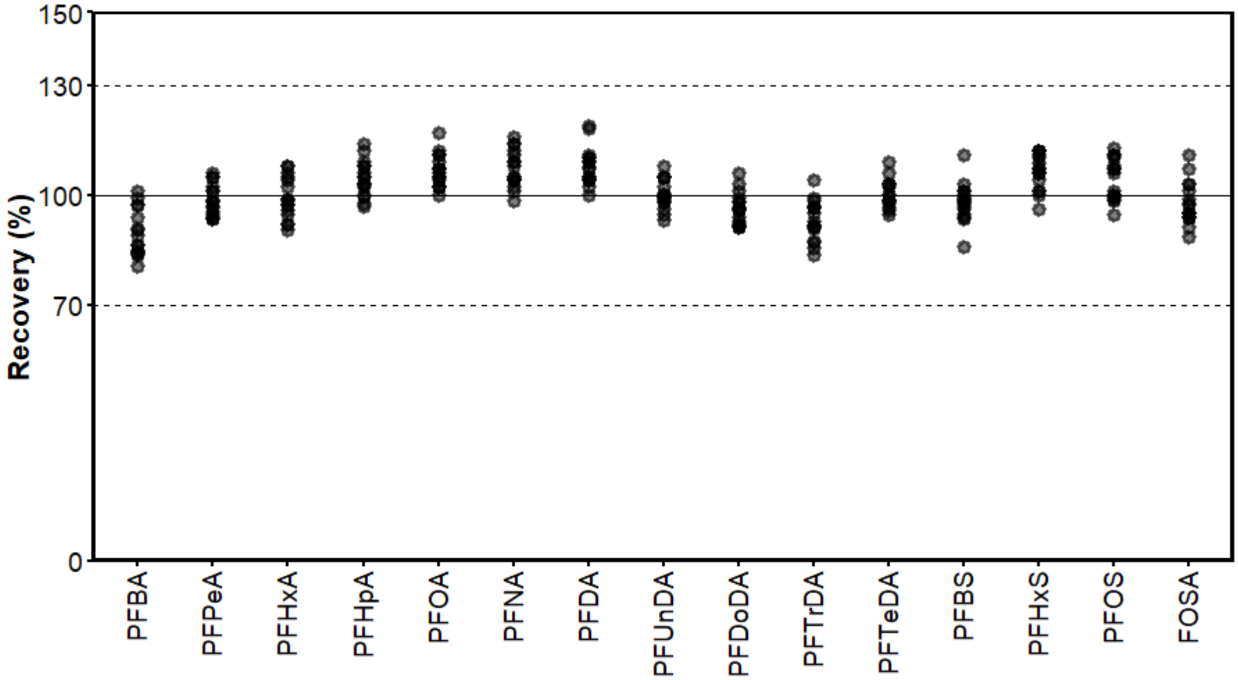


Figure 18. Recoveries of reference PFAS in NIST reference materials 8446 and 8447 across 16 analytical sequences. 100 % recovery is indicated with a solid line while 70 % and 130 % recoveries are indicated with dashed lines.

A.3.6. Method Reproducibility Materials (OS-FRM)

Extraction batches included a single cutting of OS-FRM to determine extraction consistency. Recovery across nine nonvolatile, eight semivolatile, and 10 volatile extraction batches are shown in Figure 19. Some analytes were not quantified in all batches due to reporting limits being above the measured or nominal PFAS concentrations. Recoveries ranged from 81.3 % to 128 % for nonvolatile PFAS, 59.5 % to 141 % for semivolatile PFAS, and 38.0 % to 132 % for volatile PFAS.

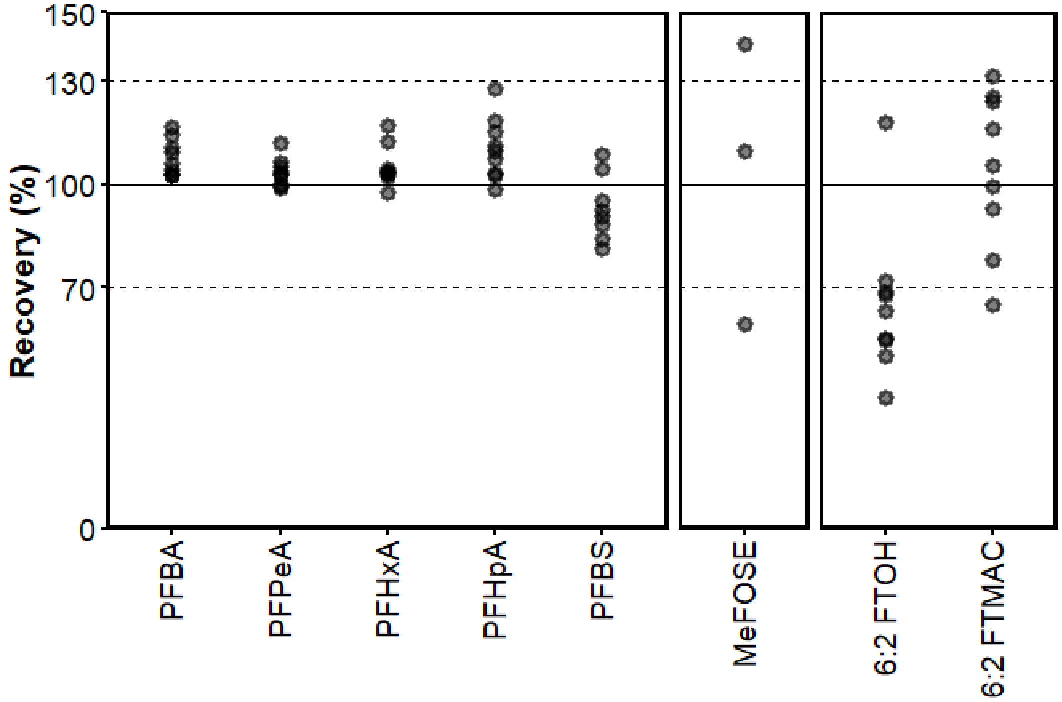


Figure 19. Recovery of PFAS in OS-FRM that had a previously measured concentration over 0.5 µg/kg across 9 nonvolatile, 8 semivolatile, and 10 volatile PFAS extraction batches. 100 % recovery is indicated with a solid line while 70 % and 130 % recoveries are indicated with dashed lines.

A.3.7. PFAS Concentrations in Unstressed Firefighter Gear Textiles

PFAS concentrations in unstressed firefighter gear textiles were previously reported in NIST TN 2248 [22]. The summed PFAS concentrations determined in unstressed firefighter textiles are shown in Figure 20.

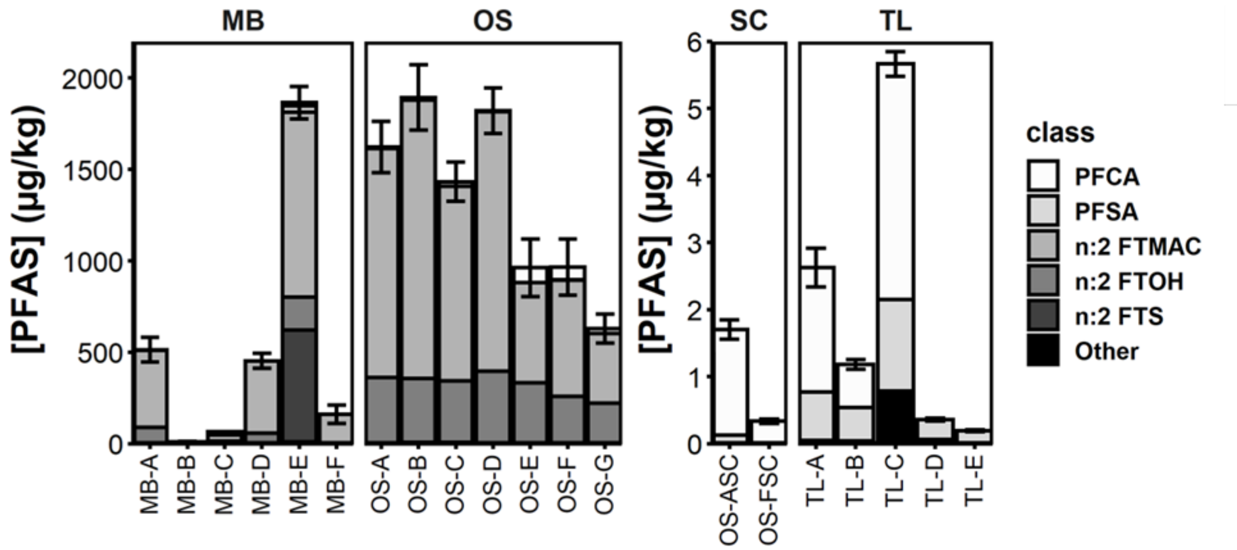


Figure 20. Summed PFAS concentrations in unstressed firefighter turnout gear textiles according to textile type (MB = moisture barrier, OS = outer shell, SC = scoured outer shell, TL = thermal liner). Error bars indicate the combined standard uncertainty of the summed PFAS concentrations. Bar shade indicates PFAS class. This figure was previously Figure 2 in NIST TN 2248 [22].

