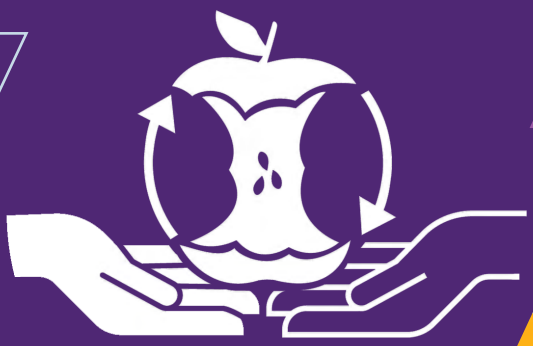
Training Guide

Per- and polyfluoroalkyl substances (PFAS)



Iowa Waste Reduction Center

University of Northern Iowa
College of Business

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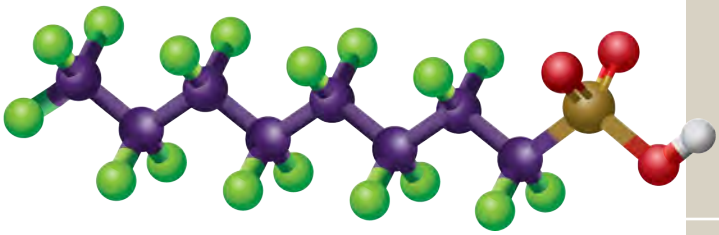
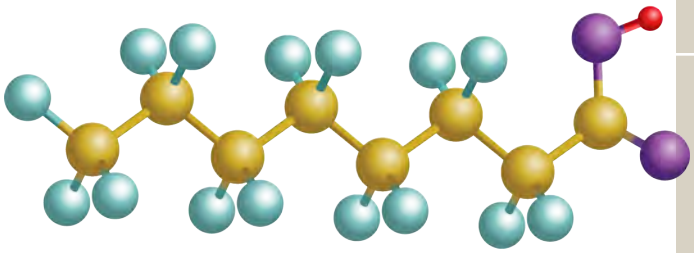
PFOS
perfluorooctanesulfonic acid



PFOA
perfluorooctanoic acid



What Are PFAS?

Per- and polyfluoroalkyl substances (PFAS) are a group of manufactured, highly fluorinated organic compounds that have been used since the 1950s in various industrial processes and in consumer and household products. PFAS are sometimes referred to as 'forever chemicals' because they are difficult to break down and can remain in the environment indefinitely.

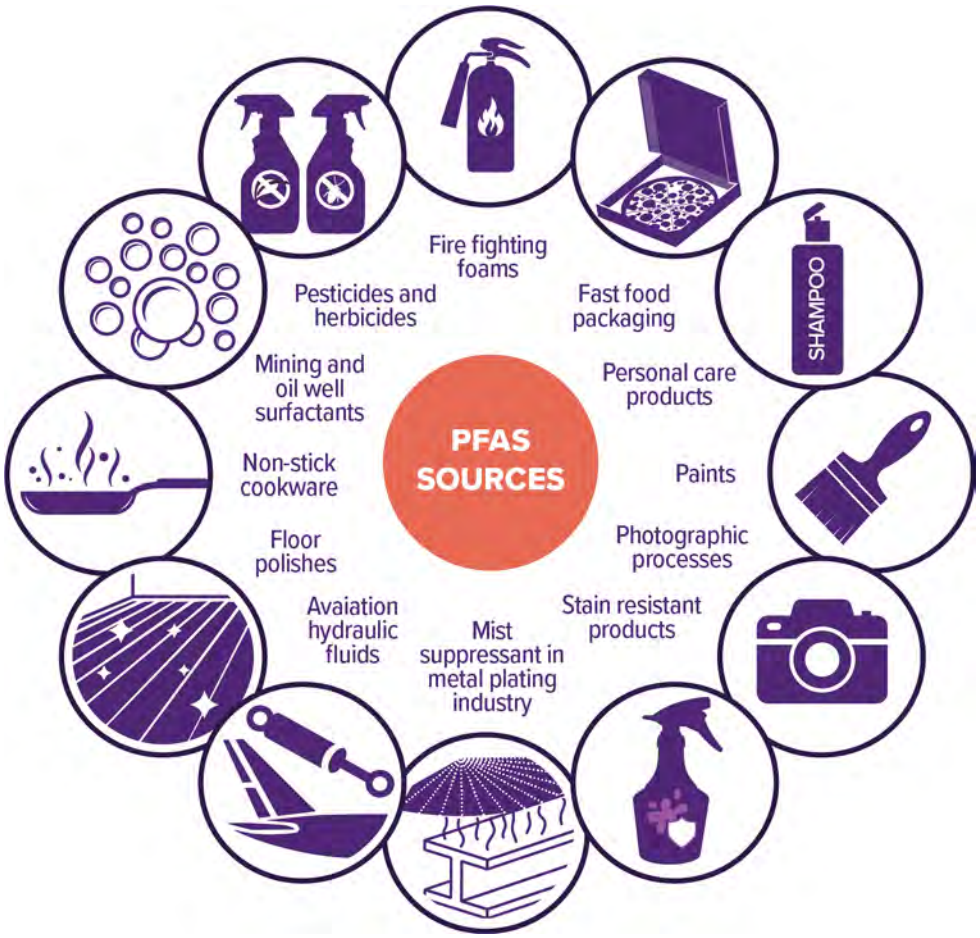
PFAS have been detected globally in water, soil, people and wildlife. There is growing public concern about PFAS contamination due to its widespread detection, documented toxicity in animals, and epidemiological studies which have indicated possible links to adverse human health impacts.

