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Per- and Polyfluoroalkyl Substances

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Per- and polyfluoroalkyl substances (PFAS) represent a family of more than 3,000 manmade chemicals with unique chemical and physical properties. PFAS are used in a range of products due to their ability to impart oil and water repellency, temperature resistance, and friction reduction. However, an evolving scientific understanding of PFAS has revealed that some of these substances may threaten environmental and public health. Notably, various PFAS are highly persistent and mobile in the environment. PFAS may also bioaccumulate, with PFAS measured widely in blood samples of humans and animals alike. Finally, PFAS have been associated with an array of adverse health outcomes, leading to growing efforts to regulate these substances.[1,2]

History and Sources of PFAS

Since their introduction in the 1940s, the application of PFAS has spread to a vast range of consumer and industrial products including textile coatings, food packaging, cookware, and firefighting foams. However, as early as the 1970s, concerns began to emerge regarding the potential impacts of PFAS with early studies reporting PFAS in the blood of occupationally exposed workers. Subsequent studies in the 1990s revealed the ubiquity of PFAS in blood samples from the general population, highlighting the potential scope of the issues posed by these compounds.[3]

The terms "long-chain" and "short-chain" are often used as shorthand to classify PFAS based upon the number of carbon atoms contained in a given compound. Much of the early (and present) concern surrounding PFAS centers on long-chain perfluoroalkyl acids (PFAAs), especially perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). A growing realization of the health effects of these compounds led to cooperative efforts between the Environmental Protection Agency (EPA) and chemical manufacturers to voluntarily phase out their production. While much of this phaseout was completed in the early 2000s, production of PFOA and PFOS continues internationally and stocks of products bearing these compounds (especially firefighting foams) remain in the United States. In U.S. manufacturing, long-chain PFAS have been widely replaced by short-chain PFAS chemistries. While research on these compounds is ongoing, concerns exist about the persistence and mobility of short-chain PFAS and comparably little is known about the potential health impacts of these substances.[4]

Exposure to PFAS

The primary pathway of PFAS exposure in the general public is through ingestion in food products. Such exposures may result from contaminated food, as well as PFAS-containing food packaging and cookware. In addition to these foodborne exposures, significant local exposure may occur through consumption of contaminated drinking water. Major sources of local contamination to drinking water supplies (i.e., surface and groundwater) include fire training and fire response sites, industrial sites, landfills, wastewater treatment plants, and the spreading of biosolids generated during wastewater treatment.[5]

Health Effects of PFAS

A growing body of epidemiological research has revealed potential links between PFAS and an array of adverse health effects. These effects include increased cholesterol levels, interference with hormonal activity, disruption to the immune system, reduced fertility in women, and an increased risk of cancer. Many of these findings center on PFOA and PFOS, which remain persistent in the environment despite their phaseout by U.S. manufacturers. As noted previously, little is known about the potential health effects of short-chain PFAS that have served to replace long-chain PFAS.[6]

REGULATION AND GUIDANCE ON PFAS

Following an evolving scientific understanding of the potential impacts of PFAS, federal and state authorities have established a variety of guidance values and regulatory standards for these substances. At the federal level, regulation on PFAS remains relatively limited. While the use of various PFAS is controlled under the Toxic Substances Control Act, PFAS are not specifically regulated within other major federal environmental statutes. In 2016, the EPA established a Lifetime Health Advisory value for PFOA and PFOS in drinking water, though there is no binding federal standard. In February 2019, the EPA released its Per- and Polyfluoroalkyl Substances Action Plan. Under this plan, the EPA will evaluate the need for regulatory standards for PFOA and PFOS in drinking water. Additionally, the EPA is beginning the steps to propose designating PFOA and PFOS as hazardous substances through relevant federal statutory mechanisms.[7]

Alongside the EPA, the Department of Defense (DoD) has played a prominent role in addressing PFAS, largely due to the contamination associated with firefighting foams at DoD sites. In July 2019, the DoD established a PFAS Task Force with focus areas including the health aspects of PFAS exposure and science-supported standards for exposure and clean up. Additionally, defense appropriation bills that passed the U.S. House and Senate in 2019 mandate that the DoD cease usage of PFAS-containing firefighting foams at its facilities within the next decade. Notably, this prohibition extends to all PFAS-containing foams, rather than exclusively foams containing long-chain PFAS.[8]