A.3.8. PFAS Concentrations in Stressed Firefighter Gear Textiles

The measured PFAS concentrations determined in unstressed firefighter gear textiles in NIST TN 2248 [22] as well as the same firefighter gear textiles following exposure to each stressing process are shown in Figure 21 - Figure **27**. Scatter plots comparing summed nonvolatile or volatile PFAS concentrations before and after each stressing process are in Figure 28 - Figure **35**.

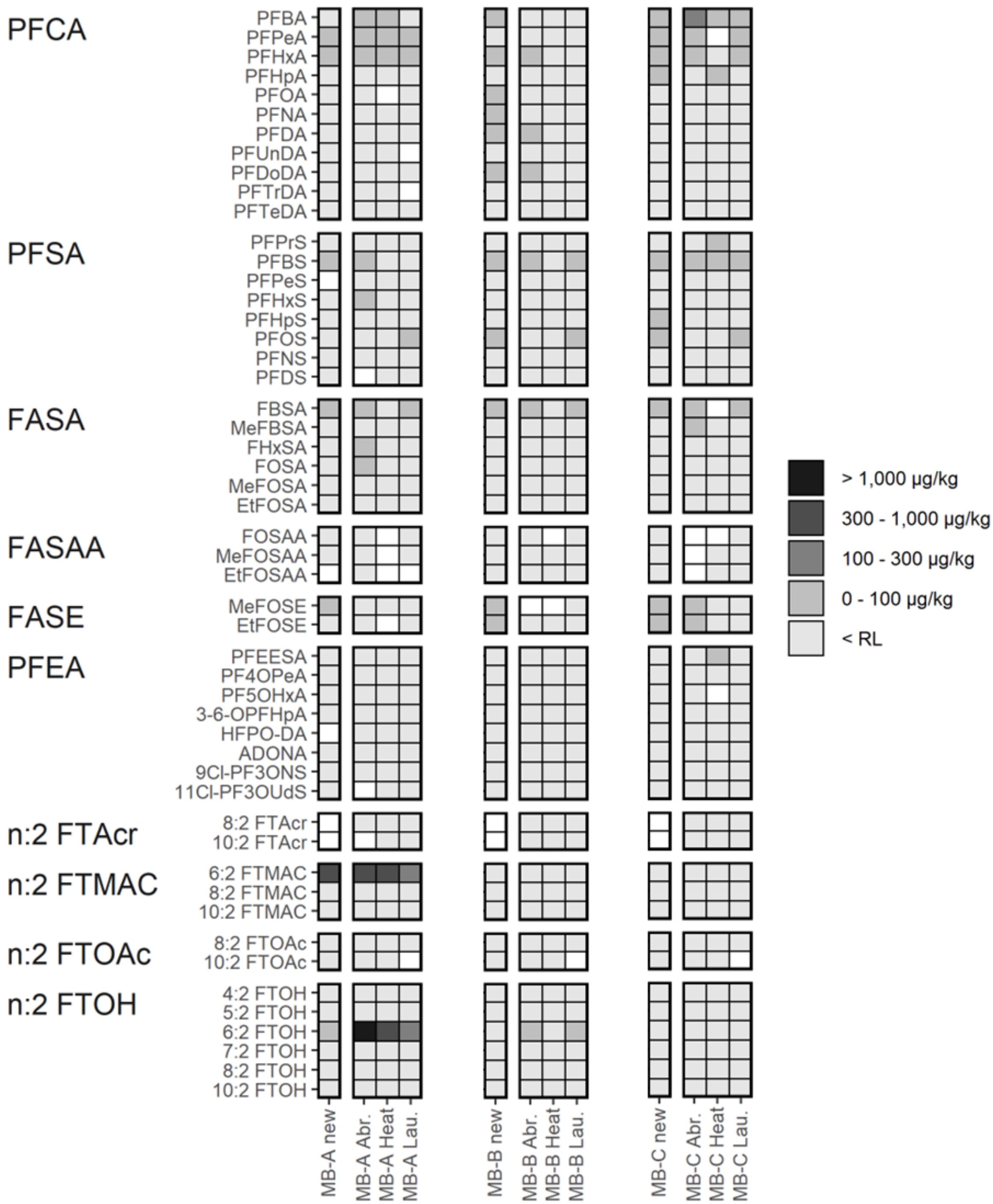


Figure 21. Mean PFAS concentrations determined from triplicate analysis of MB-A (left), MB-B (center), and MB-C (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), or laundering (Lau.). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

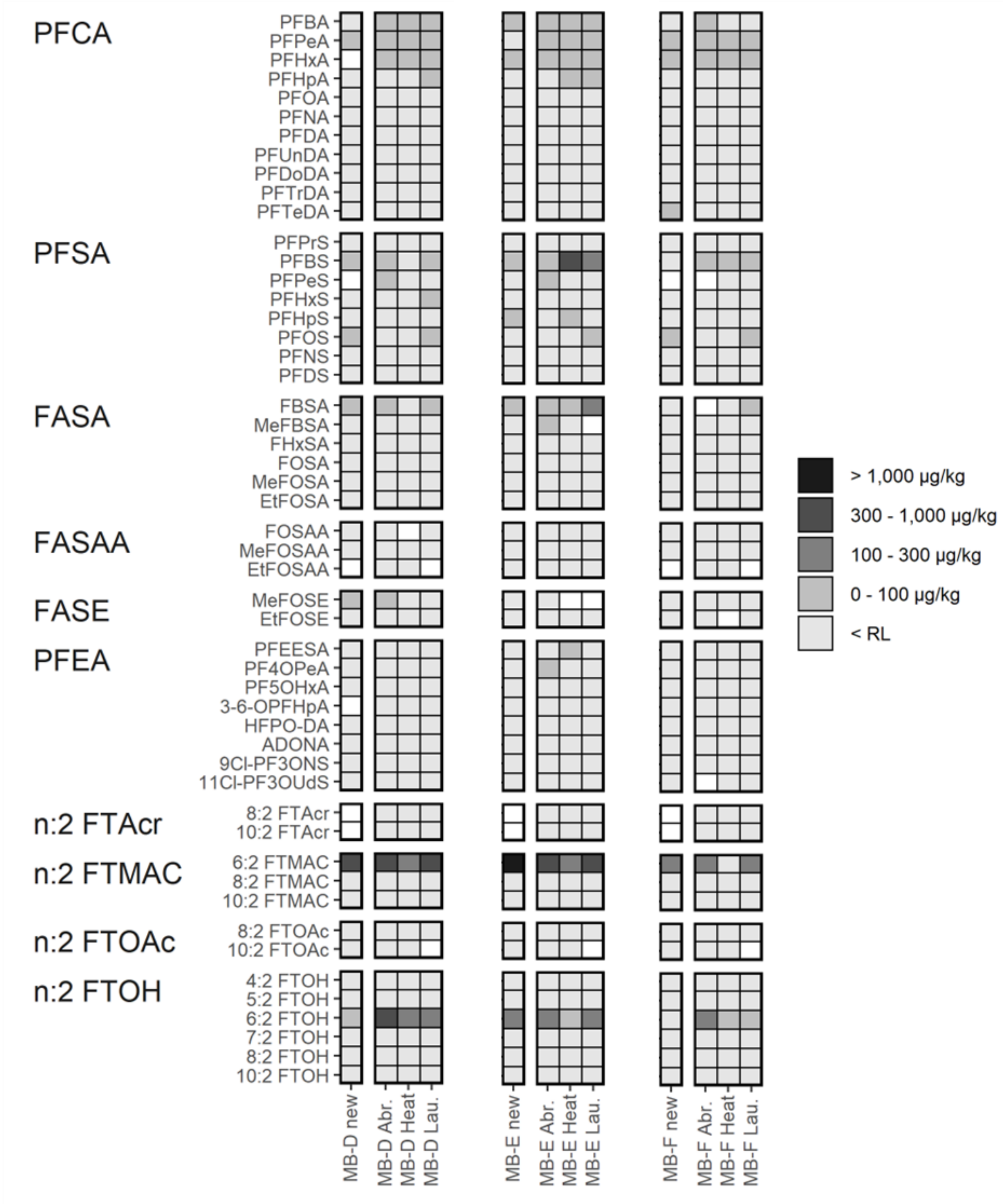


Figure 22. Mean PFAS concentrations determined from triplicate analysis of MB-D (left), MB-E (center), and MB-F (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), or laundering (Lau.). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

