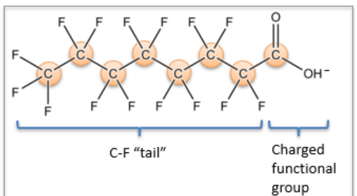
A Reintroduction to Per- and Polyfluoroalkyl Substances (PFAS)

What are PFAS?

Current estimates suggest there are more than 6,500 individuals in the PFAS family, though only a handful are measurable, and an even smaller number are regulated. The two most widely known and studied PFAS are perfluorooctanoic acid (PFOA) and perfluorosulfonic acid (PFOS), both sometimes referred to as "C8" compounds. Individual PFAS are named based on the number of fully fluorinated carbons in the chemical structure.



PFOA: Perfluoro**octa**noic acid

When discussing PFAS in the context of environmental remediation, we are typically talking about the nonpolymer class of PFAS that include sub-classes of perfluoroalkyl acids (PFAAs), including perfluorocarboxylic acids (PFCAs) and perfluorosulfonic acids (PFSAs), to which PFOA and PFOS belong, respectively. Additional PFAS, including fluorotelomers, are increasingly of interest as precursors to other PFAS. Within this Fact Sheet, we will largely be referring to PFAS as a whole or, specifically, the PFAAs PFOA and PFOS.

How are PFAS used?

Since discovery in the late 1930s, PFAS have been in widespread use. The surfactant properties of PFAS make the material they are applied to repel oil, water, soil, and stains; reduce friction; and resist chemical and thermal degradation. These properties have made PFAS use a symbol of modern conveniences like non-stick pans, stain resistant carpets, and some floor waxes, to name a few examples. But some uses of PFAS, like in Mil-Spec aqueous film forming form (AFFF) formulations, are considered essential for health and safety and important to the operational mission of the Department of Defense (DoD).

Why are PFAS a concern?

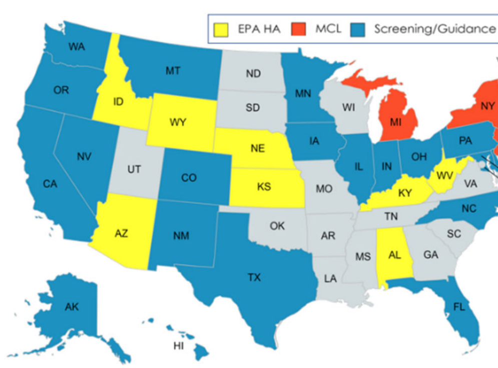
PFAS are known to be persistent and resist degradation, and some are known to bioaccumulate and biomagnify within the food chain. Animal studies have found links between some PFAS and negative health effects including disruption of lipid metabolism, decreased immune function, low infant birth weight, thyroid disease, and certain types of cancer.

Nearly all people in industrialized nations have PFAS in their blood. However, those with occupational exposures are at the greatest risk of adverse health outcomes in comparison to the general population. The presence of some PFAS in blood samples from the general U.S. population have been declining steadily since the 2000s when U.S. manufacture was phased out by the eight largest chemical manufacturers. PFAS have been found in ice core samples from the arctic where no industries are present and were recently documented in rain samples in the Midwest, pointing to atmospheric deposition as a possible worldwide source.

How are PFAS regulated?

PFAS are not yet regulated by the U.S. Environmental Protection Agency (EPA), but in 2016, EPA issued Lifetime Health Advisories for drinking water for two PFAS (PFOA and PFOS). In June 2022, EPA issued interim updates to the Lifetime Health Advisories, lowering the standards by as much as 10,000-fold. Restrictions to limit manufacture, use, and import, and to require reporting of hundreds of PFAS have been enacted. In 2021, EPA issued its Strategic Roadmap that detailed plans to address PFAS, reduce their presence in the environment, and reduce human exposure. EPA has also indicated that it intends to regulate some PFAS under CERCLA and RCRA as hazardous substances.

Many states have promulgated PFAS standards in various environmental media including drinking water. Six states



(AK, CO, MI, NJ, NY, and VT) have designated some PFAS hazardous wastes or substances while four states (CA, NY, ME, and WA) have established various consumer protection measures.

How do PFAS behave in the environment?

Once released to the environment, PFAS move through air, water, and soil in manners unique to their physio-chemical properties and the environmental conditions. For example, PFAS may partition at the soil/water, air/water, or non-aqueous phase liquid/water interfaces. Certain types of PFAS stick to the organic carbon in soils and sediments, but once in groundwater are mobile, forming long and dilute plumes. PFAS are also subject to typical transport mechanisms including advection, dispersion, diffusion, deposition, and leaching.

What are the specific sampling and analysis considerations?

Common sampling equipment, materials, and supplies may contain PFAS measured at ultra-low concentrations. Best practices for sampling are to eliminate the potential for PFAS-containing products to be in or near the sampling area. Collection of equipment blanks and field blanks should be included in the sampling plan to confirm decontamination procedures and ambient site conditions are not inadvertently contaminating the samples.

EPA has approved several methods for analysis of PFAS in various media. Some of the newest methods are still draft and going through validation processes. Additional information pertaining to sampling and analytical considerations can be found in the "PFAS Sampling Considerations and Analytical Chemistry" Fact Sheet, to be published by SAME in summer 2022.

What can be done to treat or remediate PFAS?

PFAS treatment technologies can be described in three categories: demonstrated (or conventional); limited demonstration; and developing. Most conventional technologies are ex-situ, and, in most cases, multiple technologies will be necessary to meet project remedial objectives. To-date, there is no singular technology that can be used to treat the impacted environmental media and destroy PFAS.

The most widely used to remove PFAS from liquid waste streams are sorption and filtration technologies. Other liquid treatments include deep well injection (Class I), coagulation, foam fractionation, and novel sorbents. As of early 2022, DoD placed a moratorium on incineration of PFAS-impacted materials due to concerns about incomplete combustion and production of harmful byproducts.

Allowable conventional options include capping and excavation and transportation to an offsite and permitted landfill. Technologies under development in lab and field scale testing include thermal desorption and biopiles.

A handful of additional technologies are in various stages of development and will be discussed in greater detail in a future IGE PFAS Project Fact Sheet discussing treatment alternatives.

Are there alternatives to AFFF?

Modern AFFF and legacy AFFF are responsible for the majority of PFAS impacts at DoD sties. Legacy PFOS-containing AFFF is no longer manufactured and most current fluorotelomer foams contain different PFAS that do not breakdown to form PFOS. Firefighting foams in use at installations and civil airports must continue to meet Mil-Spec and FAA performance requirements. While fluorine-free foams (F3) are available on the market and do not contain PFAS, they also do not meet Mil-Spec performance requirements. However, the National Defense Authorization Act (FY20) requires full phase out of AFFF by October 1, 2024. By October 1, 2023, the U.S. Navy must revise specification for and ensure PFAS-free foam is available at all military installations.

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