

Sources of Exposure

Toxicokinetics and Normal Human Levels

Biomarkers/Environmental Levels

General Populations

- The major exposure pathways for perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are food and water ingestion.
- Exposure can occur also from dust ingestion and inhalation from impregnated clothes.
- Exposure from hand-to mouth transfer from treated carpets can be a major exposure pathway for infants and young children.
- Upper intakes of PFOS and PFOA for adults in North America and Europe have been estimated to be approximately 30 and 47 ng/kg/day. Another survey of people in western countries estimated respective intakes of 8.8 and 12.6 ng/kg/day.

Occupational Populations

- Workers at fluorochemical facilities or who perform jobs that require frequent contact with perfluoroalkyl containing products, such as installing and treating carpets, may have higher exposure than the general population.
- Estimated onsite intake of PFOA by workers at a fluorochemical facility ranged from 3.2×10^{-6} to 2.4 ng/kg/day. This amount reflects combined inhalation, oral, and dermal exposure.

Toxicokinetics

- Perfluoroalkyls can be absorbed through the lungs as evidenced by high blood levels in workers exposed to aerosols and dusts of perfluoroalkyls
- Perfluoroalkyls in food and water can enter the bloodstream through the gastrointestinal tract.
- Small amounts of perfluoroalkyls may enter the body through the skin.
- The commonly used PFOA and PFOS stay unchanged in the body for many years. Perfluoroalkyls do not accumulate in fat, but bind to serum proteins. Higher extravascular concentrations are usually found in the liver.
- In general, the shorter the carbon-chain length, the faster the perfluoroalkyl leaves the body.
- PFOA and PFOS are excreted mainly in the urine.

Normal Human Levels

- Mean PFOA, PFOS, and perfluorohexane sulfonic acid (PFHxS) concentrations in serum from the U.S. general population are 2.1–9.6, 14.7–55.8, and 1.5–3.9 ng/mL, respectively. Levels of other perfluoroalkyls are generally <1 ng/mL.

Biomarkers

- Perfluoroalkyls in serum are biomarkers of exposure to themselves. However, based on studies in animals, PFOA and PFOS in blood could also indicate exposure to other perfluoroalkyl compounds.

Environmental Levels

Air

- Concentrations of up to 46 and 919 pg/m³ of PFOS and PFOA have been measured in outdoor urban air. Other perfluoroalkyls are generally <1 pg/m³.

Sediment and Soil

- No data regarding background levels in sediment and soil have been identified.

Water

- No data on background levels in groundwater have been identified. Levels in surface water are generally <50 ng/L.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2009. Toxicological Profile for Perfluoroalkyls (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Perfluoroalkyls

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U.S. Department of Health and
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Chemical and Physical Information

- Perfluoroalkyls are very stable synthetic chemicals made of a carbon chain surrounded by fluorine atoms and an acid or amide group at the end of the carbon chain.
- Their chemical structure makes them unique because they repel oil, grease, and water.
- PFOA and PFOS are manufactured in the largest amounts in the United States.
- Perfluoroalkyls have been used in surface protection products such as carpet and clothing treatments and coatings for paper and cardboard packaging.
- Perfluoroalkyls have been used in fire-fighting foams.
- Perfluoroalkyls have also been used as processing aids in the manufacture of fluoropolymers such as nonstick coatings on cookware.
- Some facilities have announced that they will begin replacing many of the perfluoroalkyls that have been used in the above applications with other substances.

Routes of Exposure

- Inhalation – Minor route of exposure for the general population. Predominant route of exposure for perfluoroalkyl workers.
- Oral – Predominant route of exposure for the general population via ingestion of perfluoroalkyls in food and water. Important for children from hand-to-mouth transfer from treated carpets.
- Dermal – Minor route of exposure for the general population.

Perfluoroalkyls in the Environment

- Perfluoroalkyls can be found in air, soil, and water from the manufacture, use, and disposal of products that contain these chemicals, and during the manufacturing process.
- Perfluoroalkyls can also be formed in the environment when other related chemicals break down.
- Perfluoroalkyls break down very slowly in air, but fall to the ground within days to weeks.
- Perfluoroalkyls do not break down in water.
- Perfluoroalkyls are not known to break down in soil and may be carried through soil by groundwater.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- No inhalation MRLs were derived for perfluoroalkyls.

Oral

- No oral MRLs were derived for perfluoroalkyls.

Health Effects

- Long-term exposure to perfluoroalkyls at work has not been associated with significant adverse health effects, but two studies of workers found changes in sex hormones and cholesterol associated with levels of PFOA in blood.
- A single study of people whose drinking water contained perfluoroalkyls did not find problems in a number of clinical measures tested, but did not examine developmental risks for children or cancer.
- The EPA has begun an evaluation of the carcinogenicity of perfluoroalkyls.

Children's Health

- A study of people, including children, whose drinking water was contaminated with PFOA found no short-term adverse health effects associated with PFOA.
- Three studies of pregnant women found levels of PFOA in the mother's blood associated with slightly lower birth weight. However, another study that looked at exposure to PFOA in drinking water found no such association.
- Perfluoroalkyls have been detected in human breast milk and umbilical cord blood. This indicates that exposure to the fetus and nursing children can occur.