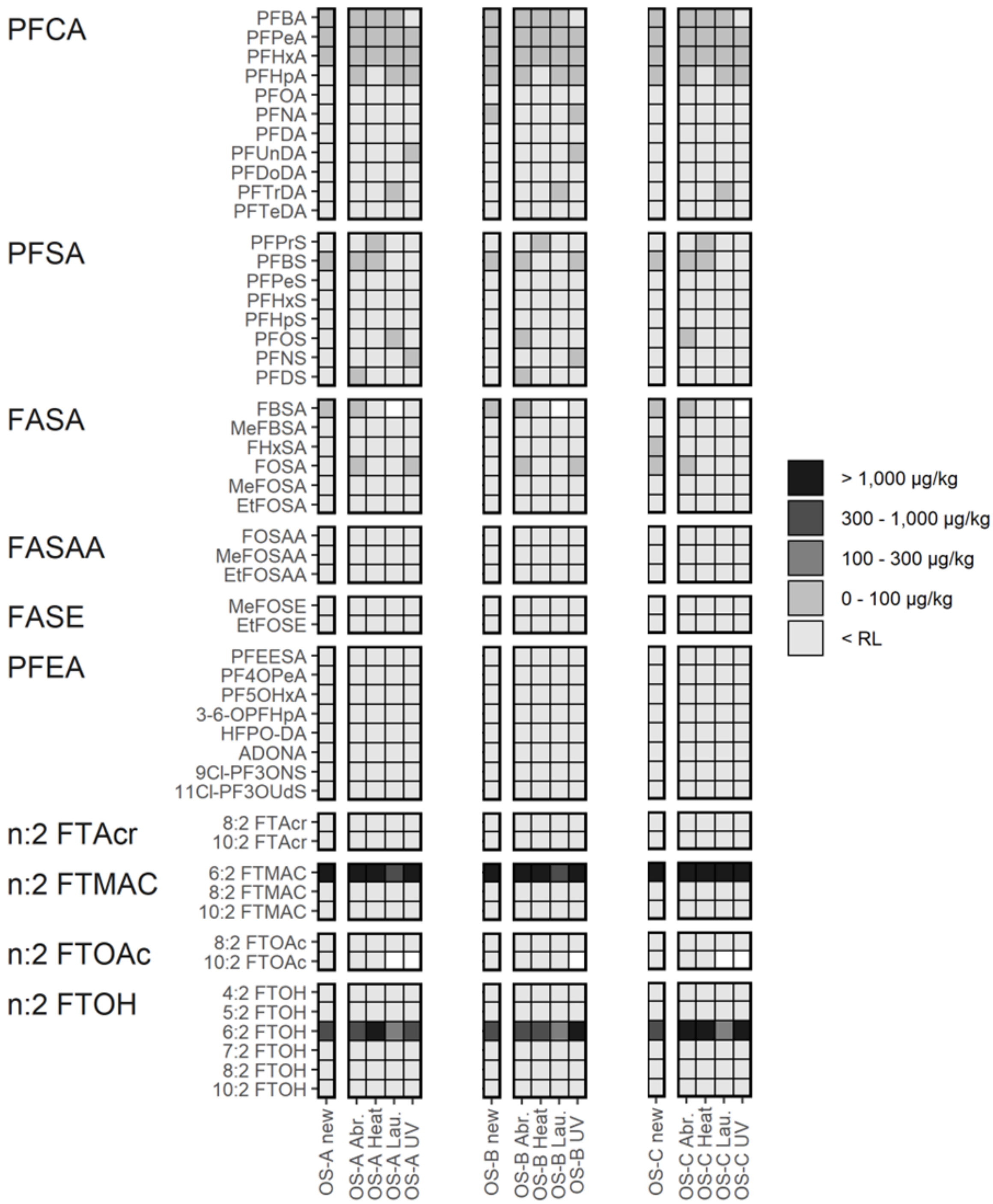


Figure 23. Mean PFAS concentrations determined from triplicate analysis of OS-A (left), OS-B (center), and OS-C (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), laundering (Lau.) or exposure to UV radiation (UV). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

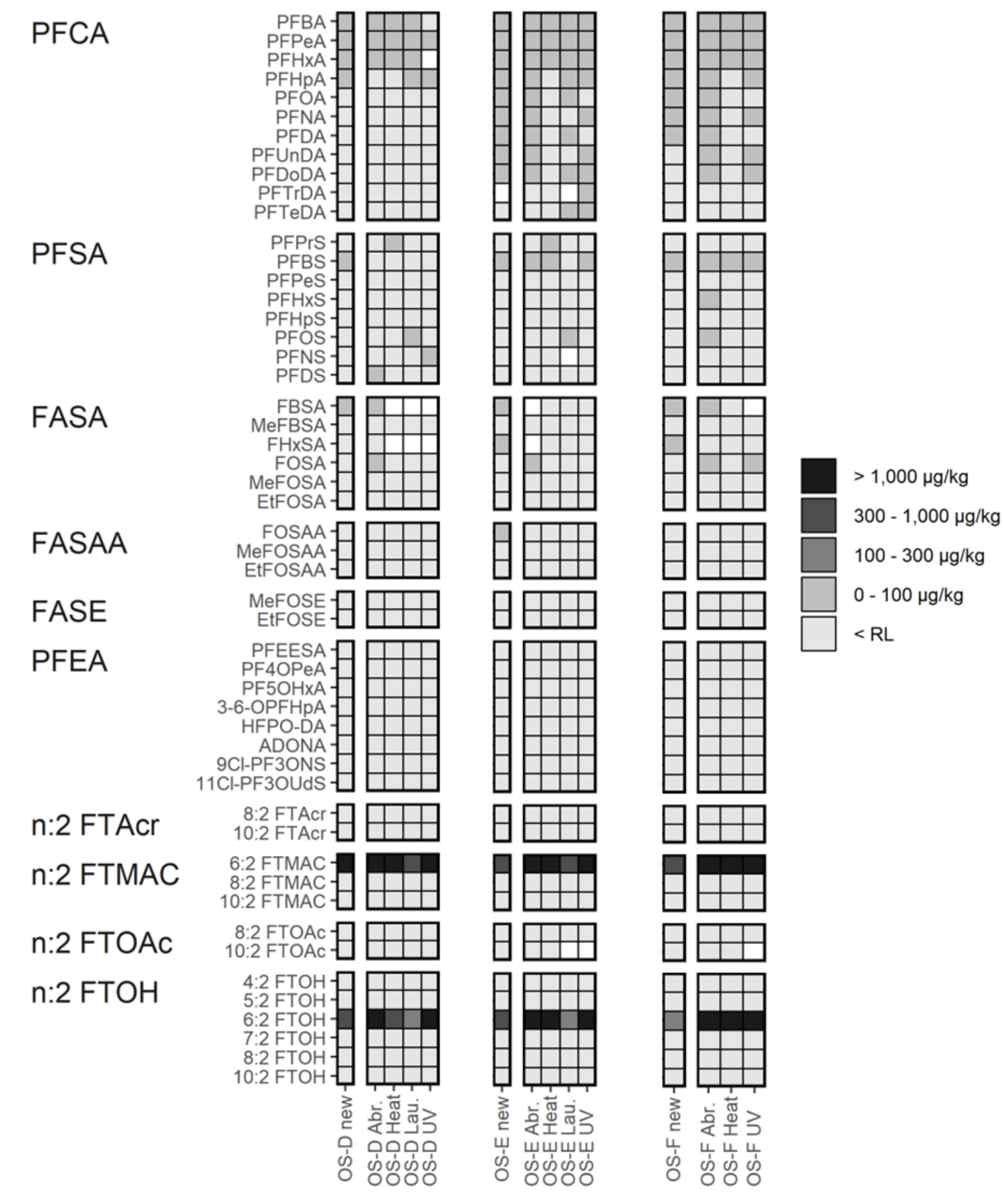


Figure 24. Mean PFAS concentrations determined from triplicate analysis of OS-D (left), OS-E (center), and OS-F (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), laundering (Lau.) or exposure to UV radiation (UV). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