In the absence of federal regulation, a number of states have addressed PFAS contamination through a variety of programs. In some instances, states regulate PFAS through labeling and consumer protection laws, as well as through the designation of various PFAS as hazardous wastes. More commonly, states have developed standards and guidance values for PFAS in drinking water and groundwater. In most instances, these values apply to PFOA and PFOS though some states have also moved to promulgate values for other PFAS, including both short- and long-chain compounds. While regulatory and advisory values differ state-to-state, these differences may arise from differences in the selection of toxicity data, uncertainty factors, animal-to-human extrapolation, and exposure assumptions. Importantly, these differences do not appear to result from disputes over the science underlying the effects of PFAS.[9]

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[1] Interstate Technology & Regulatory Council (ITRC), *Per- and Polyfluoroalkyl Substances (PFAS) Fact Sheets*, (November 2017), https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_introductory__11_13_17.pdf.

[2] ITRC, *History and Use of Per- and Polyfluoroalkyl Substances (PFAS)*, (November 2017), https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf.

[3] *Id.*, ITRC, *History and Use of Per- and Polyfluoroalkyl Substances (PFAS)*, (November 2017).

[4] *Id.*, ITRC, *History and Use of Per- and Polyfluoroalkyl Substances (PFAS)*, (November 2017), ITRC, *Naming Conventions and Physical and Chemical Properties of Per- and Polyfluoroalkyl Substances (PFAS)*, (March 2018), https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_naming_conventions__3_16_18.pdf, and Fan Li, Jun Duan, Shuting Tian, Haodong Ji, Yangmo Zhu, Zongsu Wei, Dongye Zhao, *Short-chain per- and polyfluoroalkyl substances in aquatic systems: Occurrence, impacts and treatment*, Chemical Engineering Journal, Volume 380, (2020).

[5] ITRC, *Environmental Fate and Transport for Per- and Polyfluoroalkyl Substances (PFAS)*, (March 2018), https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_fate_and_transport__3_16_18.pdf.

[6] Agency for Toxic Substances & Disease Registry. *Toxicological Profile for Perfluoroalkyls. Chapter 2. Health Effects*, (June 2018), https://www.atsdr.cdc.gov/toxprofiles/tp200-c2.pdf. Stephan Brendel, Éva Fetter, Claudia Staude, Lena Vierke, Annegret Biegel-Engler, *Short-chain perfluoroalkyl acids: environmental concerns and a regulatory strategy under REACH*, Environmental Sciences Europe, Volume 30(1), (2018).

[7] ITRC, *Regulations, Guidance, and Advisories for Per- and Polyfluoroalkyl Substances (PFAS)*, (January 2018), https://pfas-1.itrcweb.org/wp-content/uploads/2018/01/pfas_fact_sheet_regulations__1_4_18.pdf. U.S. EPA, *EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan*, (February 2019), https://www.epa.gov/sites/production/files/2019-02/documents/pfas_action_plan_021319_508compliant_1.pdf.

[8] National Defense Authorization Act for Fiscal Year 2020, S. 1790, 116th Congress, (2019-2020). National Defense Authorization Act for Fiscal Year 2020, H.R. 2500, 116th Congress, (2019-2020). Mark Esper. (July 23, 2019). *Per- and Polyfluoroalkyl Substances Task Force*. [Memorandum], Washington, DC: Department of Defense. Retrieved from https://media.defense.gov/2019/Aug/09/2002169524/-1/-1/1/PER-AND-POLYFLUOROALKYL-SUBSTANCES-TASK-FORCE.PDF.

[9] *Id.*, ITRC, *Regulations, Guidance, and Advisories for Per- and Polyfluoroalkyl Substances (PFAS)*, (January 2018), https://pfas-1.itrcweb.org/wp-content/uploads/2018/01/pfas_fact_sheet_regulations__1_4_18.pdf.