Perfluorooctanoic Acid (PFOA)

Perfluorooctanoic acid (PFOA) is a synthetic per- and polyfluoroalkyl substance (PFAS) that was widely manufactured and used for decades because of its exceptional resistance to heat, water, oil, and chemical degradation. PFOA has historically been used in the production of fluoropolymers, including polytetrafluoroethylene (PTFE), as well as in stain-resistant textiles, food packaging, nonstick cookware, firefighting foams, wire coatings, and numerous industrial applications. Because of the strength of the carbon-fluorine bond, PFOA is extremely persistent in the environment and has been referred to as a "forever chemical." It does not readily degrade under typical environmental conditions and may persist in air, soil, groundwater, surface water, sediment, and living organisms for many years.

Scientific concern regarding PFOA increased substantially during the late twentieth century as environmental monitoring demonstrated widespread contamination of drinking water supplies, wildlife, and human blood. Epidemiological studies involving communities near fluorochemical manufacturing facilities, combined with occupational studies and laboratory research, identified associations between chronic PFOA exposure and multiple adverse health outcomes. These findings prompted increasing regulatory scrutiny and the voluntary phase-out of PFOA production by major U.S. manufacturers during the 2000s. Although domestic production has largely ceased, legacy contamination remains widespread because of historical industrial releases, disposal practices, and the environmental persistence of PFOA.

PFOA is regulated under numerous federal environmental programs because of its persistence, mobility, and potential health risks. In 2024, the U.S. Environmental Protection Agency (EPA) established the first legally enforceable National Primary Drinking Water Regulation for PFOA under the Safe Drinking Water Act, setting a Maximum Contaminant Level (MCL) of 4 nanograms per liter (ng/L). EPA has also designated PFOA as a hazardous substance under CERCLA, requiring reporting of qualifying releases and facilitating cleanup of contaminated sites. Additional regulation occurs under TSCA, the Clean Water Act, and state PFAS programs, while the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) provide guidance for workplace exposure.

PFOA has been extensively evaluated by regulatory and public health agencies because of its carcinogenicity and systemic toxicity. The International Agency for Research on Cancer (IARC) classifies PFOA as Group 1 (carcinogenic to humans). The U.S. Environmental Protection Agency (EPA) has concluded that PFOA is likely to cause cancer in humans following prolonged exposure, while the National Toxicology Program (NTP) has identified evidence linking PFOA exposure to adverse immune, developmental, and systemic health effects. California has also listed PFOA under Proposition 65 as a chemical known to cause cancer. These conclusions are supported by epidemiological studies demonstrating associations between long-term PFOA exposure and kidney cancer, testicular cancer, elevated cholesterol, immune suppression, thyroid disease, liver effects, developmental toxicity, and reduced vaccine response.

Scientific understanding of PFOA toxicity has continued to evolve as research has demonstrated that adverse effects may occur at very low exposure concentrations. Unlike many environmental contaminants, PFOA is highly mobile in groundwater and readily migrates through drinking water aquifers while remaining resistant to natural degradation. PFOA has also been shown to bioaccumulate in humans, with elimination half-lives measured in years. Chronic exposure has been associated with immune system dysfunction, developmental effects, liver injury, endocrine disruption, reproductive effects, elevated cholesterol, and several cancers. Because of its persistence and widespread distribution, PFOA has become one of the most intensively studied PFAS compounds worldwide.

PFOA remains one of the most frequently evaluated contaminants in environmental forensic investigations because of its persistence, mobility, and extensive historical use. Environmental investigations commonly evaluate PFOA in groundwater, drinking water, surface water, soil, sediment, biosolids, ambient air, and biological samples while considering historical manufacturing activities, aqueous film-forming foam (AFFF) use, waste disposal practices, atmospheric deposition, hydrogeology, and groundwater migration to identify sources and assess potential human exposure. Because PFOA often occurs alongside other PFAS compounds, forensic investigations frequently evaluate complete PFAS chemical fingerprints rather than individual compounds alone.

References

Agency for Toxic Substances and Disease Registry. (2021). *Toxicological profile for perfluoroalkyls.* U.S. Department of Health and Human Services. https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

California Office of Environmental Health Hazard Assessment. (2025). *Proposition 65 chemicals list.*https://oehha.ca.gov/proposition-65/proposition-65-list

International Agency for Research on Cancer. (2023). *Perfluorooctanoic acid (PFOA)* (IARC Monographs, Vol. 135). World Health Organization. https://monographs.iarc.who.int/

National Toxicology Program. (2023). *Monograph on the state of the science concerning perfluorooctanoic acid (PFOA).* U.S. Department of Health and Human Services. https://ntp.niehs.nih.gov/

U.S. Environmental Protection Agency. (2024). *Drinking water standards and health advisories for PFAS.*https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas

U.S. Environmental Protection Agency. (2024). *Designation of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) as CERCLA hazardous substances.* https://www.epa.gov/pfas

U.S. Environmental Protection Agency. (2024). *PFAS explained.* https://www.epa.gov/pfas

World Health Organization. (2024). *PFAS and public health.* https://www.who.int/health-topics/chemical-safety