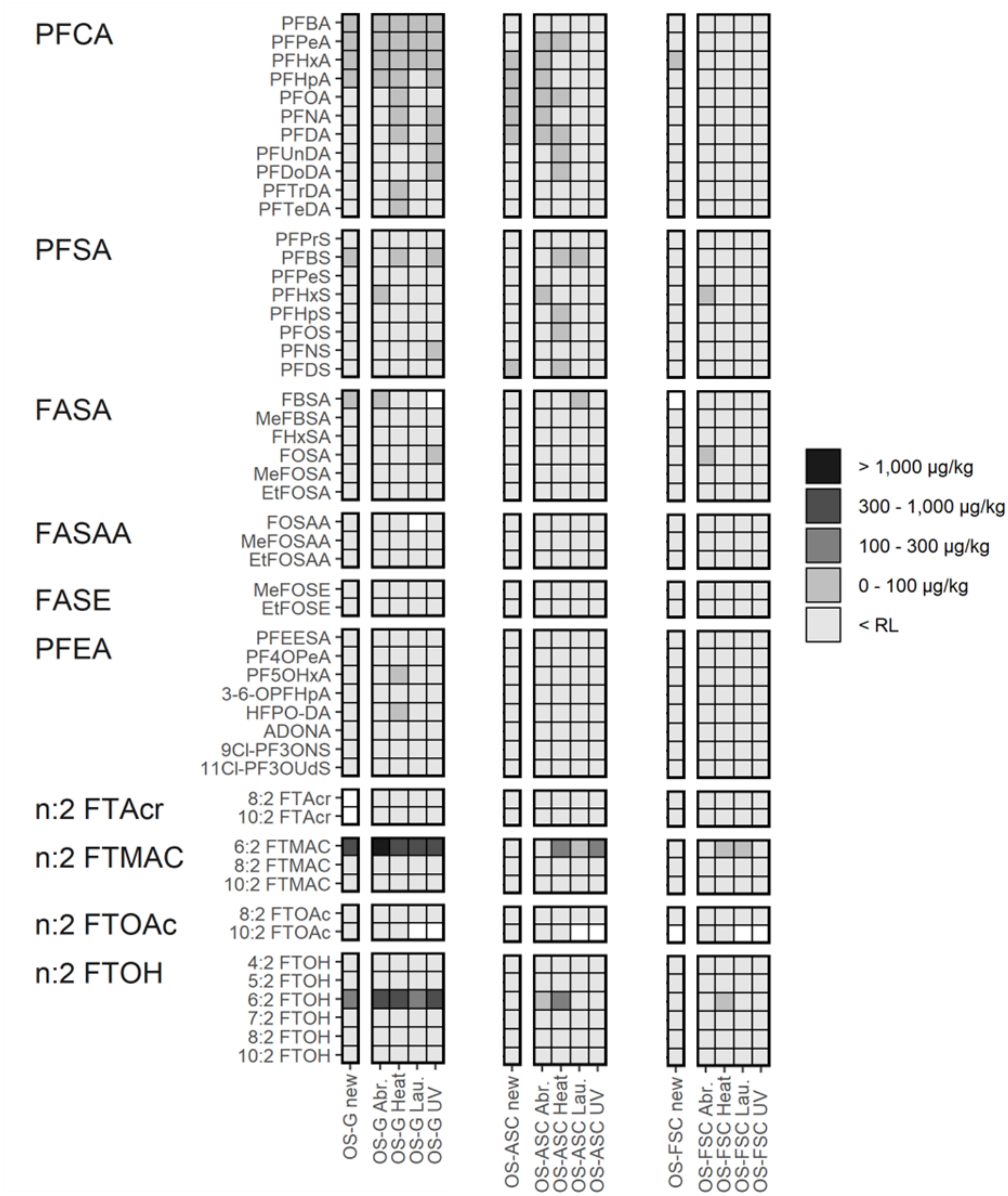


Figure 25. Mean PFAS concentrations determined from triplicate analysis of OS-G (left), OS-ASC (center), and OS-FSC (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), laundering (Lau.) or exposure to UV radiation (UV). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

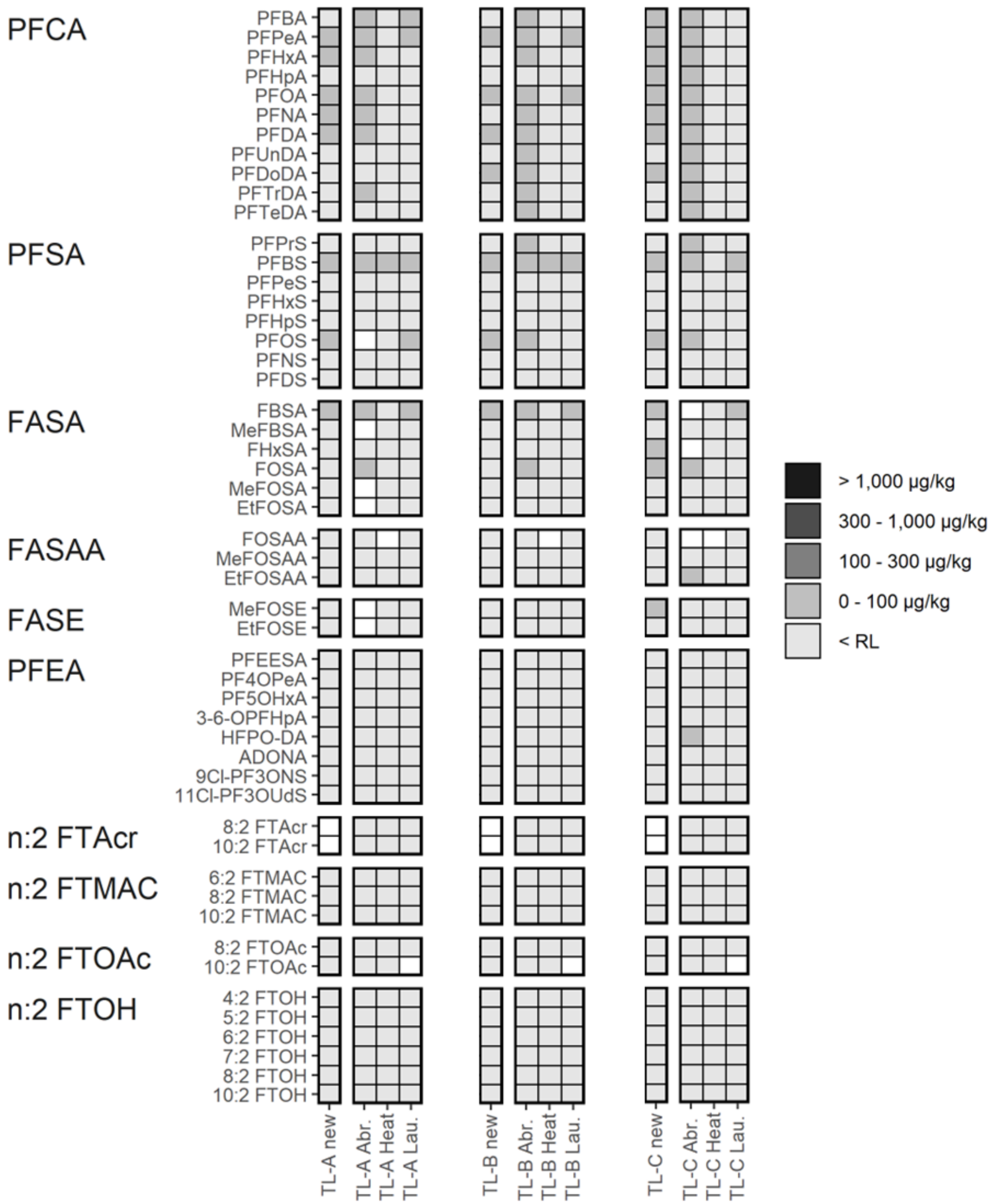


Figure 26. Mean PFAS concentrations determined from triplicate analysis of TL-A (left), TL-B (center), and TL-C (right) either prior to stressing (new) or following abrasion (Abr), exposure to elevated temperatures (Heat), or laundering (Lau.). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

