THE GLOBAL PFAS PROBLEM: FLUORINE-FREE ALTERNATIVES AS SOLUTIONS

FIREFIGHTING FOAMS AND OTHER SOURCES – GOING FLUORINE-FREE

IPEN Expert Panel

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EXECUTIVE SUMMARY

The use of fluorinated organic compounds (PFAS) is widespread across many industrial and domestic applications including for textiles, food packaging, stain and oil resistant treatments, industrial processes and firefighting foam. Relatively speaking the high-profile dispersive use of firefighting foam accounts for about a third of total global production whereas the greater proportion of the other two-thirds are no less likely to be released but as less visible and diffuse releases during use and as end-of-life waste.

Alternative non-persistent products are now available for all the PFAS uses that cannot be fully contained. This includes PFAS-containing firefighting foams that represent a major source of PFAS contamination that can be easily managed by transition to the fully effective alternatives that are now readily available.

The current generation of fluorine-free firefighting foams (F3) are viable alternatives to aqueous film-forming foams (AFFF, FFFP, FP) for many operational scenarios. Where possible the use of fluorine-free firefighting foam (F3) avoids the socio-economic impacts and financial liabilities associated with costly legal action, regulatory prosecutions, infringement of license conditions, clean-up and remediation.

Any operational differences between persistent and non-persistent foams can now either be engineered out or dealt with by appropriate training. Many of the detailed arguments in support of this conclusion were covered in the IPEN White Paper presented at the 14th Stockholm Convention Persistent Organic Pollutants Review Committee meeting held at FAO Headquarters in Rome in September 2018 and in summarised form as a short invited presentation during the POPRC-14 Plenary Session.

For many end-users the discussion whether to change over to fluorine-free firefighting foam from traditional AFFF is no longer about - "*Is foam 'A' more effective than foam 'B'?*" Operational use in incidents in the real world and due diligence during the procurement process have proved beyond all reasonable doubt that fluorine-free foams perform equally well compared to AFFF under many conditions and continue to improve. This has shifted the main consideration for end-users to how much extra risk do we continue to carry with fluorinated foam, what cost will we incur in the longer term by not changing over to F3 products and what is our potential liability from damage caused by releases of foam-contaminated runoff.

The decision on foam selection and use has now matured with business decisions based on a proper and holistic cost-benefit-analysis, including the ability to maintain business continuity, avoiding reputational damage and limiting remediation and third-party harm costs. It has been realised that the true lifetime cost of firefighting foam cannot be based on just the original cost of purchasing the foam concentrate.

This White Paper expands the approach taken in the POPRC-14 IPEN White Paper entitled "*Fluorine-Free Firefighting Foams (3F) Viable Alternatives to Fluorinated Film-Forming Foams (AFFF)*" by considering other sources of fluorinated persistent organic pollutants (FPOPs) and their impact on human health, the environment and socio-economic values including societal infrastructure.

Although firefighting foams are unavoidably dispersive in the way they are used operationally by fire departments and have become the most recognisable and obvious point sources of environmental pollution, there are a number of less obvious but nonetheless important other PFAS sources that can generate PFOA or other PFAS products leading to contamination, for example diffuse PFAS sources from:

- Textile stain repellent coatings released from landfills as leachates and volatiles.
- Agricultural soil amendment by WWTP biosolids and effluent irrigation.
- Unregulated domestic fabric, PPE and furniture treatment products.
- Washing of treated textiles and fabrics with PFAS in wastewater sent to sewer.
- Treated food packaging with PFAS ending up in leachate releases.
- 'Hidden dispersive' scenarios, e.g., hand-held and portable foam extinguishers.

Current advances in feedstock C6-technology mean that products including AFFF firefighting foams recently put on the market, but not older than a couple of years, represent an unlikely source of free PFOA (best currently available fluorosurfactant feedstock < 25 ppb PFOA derivatives and precursors). This is largely not true for older foam stocks and other applications that also contain a significant proportion of long-chain PFAS up to C14 that are precursors to PFOA and its related toxic longer-chain equivalents.