PFAS are valued for their oil, stain and water-resistant properties and became important in firefighting as a fire retardant called Aqueous Film Forming Foam (AFFF). AFFFs are most commonly deployed at military sites and airports. In addition, PFAS are used in industrial and consumer products to prevent corrosion, reduce friction and make products waterproof and stain-resistant. At present, there are over 4700 known PFAS compounds.

Products containing PFAS represent a wide variety of items including: food packaging, cosmetics, paints, wood treatments, and fabrics. They are also utilized in a number of industrial processes including metal-plating, mining and fracking, textile production, manufacturing of industrial chemicals and plastics, photography, and in the semiconductor industry.

PFOA and PFOS have been the most widely produced and studied of this family of chemicals. They have been used in carpets, clothing, fabrics for furniture, cookware, food packaging and other materials that are designed to resist water, oil or stains. PFOA and PFOS were voluntarily phased out of production in the United States in 2015-2016; however, these chemicals continued to be produced abroad.

PFAS Sources



How We Get Exposed to PFAS

PFAS in Our Drinking Water

- PFAS from factories, military bases, airports or firefighting training sites that are released into the environment can be moved by natural processes into our surface water and groundwater.
- PFAS-contaminated consumer products or industrial waste that is thrown away or deposited at landfills can leach PFAS into our soil and groundwater.

PFAS in Our Food Sources

- We can ingest PFAS by eating produce and animal products raised on land and water that is contaminated with PFAS.
- PFAS contamination of some agricultural products is tied to the use of PFAS-contaminated biosolids, a fertilizer made from wastewater byproducts.
- We can also be exposed to PFAS if our food is packaged in containers containing PFAS.
- PFAS contamination bioaccumulates, or concentrates over time, in wildlife. In fact, PFAS have already been discovered in wild game & fish, conventional beef and dairy products, as well as produce.

PFAS in Our Household Products

- PFAS are found in a large number of household items including stain and water resistant fabrics, nonstick cookware, cosmetics, and cleaning products such as floor polishes. Other exposure routes can include carpeting, waxes, pesticides, and herbicides.

Health Risks Associated with PFAS

Over 95% of adolescents and adults have detectable levels of PFAS in their blood. Long-term, low-level exposure is a concern because studies indicate PFAS can remain in our bodies for 4 to 9 years, making them nearly impossible to eliminate due to our continuous exposure to these chemicals.

The EPA's current Health Advisory Level (HA) of 70ppt (parts per trillion) for PFAS only accounts for two of the 4700+ PFAS compounds that exist today. It is important to note, however, that EPA Health Advisories are not enforceable or regulatory.