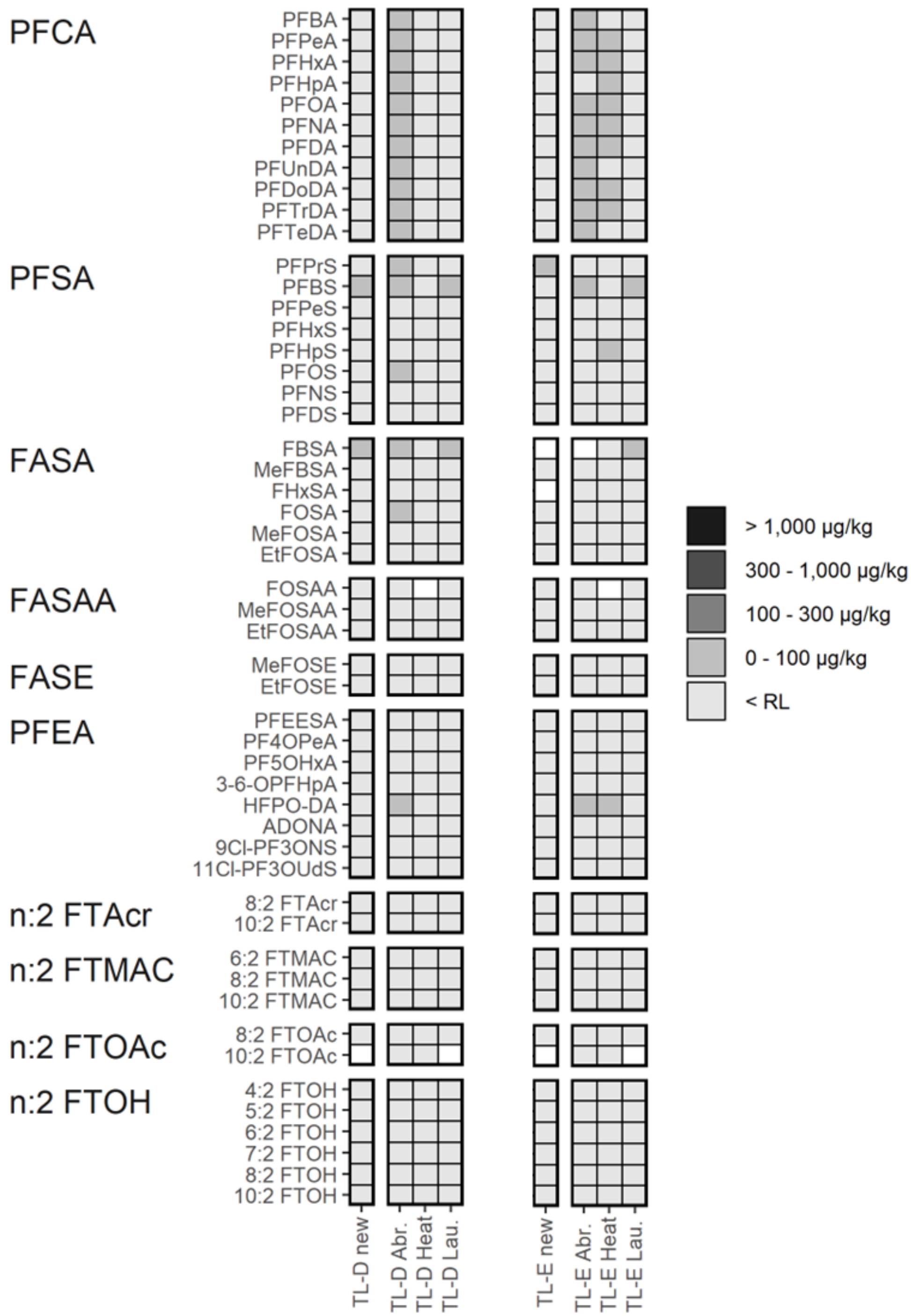


Figure 27. Mean PFAS concentrations determined from triplicate analysis of TL-D (left) and TL-E (right) either prior to stressing (new) or following abrasion (Abr.), exposure to elevated temperatures (Heat), or laundering (Lau.). Concentrations indicated by shade. Measurements not reported due to unmet QC standards are in white.

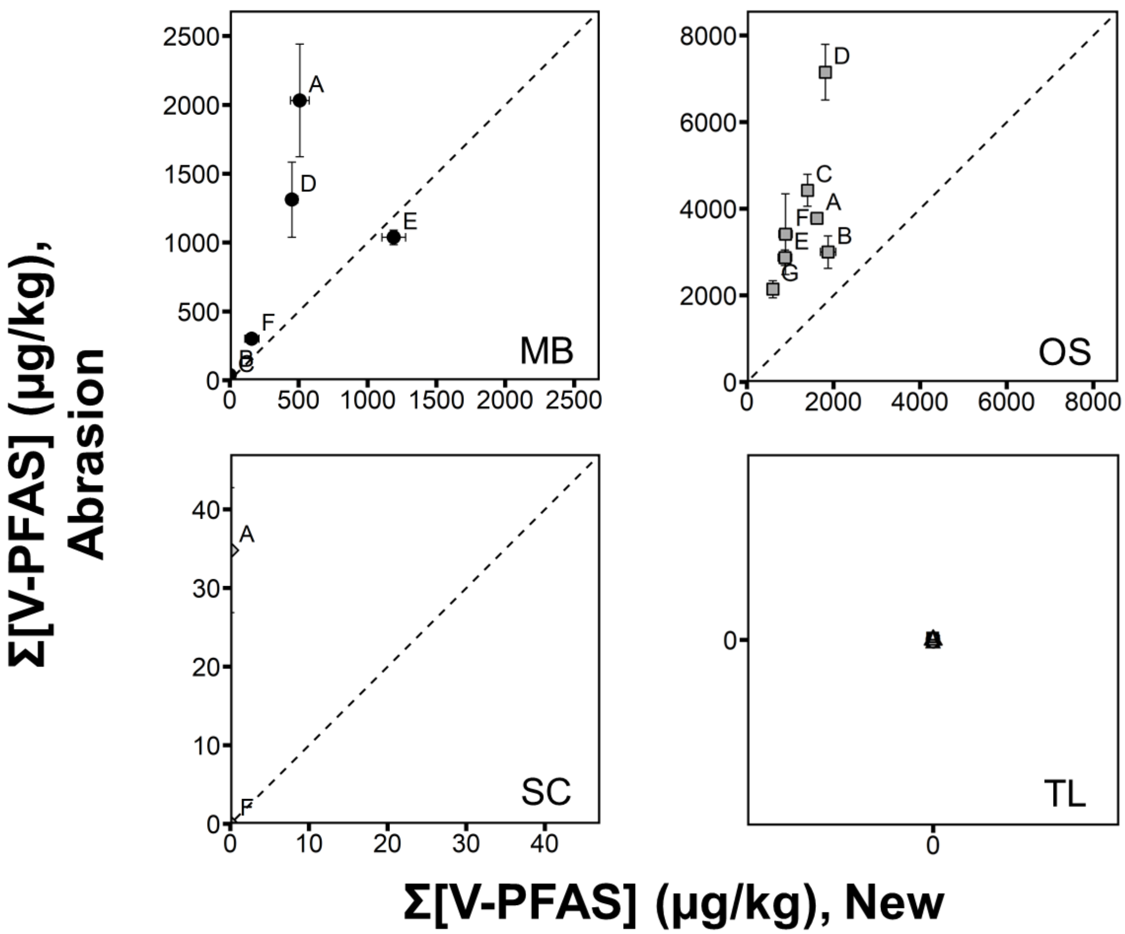


Figure 28. Mean summed concentrations of PFAS determined from triplicate analysis of volatile PFAS in abraded firefighter gear textiles on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

