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Comment on "Fluorotechnology Is Critical to Modern Life: The FluoroCouncil Counterpoint to the Madrid Statement"

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We commend the FluoroCouncil for phasing out long-chain poly- and perfluoroalkyl substance (PFAS) chemistry. However, members of the FluoroCouncil have been producing long-chain PFASs for decades while in possession of research showing adverse health effects in humans and animals. This model of chemical manufacturing needs to change. We recommend implementing the principles of green chemistry (Anastas and Warner 1998) in chemical manufacturing to ensure safer and sustainable chemical products. The scientific consensus of the Madrid Statement authors and signatories is that the use of all PFASs is unsustainable, and can and should be greatly reduced and discontinued where feasible. Short-chain fluorinated alternatives were therefore intentionally included in the scope of the Madrid Statement.

Some of the functionalities provided by fluorotechnology have become part of modern life. However, we disagree that PFASs are critical to modern life. Sustainable and less hazardous alternatives are available for many functionalities, and others will be developed. PFAS-based chemistries are used in many nonessential applications such as clothing, sports equipment, food packaging materials, blooming and dispersion agents, and stain-repellant treatments. We urge the FluoroCouncil to provide as much information as possible on the PFAS chemistries used in different commercial products and technologies.

We are aware that short-chain perfluoroalkyl acids bioaccumulate less than long-chain ones. However, some short-chain PFASs have been linked to adverse biological effects (Bull et al. 2014), and further systematic, representative studies on additional end points are needed. Given the ongoing release and environmental persistence of short-chain acids, increasing environmental and human exposures such as those documented by Glynn et al. (2012) are expected, for example, via contaminated drinking water aquifers (Xiao et al. 2015). Thus, continuous release of short-chain PFASs can be expected to lead to poorly reversible internal exposures, regardless of their low bioaccumulation potential (Scheringer et al. 2014).

Bowman commented that the Madrid Statement cannot claim insufficient data on the hazards and risks of fluorinated alternatives. However, Wang et al. (2015) highlighted the specific data gaps that prohibit conducting hazard and risk assessments for many fluorinated alternatives. An assessment commissioned by the FluoroCouncil (ENVIRON International Corporation 2014) also identified many gaps regarding human health data.

Bowman stated that "decisions on the societal acceptability of strategic materials such as PFASs cannot be wisely made on a single attribute such as persistence." However, persistent chemicals are unsustainable in a world with limited resources. We cannot afford to "lose" portions of resources (water, soil, or food) because potentially harmful and persistent chemicals are accumulating over centuries and causing continuous exposure. Because of their persistence, an enormous inventory of PFASs is being created: Even if all PFAS production and uses were to stop immediately, PFASs would continue to be released for decades during products' use and disposal life-cycle phases (Wang et al. 2014a, 2014b). One of the 12 principles of green chemistry is "design for degradation: chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment" (Anastas and Warner 1998). We endorse this principle and urge the FluoroCouncil to follow it also.

We welcome collaboration with the FluoroCouncil to establish information-sharing platforms for PFASs and support all opportunities for dialogue. We ask the FluoroCouncil to take leadership and responsibility for the global management of the PFASs they produce, from manufacturing to end of life.

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The FluoroCouncil's voluntary development of alternative chemistries is unprecedented and a model for the development and introduction of more sustainable chemistry worldwide. More than a decade ago, the FluoroCouncil member companies responded to concerns about long-chain poly- and perfluoroalkyl substances (PFASs) by working with regulators to voluntarily phase out those substances and develop alternatives with improved health and environmental profiles. The FluoroCouncil also works with regulators and other stakeholders to support a global transition away from long-chain PFASs. This effort stands as a historic collaboration by government and industry to foster sustainable development.