Peer-reviewed laboratory studies in animals combined with human epidemiological studies indicate that exposure to PFAS at certain levels may lead to adverse health effects, including:

- Developmental Impacts to fetuses during pregnancy and to breastfed infants that may include low birth weight and skeletal variations. Evidence also suggests that children exposed to PFAS can experience developmental effects and delays, as well as lower average weight, accelerated puberty, bone variations and/or behavioral changes.
- Reproductive Impacts such as decreased fertility and high blood pressure in pregnant women.
- Cancers including prostate, testicular and kidney, especially from PFOA exposure.
- Adverse Liver Effects and tissue damage.
- Reduced Immune System Effects including a reduced ability to fight infections and a decreased response to vaccines.
- Hormone Disruption including thyroid hormone disruption from PFOS exposure, as well as interference with the body's other natural hormones.
- Obesity Risk and High Cholesterol

Scientists continue to improve their understanding of the human and environmental health impacts of exposure to PFAS but the process is challenging. First, there are thousands of PFAS with varying effects and toxicity but most studies focus on a small group of these substances.

In addition, people can be exposed to PFAS in a variety of ways at varying levels over a long period of time. The impact of these chemicals on human biology can also vary depending on the different life stages in which PFAS exposure occurs. Finally, the variety of PFAS and their uses have changed over time making it difficult to track the ways we are exposed to them and to understand their environmental and human health impacts.

Federal Oversight & Regulaton

1930s - 1950s

PFAS CHEMISTRY DISCOVERED

PFAS are discovered and manufacturing of these substances began in the 1930s with the notable trademarking of Teflon® in 1945.

1999

PFAS DETECTED IN HUMAN BLOOD

The National Center for Environmental Health (NCEH) reports widespread detection of PFAS in the blood of the US population.

2006

VOLUNTARY PHASE-OUT OF PFOA / PFOS

The US EPA asked that 8 PFAS manufacturers in the US phase out PFOA and PFOS by 2015.

2016

EPA Publishes Formal Health Advisory Levels (HAs) for both PFOA & PFOS at 70ppt (parts per trillion)

2021

EPA Releases PFAS STRATEGIC ROAD MAP OCTOBER 2021

The EPA releases its *PFAS Strategic Road Map* with a focus on developing analytical testing methods, cleanup criteria, and regulatory guidelines for PFAS.

2022

MULTI-AGENCY APPROACH AT THE FEDERAL LEVEL

Currently, the US EPA is finalizing testing standards, improving its understanding of the health effect of PFAS, and moving to regulate PFAS through a variety of federal mechanisms.

Preventing PFAS Contamination

Firefighting Foams (AFFF or Aqueous Film-Forming Foam)

- Fire Departments and airports can implement risk management procedures to prevent uncontrolled releases of AFFF during maintenance, testing, and training.
- 100+ viable alternatives to AFFF exist today that are fluorine-free and meet international aviation standards like GreenFire® Firefighting Foam (GFFF), Universal Green®, and Eco-Gel® among others.
- Update state, federal, and military guidelines to support the use of PFAS-free firefighting foams at fire departments and airports.

Food Packaging

- PFAS-free packaging materials include: uncoated packaging and packaging made from polylactic acid (PLA) a compostable plastic typically made from corn, bamboo (Bambu®), or palm leaf (such as Leafware®).
- PFAS-free package coatings include: PLA (Ecotainer®, Eco-Products®, PrimeWare® and World Centric®), Clay (Bare® and Eco-Forward®), Bio-wax (Ecowax®, Paraflex NoWax).
- Two companies, Zume and Solenis, have open-sourced their recipe for PFAS-free, grease-resistant food containers to all food packaging manufacturers.

Metal-Plating Industries

- Use EPA-approved, non-fluorinated fume suppressants. The surface-finishing industry phased out PFOS in 2015 but some replacements contain other PFAS.
- There are five EPA-approved chrome-plating applications that are PFOS-free: Fumetrol 21 LF2, Dicolloy CRPF, HCA - 8.4, and Macuplex STR NPFX.