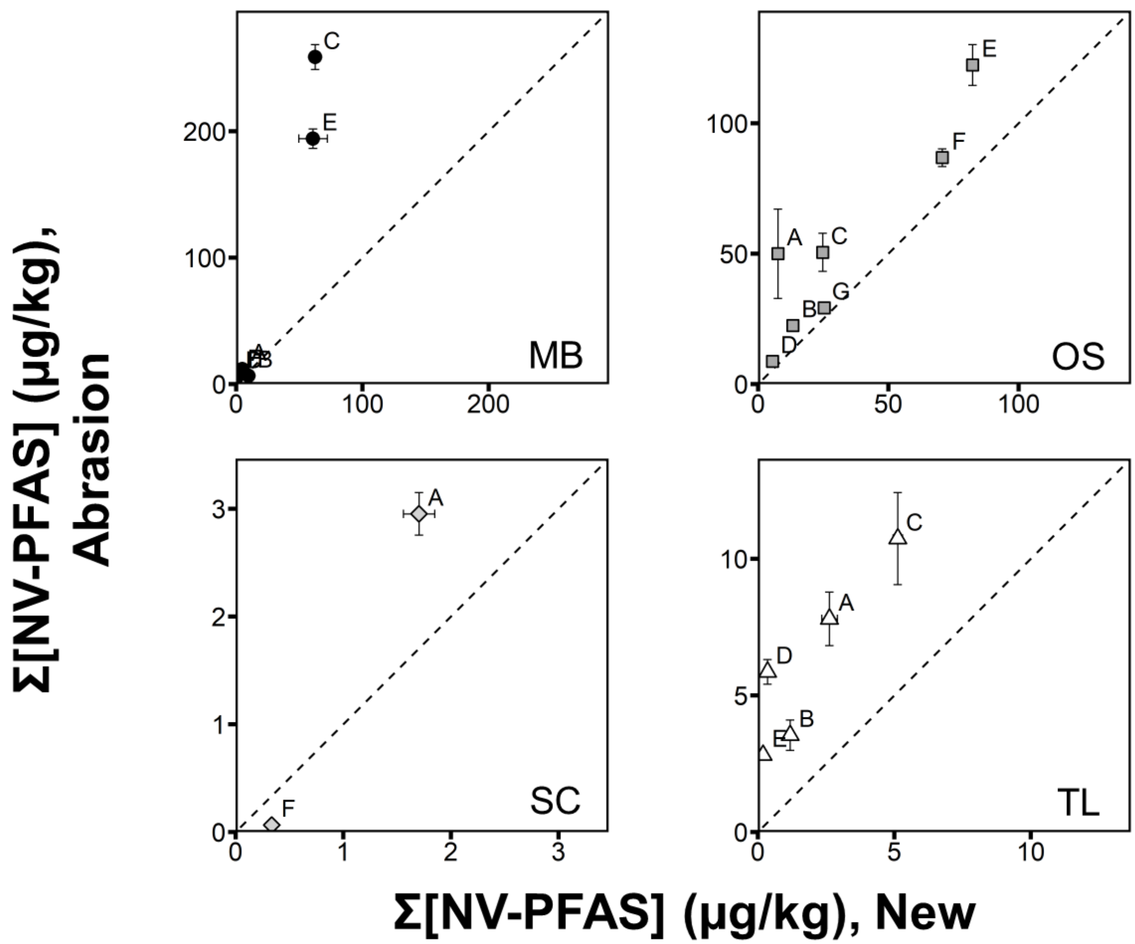


Figure 29. Mean summed concentrations of PFAS determined from triplicate analysis of nonvolatile PFAS in abraded firefighter gear textiles on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

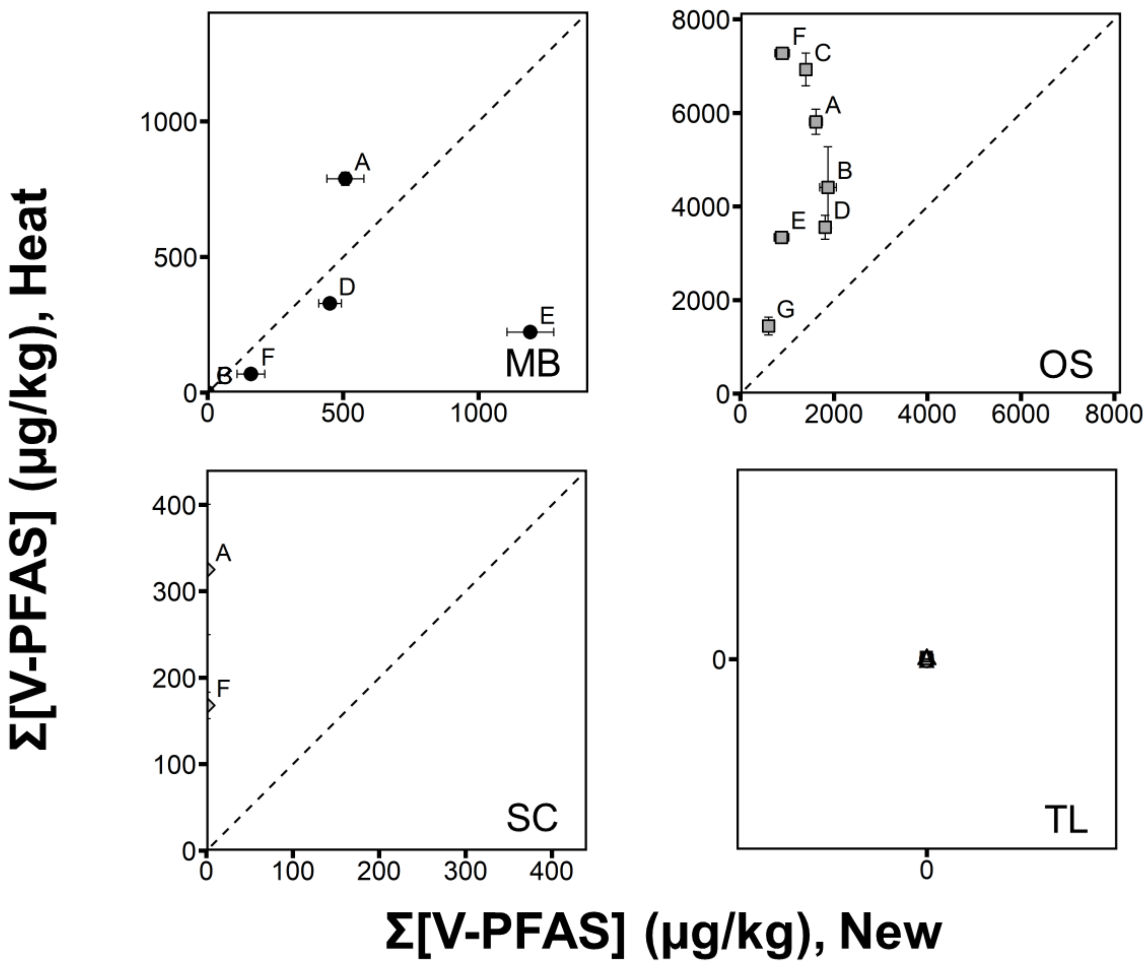


Figure 30. Mean summed concentrations of PFAS determined from triplicate analysis of volatile PFAS in firefighter gear textiles following exposure to elevated temperatures on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