The claim that all PFASs are problematic is simply not supported by the wealth of data available on both long- and short-chain PFASs. Because of the concerns raised in regard to long-chain PFASs, the U.S. Environmental Protection Agency (EPA) has held the fluorotechnology industry to high standards and increased data requirements to ensure the alternatives are well studied and safer than the substances being replaced. Consequently, short-chain PFASs are some of the most robustly studied new chemicals introduced to the market, having undergone years of toxicity and environmental testing at the request of regulators. Industry continues this collaboration with regulators, developing additional data on the alternatives and working to make those data publicly available, including on the FluoroCouncil website (http://www.fluorocouncil.org/Resources/Research). Based on this robust body of data, regulators globally have determined the alternatives are safe for their intended use. The "sustainable and less hazardous alternatives" sought by the Madrid Statement authors already exist in the form of short-chain PFASs.

We continue to be perplexed by assertions from the authors of the Madrid Statement that short-chain PFASs present hazards comparable to those of long-chain PFASs, citing publications such as Bull et al. (2014) and Wang et al. (2015). These publications suffer from important data gaps, such as the failure to cite key published articles on the toxicity of short-chain PFASs (e.g., Klaunig et al. [2015], which presents animal data indicating perfluorohexanoic acid is not carcinogenic). Furthermore, these publications actually acknowledge or demonstrate that many of the leading short-chain PFASs are less bioaccumulative and less toxic than the long-chain PFASs with which they have been compared, based on the available data taken as a whole. This conclusion, which is well accepted by regulatory agencies such as the EPA, compels a different policy outcome than the Madrid Statement suggests. The first priority for risk management should be phase-out of the long-chain PFASs. Attempting to broaden that phase-out to effective alternatives that are less hazardous can only create a technological impasse that supports the retention of long-chain PFASs in the marketplace.

The authors of the Madrid Statement also contend that PFASs are not critical to modern life. The importance of PFAS chemistry, however, was long ago determined by the market. Industries relying on PFASs evaluated fluorinated and nonfluorinated alternatives, as well as alternative technology, and decided on the products that met their specifications and performance needs. Some decisions involved continuing to use PFASs because they meet performance needs that nonfluorinated alternatives cannot. For example, first-responder protective gear is treated with fluorinated products to help maintain performance in fires; firefighting foam produced with fluorinated surfactants provides shorter extinguishment times and critical burnback resistance when fighting flammable liquid fires; and hospital gowns, drapes, and divider curtains rely on fluorinated polymers to provide protective barriers against transmission of diseases. Because the short-chain PFASs have been reviewed and approved by regulatory authorities globally, all applications relying on these substances can be used without presenting a significant risk.

The largest use of short-chain PFASs is for polymeric products. These products—like other polymers—are quite stable under environmental conditions. The resilience of short-chain PFASs is directly connected to its performance, providing long-lasting, durable properties. First responders, medical personnel, and patients would certainly not want the properties in safety gear or medical garments to quickly become ineffective. Even when the short-chain PFASs, which do not present a significant risk, are used in what some people may characterize as "nonessential applications," such as clothing and furniture, these substances significantly extend the effective lifetime of those products, meaning less waste, infrequent washings, and economic savings. These benefits of short-chain PFASs can be further enhanced by reducing emissions through the adoption of best environmental practices, which the FluoroCouncil has identified and is encouraging in the supply chain.

The FluoroCouncil members remain committed to science-based stewardship activities, including continually enhancing the sustainability of their chemistries and products by improving their environmental, health, safety, and performance profiles. We are open to working collaboratively and constructively with stakeholders on *1*) strategies to complete the global transition away from long-chain PFASs, *2*) identification of issues that warrant further data development and risk assessment, *3*) actions that can foster additional stewardship activities within the supply chain, and *4*) best methods for transparently sharing information relevant to the health and environmental impact of PFASs.

The author is employed by the American Chemistry Council and manages the FluoroCouncil, a global organization representing the world's leading fluorotechnology companies. The members of the FluoroCouncil are Archroma Management LLC, Arkema France, Asahi Glass Co., Ltd., Daikin Industries, Ltd., Solvay Specialty Polymers, and The Chemours Company LLC.

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