Even with the use of so-called C6-pure AFFF there remains the problem of the generation of a diversity of toxic short-chain perfluoroalkyl intermediate and end-products which are extremely mobile and environmentally persistent. Short-chain PFAS contradict their supposed advantages of lower toxicity by having much higher environmental mobility than long chain material resulting in extended groundwater and soil plumes, are almost impossible to remove from drinking water and waste water effluent streams, and are known to concentrate in edible crops and grasses providing a direct contamination pathway into the food chain.

In addition, this White Paper considers the problem that contamination of the environment with end-point fluorochemical degradation products, mainly perfluorinated carboxylic acids (PFCA) or sulphonates (PFSA), never involves only one end product of degradation but also a whole range of highly persistent intermediate products of likely enhanced biological action and toxicity and bio-accumulative potential through synergism. It has been estimated that there are likely to be many hundreds of such compounds produced as the result of breakdown in the environment.

Focussing on just legacy compounds such as PFOS, PFHxS or PFOA, as so often happens, is therefore a form of tunnel vision which ignores the greater part of the problem, especially since these compounds are unlikely to be representative of the occurrence, effects and risk posed by the vast range of far more complex PFAS produced since the early 2000s. Moreover, the spectrum of perfluorinated end-products which arise even from the degradation of a single relatively simple fluorochemical such as a fluorotelomer fluorosurfactant make industry statements about the persistence, bio-accumulation and toxicity (PBT) profiles for any single breakdown product simplistic and largely irrelevant as these ignore the range of intermediate and end-point PFAS likely to be produced and the effects of combined exposure to multiple chemicals. All PFAS end-point compounds are environmentally extremely persistent with, in known instances, long half-lives in humans together with intermediate transformation compounds also persistent in their own right which may be chemically reactive and of higher toxicity than the end-point substances.

Toxicology studies for a single substance such as PFHxA do not account for possible synergism between substances for which there is, and is unlikely to be, any detailed PBT data for the vast array of compounds that can occur. With so little ever likely to be known about the effects of the diversity of PFAS exposures possible, a read-across approach is necessary from the characteristics of known PFAS and other structurally or functionally allied organic compounds using methods that identify suites of individual compounds, or can provide information about the proportions of carbon-chain precursors in such mixtures such as the total oxidisable precursor assay (TOP assay).

This situation brings into sharp focus Donald Rumsfeld's memorable phrases around the risks of what we know and don't know, as applied to the uses and effects of PFAS:

- ***"Known knowns"*** – It is well established that PFAS are persistent, toxic, bio-accumulative to varying degrees and highly dispersive.
- ***"Known unknowns"*** – We are being exposed to many more (and increasing) PFAS than the few that are recognised and can be analysed for. While we know the PFAS family is very large much is unknown about their diversity, sources, identities and effects.
- ***"Unknown unknowns"*** – We don't know the full extent of the PFAS problem but the rate and growth of new information consistently pointing to adverse effects of PFAS exposure implies that there is a large body of unknown risk and as such a conservative approach to use and management is essential.
- In other words, ***not knowing about a risk is not evidence that there is no risk*** and therefore, as has been long established for PFAS, when there are indications and evidence of adverse effects the ***Precautionary Principle*** needs to be applied with the legal ***burden of proof on the proponent*** to provide absolute proof of no adverse effects before release of the product for use, an obligation that is not currently being met.

THE GLOBAL PFAS PROBLEM: FLUORINE-FREE ALTERNATIVES AS SOLUTIONS – HAS TIME RUN OUT FOR SHORT-CHAIN REPLACEMENTS FOR C8 PFAS?

FIREFIGHTING FOAMS, TEXTILES, FABRICS AND OTHER SOURCES OF PFAS DISPERSAL AND CONTAMINATION

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