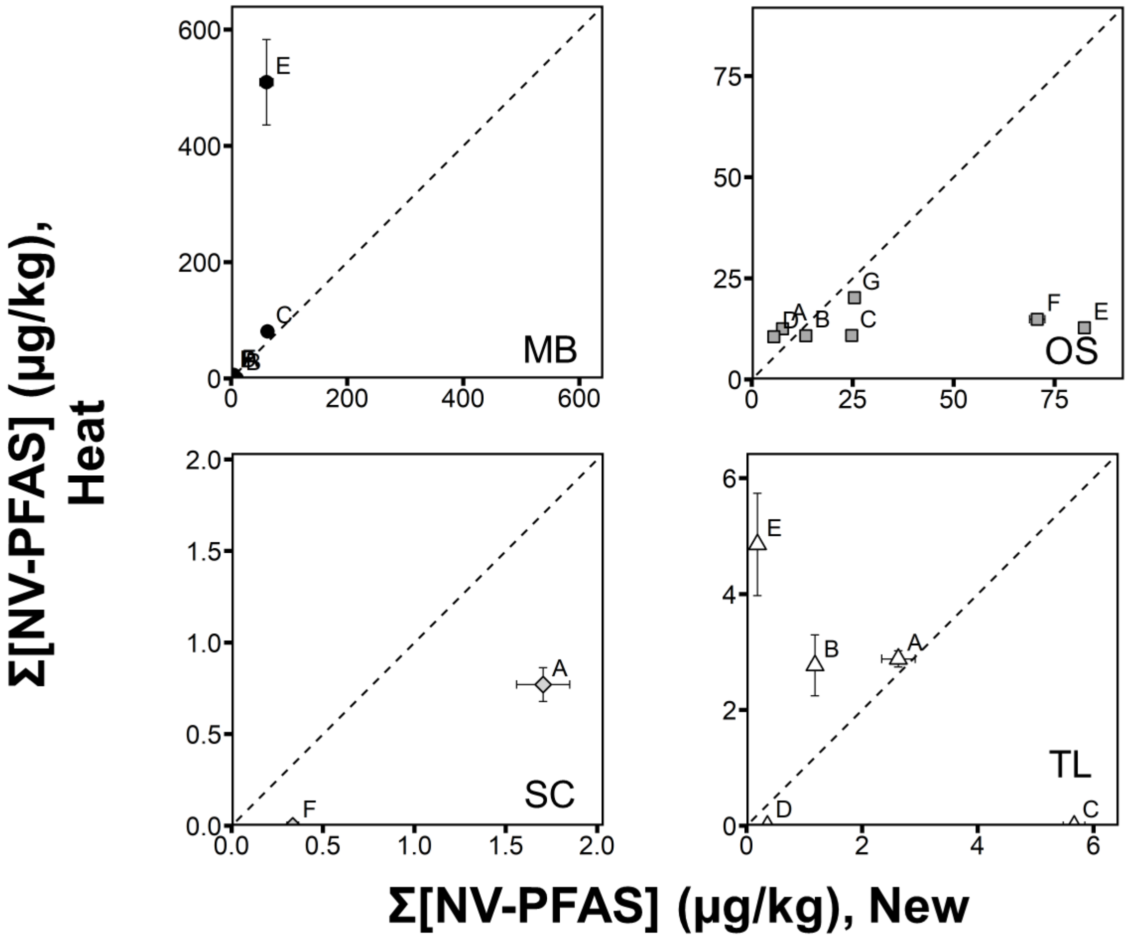


Figure 31. Mean summed concentrations of PFAS determined from triplicate analysis of nonvolatile PFAS in firefighter gear textiles following exposure to elevated temperatures on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

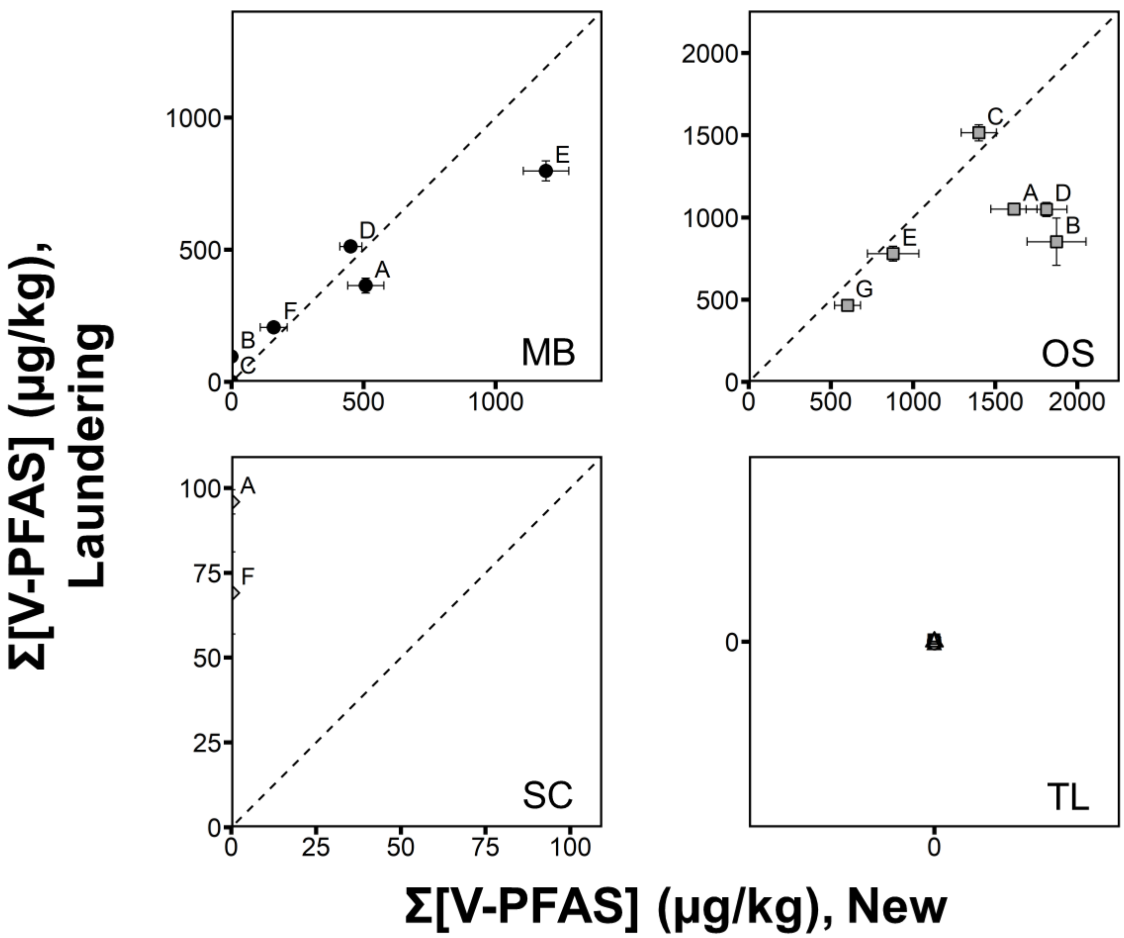


Figure 32. Mean summed concentrations of PFAS determined from triplicate analysis of volatile PFAS in firefighter gear textiles following laundering on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

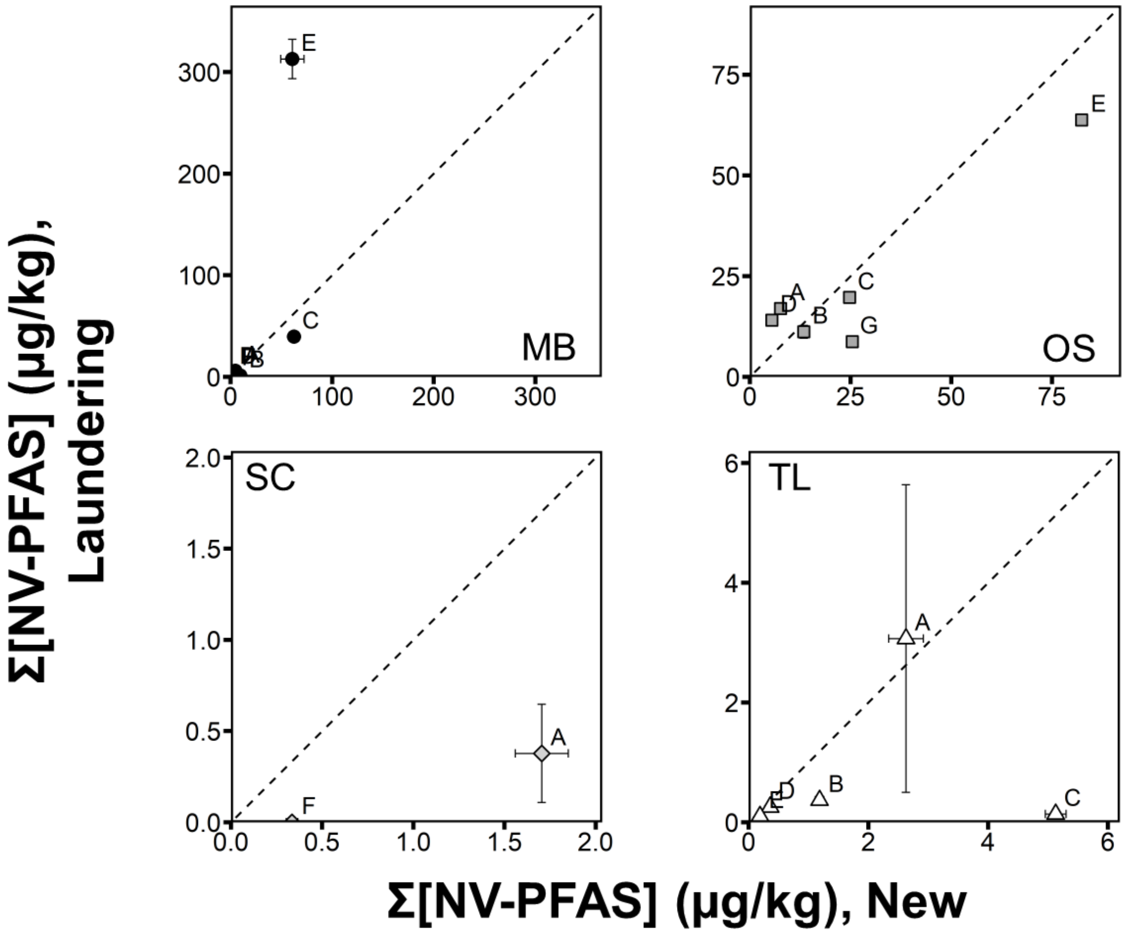


Figure 33. Mean summed concentrations of PFAS determined from triplicate analysis of nonvolatile PFAS in firefighter gear textiles following laundering on y-axis and unstressed firefighter gear textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