Textiles & Furniture

- PFAS-free waterproof fabrics have been developed for the textile and clothing industry. For example, the maker of GORE-TEX® has designed a PFAS-free waterproof membrane called ePE as a replacement for its ePTFE membrane.
- Manufacturers of stain resistant fabrics and furniture can replace applications such as Scotchguard® with non-fluorinated treatments that use acrylic, polyurethane or silicone-based coatings.

Remediating PFAS Contamination

Below are some of the most popular remediation methods. Questions remain however, such as how to deal with PFAS in filtering materials and whether or not there are potential byproducts of these methods, and if incineration releases PFAS into the air.

Granular Activated Carbon (GAC)

- an established and effective treatment for removing long-chain PFAS but further studies are needed on its effectiveness in removing shorter-chain PFAS. GAC can be reused after heat reactivation.

Reverse Osmosis (RO)

- an effective technology for removing contaminants by passing water through a semipermeable membrane. Pretreatment or nanofiltration may be required.

Biochar

- a carbon-rich material generated from heating biomass such as wood or manure in a low-oxygen environment. Biochar functions similarly to GAC and has been tested as a PFAS removal material.

Ion Exchange (IX) Resins

- shown to reduce PFAS concentrations to below detection limits and can be single-use or regenerable. Single-use resins appear to be more effective at PFAS removal.

Incineration

- thermal treatment of PFAS contamination in solids is believed to have a >90% removal rate at temperatures ranging from 842 - 1749.2°F and two studies in 2019 suggested low-heat treatments at 752°F achieved similar results.

Oxidation

- a method using electrical current passed through a chemical solution to oxidize PFAS contamination. PFAS removal ranged from 70% - +90% depending on the technique used.

Ways to Reduce Our Exposure

Any effective, long-term approach to reduce our exposure to PFAS is a pollution prevention approach that seeks to reduce and/or eliminate the chemicals from production at their sources before they ever make their way into the environment and our bodies. In the meantime, there are some simple things that we can do to reduce or eliminate our exposure to PFAS:

- Filter your household's water. Reverse osmosis, undersink two-stage filters, and activated carbon filters are some of the filtration technologies that can be used to filter out PFAS. Most under-sink reverse osmosis filters and two-stage filters have been shown to reduce PFAS by up to 94%.
- Use common PFAS-free cookware such as cast iron, ceramic or stainless steel cooking skillets and pots.
- Avoid grease-resistant food packaging such as those used in fast food packaging, pizza boxes, and microwaveable popcorn.
- Avoid personal care products containing PTFE (Polytetrafluoroethylene, or Teflon®), "anti-aging" cosmetics, or that contain other 'fluoro-' ingredients such as Polyperfluoromethylisopropyl Ether, or DEA-C8-18 Perfluoroalkylethyl Phosphate.
- Support your local farmers and know where your food comes from! Try to purchase from local vendors or farmers markets that offer "chemical-free" or certified organic crops. Gathering information about how our food is grown or raised is no doubt difficult, but connecting with our local producers is the first step to being better informed about our food.
- Follow consumption advisories and public health guidance if your state is investigating PFAS in wildlife. PFAS can bioaccumulate and biomagnify in fish and game animals.
- Look for PFAS-free household products such as cleaners, paints, and home maintenance products. Several big box hardware stores such as Lowe's and Home Depot have policies in place to not carry products with PFAS.
- Discover the benefits of composting! Chemical fertilizers and pesticides can have a number of adverse environmental and health impacts. Some contain PFAS as ingredients or it can leach from their plastic containers. Iowa Waste Reduction Center has more information about community composting and local University Extension Offices, Master Gardeners group, or other local horticulturist(s) will have information about maintaining chemical-free lawns and gardens.
- Pollution prevention (P2) at PFAS sources is key to reducing or eliminating PFAS in the environment. Find out what steps are being taken to ensure your community has access to clean, safe, PFAS-free drinking water.

If you'd like additional information or assistance, please contact Jennifer Trent at jennifer.trent@uni.edu.

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