

Scientists' Statement on Defining PFAS

The undersigned are scientists with expertise in per- and polyfluoroalkyl substances ("PFAS"). We study the use and health & environmental effects of PFAS, and support reducing the adverse impacts of PFAS, the "forever chemicals". Here, we address the necessity for government agencies and legislatures to adopt complete PFAS definitions grounded in science without political interference.

PFAS are used in consumer and industrial applications as surfactants and to impart oil, water, and stain resistance. There are thousands of PFAS chemicals and all well-studied PFAS show human health harms ranging from immune system dysfunction to increased risk of certain cancers.¹ All PFAS are distinguished by the presence of at least one fully fluorinated carbon atom. The carbon-fluorine bond is the strongest single bond in organic chemistry², giving all PFAS the shared trait of persistence, leading to their accumulation in our bodies and ecosystems. The health and environmental risks of PFAS coupled with their extreme environmental persistence³ requires a class-based approach⁴ and a definition that reflects that.

The following are science-based definitions:

- The "at least one fully fluorinated carbon" definition that has been used by 23 US states, the Department of Defense, and Congress.⁵
- The nearly identical 2021 OECD definition that was crafted by a panel of international PFAS experts, including those representing the chemical industry and US EPA.⁶

PFAS definitions that exclude polymers and gases are overlooking the most widely used PFAS. Claims that these PFAS are needed to fulfill climate and infrastructure goals are irrelevant to the definition of PFAS and are continuing to be refuted through the development of safer alternatives.

PFAS polymers can be thought of as plastics that contain carbon-fluorine bonds. They have been exempted in some PFAS regulations and definitions due to their lack of direct toxicity, but life-cycle effects must be considered to protect our health and our ecosystems.⁷ The manufacturing, use, and disposal of PFAS polymers emits harmful fluorinated building blocks and PFAS greenhouse gases, with *80% of historical PFAS environmental contamination estimated to have originated from polymer production*.⁸ PFAS polymers are also persistent, contributing to the ongoing microplastic crisis. Any PFAS definition grounded in science must include all PFAS polymers.

Fluorinated gases must also be included in the class of PFAS. Many persist in the environment or decay into trifluoroacetic acid (TFA), a PFAS that has been building up in the environment since the introduction of CFC replacements like hydrofluoroolefin (HFO) gases. We are concerned that TFA has been increasingly detected in people and drinking water worldwide.^{9,10} The low global warming potential of some fluorinated gases does not justify their exclusion from the definition of PFAS.

Government agencies and legislatures should continue to define PFAS accurately using the above definitions, and if any exemptions are needed, e.g., for certain pharmaceuticals, then those can be given without changing the definition of PFAS.

Respectfully signed,

The views expressed are those of the signatories and do not represent their affiliated organizations.

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Are you a PFAS scientist who would like to add your name? Visit tinyurl.com/signPFAS.

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- ¹ Fenton, S. E.; Ducatman, A.; Boobis, A.; DeWitt, J. C.; Lau, C.; Ng, C.; Smith, J. S.; Roberts, S. M., Per- and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research. *Environ. Toxicol. Chem.* 2021, 40 (3), 606-630
- ² O'Hagan, D., Understanding organofluorine chemistry. An introduction to the C–F bond. *Chem. Soc. Rev.* 2008, 37 (2), 308-319.
- ³ Cousins, I. T.; DeWitt, J. C.; Glüge, J.; Goldenman, G.; Herzke, D.; Lohmann, R.; Ng, C. A.; Scheringer, M.; Wang, Z., The high persistence of PFAS is sufficient for their management as a chemical class. *Environ. Sci.: Process. Impacts* 2020, 22 (12), 2307-2312.
- ⁴ Kwiatkowski, C. F.; Andrews, D. Q.; Birnbaum, L. S.; Bruton, T. A.; DeWitt, J. C.; Knappe, D. R. U.; Maffini, M. V.; Miller, M. F.; Pelch, K. E.; Reade, A.; Soehl, A.; Trier, X.; Venier, M.; Wagner, C. C.; Wang, Z.; Blum, A., Scientific Basis for Managing PFAS as a Chemical Class. *Environ. Sci. Tech. Lett.* 2020, 7 (8), 532-543.
- ⁵ <https://www.saferstates.org/priorities/pfas/>
- ⁶ "PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it)" [https://one.oecd.org/document/ENV/CBC/MONO\(2021\)25/En/pdf](https://one.oecd.org/document/ENV/CBC/MONO(2021)25/En/pdf)
- ⁷ Lohmann, R.; Cousins, I. T.; DeWitt, J. C.; Glüge, J.; Goldenman, G.; Herzke, D.; Lindstrom, A. B.; Miller, M. F.; Ng, C. A.; Patton, S.; Scheringer, M.; Trier, X.; Wang, Z., Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environ. Sci. Technol.* 2020, 54 (20), 12820-12828.
- ⁸ Prevedouros, K.; Cousins, I. T.; Buck, R. C.; Korzeniowski, S. H., Sources, Fate and Transport of Perfluorocarboxylates. *Environ. Sci. Technol.* 2006, 40 (1), 32-44.
- ⁹ Zheng, G.; Eick, S. M.; Salamova, A., Elevated Levels of Ultrashort- and Short-Chain Perfluoroalkyl Acids in US Homes and People. *Environ. Sci. Technol.* 2023, 57 (42), 15782-15793.
- ¹⁰ Pickard, H. M.; Criscitiello, A. S.; Persaud, D.; Spencer, C.; Muir, D. C. G.; Lehnher, I.; Sharp, M. J.; De Silva, A. O.; Young, C. J., Ice Core Record of Persistent Short-Chain Fluorinated Alkyl Acids: Evidence of the Impact From Global Environmental Regulations. *Geophys. Res. Lett.* 2020, 47 (10).