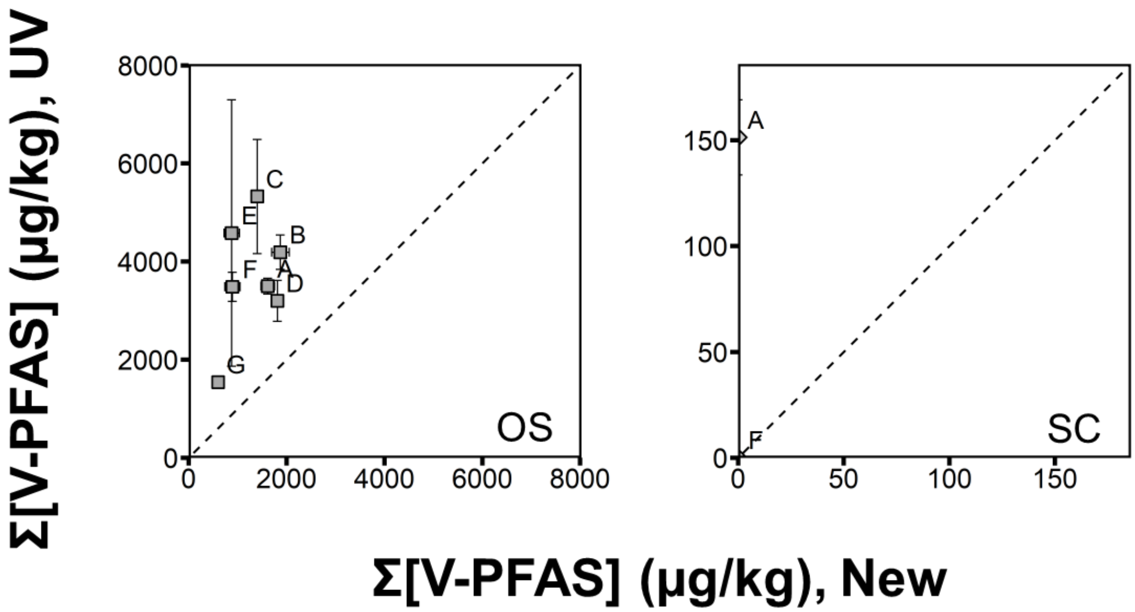


Figure 34. Mean summed concentrations of PFAS determined from triplicate analysis of volatile PFAS in firefighter gear outer shell textiles following weathering on y-axis and unstressed firefighter gear outer shell textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line.

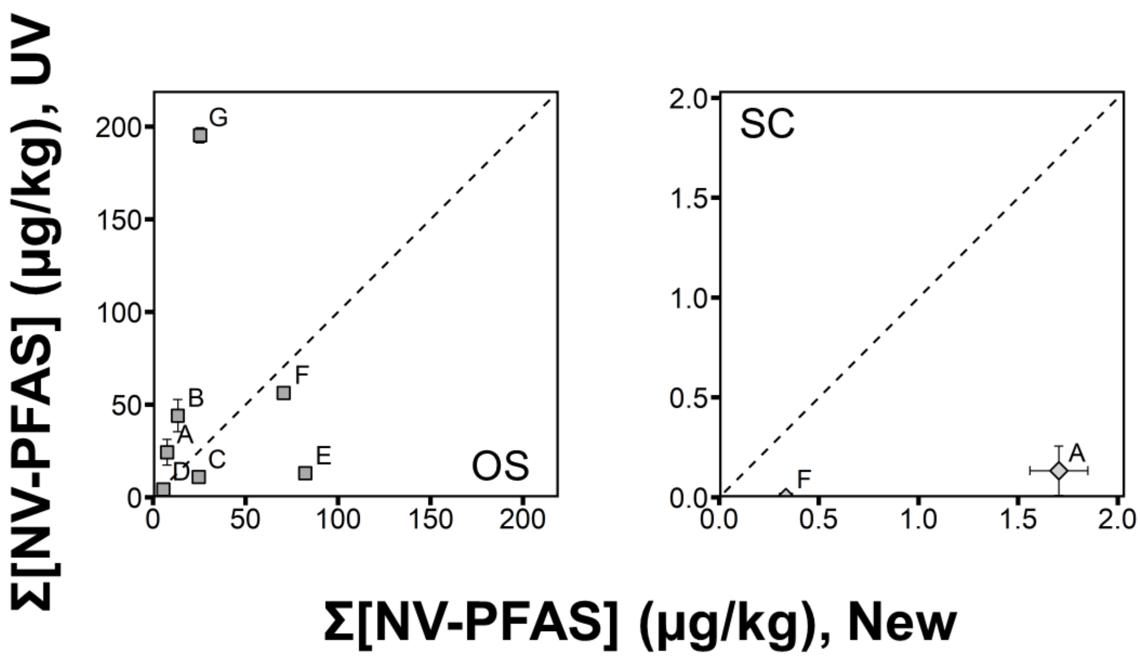


Figure 35. Mean summed concentrations of PFAS determined from triplicate analysis of nonvolatile PFAS in firefighter gear outer shell textiles following weathering on y-axis and unstressed firefighter gear outer shell textiles on x-axis. Error bars indicate combined standard uncertainty. Marker labels indicate the specific textile. A 1:1 concentration ratio (i.e., identical concentrations measured in unstressed and stressed textile) is indicated with a dashed line

Appendix B. List of Abbreviations and Acronyms

10:2 FTAcr
10:2 fluorotelomer acrylate

4:2 FTS
4:2 fluorotelomer sulfonate

6:2 FTMAC
6:2 fluorotelomer methacrylate

6:2 FTOH
6:2 fluorotelomer alcohol

6:2 FTS
6:2 fluorotelomer sulfonate

8:2 FTAcr
8:2 fluorotelomer acrylate

AFFF
Aqueous film-forming foams

CAS RN
Chemical Abstract Service Registry Number

CSD
Chemical Sciences Division

DWR
Durable water repellent

ePTFE
Expanded polytetrafluoroethylene.

FASA
Perfluoroalkane sulfonamide

FASAA
Per- and polyfluoroalkane sulfonamido acetic acid

FASE
Perfluoroalkane sulfonamido ethanol

FBSA
Perfluorobutane sulfonamide

FOSA
Perfluorooctane sulfonamide

FRD
Fire Research Division

GC-MS
Gas chromatography-mass spectrometry

HFPO-DA
Hexafluoropropylene oxide dimer acid

HPLC
High performance liquid chromatography

INJ
Injection standard

IS
Internal standard

ISO
International Organization for Standardization

LC
Liquid chromatography

MB
Moisture barrier

MeFBSE
N-Methyl perfluorobutane sulfonamidoethanol

MRM
Multiple reaction monitoring

MS
Mass spectrometry

MS/MS
Tandem mass spectrometry

n:2 FTAcr
n:2 fluorotelomer acrylate

n:2 FTOAc
n:2 fluorotelomer acetate

n:2 FTOH
n:2 fluorotelomer alcohol

n:2 FTMAC
n:2 fluorotelomer methacrylate

n:2 FTS
n:2 fluorotelomer sulfonate

NFPA
National Fire Protection Association

NIOSH
National Institute for Occupational Safety and Health

NIST
National Institute of Standards and Technology

NIST TN

National Institute of Standards and Technology Technical Note

OS
Outer shell

PF5OPxA
Perfluoro-4-methoxybutanoic acid

PFAA
Perfluoroalkyl acid

PFAS
Per- and polyfluoroalkyl substances

PFBA
Perfluorobutanoic acid

PFBS
Perfluorobutane sulfonic acid

PFCA
Perfluorocarboxylic acid

PFDA
Perfluorodecanoic acid

PFEESA
Perfluoro-2-ethoxyethane sulfonic acid

PFHpA
Perfluoroheptanoic acid

PFHxA
Perfluorohexanoic acid

PFHxS
Perfluoro hexane sulfonic acid

PFNA
Perfluorononanoic acid

PFOA
Perfluorooctanoic acid

PFOS
Perfluorooctane sulfonic acid

PFPeA
Perfluoropentanoic acid

PFSA
Perfluoroalkane sulfonic acid

PPEA
Per- and polyfluoroalkyl ether acid

PTFE
Polytetrafluoroethylene

QC
Quality control

RL
Reporting limit

RM
Reference material

SC
“Scoured” outer shell

SPE
Solid phase extraction

TL
Thermal liner