PFOA and Turnout Gear

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What is perfluorooctanoic acid (PFOA)?

PFOA has been used in many manufacturing processes including non-stick coatings on cookware, food packaging materials, and durable water repellents (DWRs) in consumer clothing, upholstery and carpets.[1] PFOA is one of a family of chemicals that contain fluorine (perfluorinated chemicals). It has a long half-life (time to decrease by half in the body) of 2-3 years in humans.[1]

How are people exposed to PFOA?

PFOA is commonly found in the blood of representative cross-sections of people in the US and Canada.[2,3,4] It is also found in dust in homes and in food and water.[1] As discussed below, PFOA manufacture and use has declined greatly in the past decade due to an EPA initiative. However, people who worked in factories that used to produce PFOA or who live nearby are exposed from these industrial facilities. Water sources have been contaminated in these communities and the exposed populations have higher PFOA levels than the general population.[1, 5] The widespread historical use of PFOA in consumer products and its persistence in the environment are thought to be factors resulting in PFOA food and water contamination that exposes the majority of people in developed countries.[6,7] However, uncertainty remains about the most important sources for non-industrially exposed populations.

The US Environmental Protection Agency (EPA) determined that PFOA is widespread and persistent in both the environment and in the general US population.[8] As research reporting adverse effects in laboratory animals was published, concern regarding PFOA increased.[*] In 2006, the EPA and the eight major US companies that manufactured PFOA launched the 2010/15 PFOA Stewardship Program, in which companies agreed to reduce emissions of PFOA by 95% by 2010 (compared to 2000 levels) and to phase out production by 2015.[9] Combined with decreasing consumer demand for PFOA-containing products, substantial reductions in PFOA content in US products have resulted. By 2012, the eight major US manufacturers of PFOA reduced their US PFOA product content by no less than 96%, in many cases eliminating PFOAs completely (See Table 3 at: https://www.epa.gov/assessing-and-managing-chemicals-

[*] See, for example: Eilperin J. Compound in Teflon A "Likely Carcinogen." *Washington Post*. June 29, 2005. Available at: http://www.washingtonpost.com/wp-dyn/content/article/2005/06/28/AR2005062801458.html

under-tsca/20102015-pfoa-stewardship-program-2014-annual-progress). In 2016, following a similar period of regulatory evaluation, Canada prohibited most uses of PFOA.[†]

Studies of representative cross-sections of the US population show that geometric mean levels have declined from 5.2 ng/mL in 1999-2000 to 2.1 ng/mL in 2011-2012.[3,10]

How does PFOA get into the body?

PFOA can be inhaled, absorbed through the skin[11] or ingested in water or food contaminated with PFOA or food in contact with grease-resistant wrappers which used PFOA in the manufacturing process (also being phased out).[3]

Are fire fighters exposed to PFOA through their work?

Although US and Canadian fire fighters are likely to share the same baseline risk of exposure that the general population faces, fire fighters may have additional occupational exposure sources. There are three possible sources, however, the extent to which PFOA may actually enter fire fighters' bodies from these sources is uncertain, particularly given the rapidly declining levels in the environment under the EPA's Stewardship Program and the Canadian ban.

Fire fighters are exposed to combustion products of consumer goods that were manufactured using PFOA as one of the raw materials (e.g., stain resistant carpets and upholstery). As personal protective equipment (PPE), including self-contained breathing apparatus and turnout gear, provide incomplete protection from inhalation and dermal exposures, if PFOA is a combustion product of these materials, it is likely that fire fighters would absorb the chemical into their bodies during firefighting operations. Fire fighters exposed to smoke from the World Trade Center disaster had higher PFOA levels compared to those exposed to dust in the disaster and compared to the US general population.[12] A study of 101 Californian fire fighters found similar PFOA levels compared to the US population, however, levels were higher in fire fighters whose turnout gear had not been professionally cleaned in the prior year.[13] This may indicate that PFOA, like many other chemicals in smoke, permeates turnout gear and later off-gases, posing a continued risk of exposure until the gear is cleaned. A pilot study evaluating various persistent chemicals in the blood of 12 fire fighters within 24 hours of a fire fighting event found a mean PFOA level of 7 ng/mL, which was approximately two-fold higher than comparable levels in the US population.[14] PFOA is released from nonstick cookware, at least initially, during use at temperatures normally encountered for cooking.[15] However, PFOA is not a combustion product of treated materials, such as carpet and fabric, at the much higher temperatures encountered in incinerators (700^{o}C and higher).[16,17] The ammonium salt of PFOA degrades at 350-400^{o}C, similar to the melting temperature of the fluorinated polymers it is used in.[15] IAFF has not identified studies of smoke that measured PFOA. Perfluorinated compounds were measured in an ongoing study entitled "Cardiovascular & Chemical Exposure Risks in Modern Firefighting" however the study has not been completed yet. Thus, it is possible that fire fighters may encounter PFOA in

[†] http://www.gazette.gc.ca/rp-pr/p2/2016/2016-10-05/pdf/g2-15020.pdf

fire suppression activities but the data to address this are limited and, as PFOA is increasingly less common, this is a decreasing concern.

In the past, PFOA was a chemical building block or by-product created within the manufacture of DWR treatments and moisture barriers for turnout gear. Major US manufacturers have assured IAFF and the public that PFOA is no longer present within the moisture barrier of turnout gear or in the barrier treatments used on turnout gear and other consumer products.[‡] This, combined with the PFOA phase-out, makes it is unlikely that PFOA is present at any significant concentrations in uncontaminated new or recently US manufactured turnout gear. However, PFOA may be present at low levels in the outer shells or moisture barriers of legacy turnout gear manufactured in the US prior to its voluntary phase-out, or manufactured in other jurisdictions. One manufacturer emailed IAFF that, although prior to 2013, PFOA could be found as a trace non-functioning residual in some of the raw materials used in the manufacture of their products nearly all of the residual was eliminated during processing of the raw materials and that authorities in the US and EU have confirmed that these residues did not pose a risk to end-users.[§] IAFF is not aware of any studies examining legacy turnout gear for PFOA content. Any such studies conducted today would be complicated by the possibility that PFOA detected in previously-worn turnout gear could represent contamination from the combustion products of burning PFOA-containing consumer products (if, as discussed above, it is a combustion product) to which the turnout gear has been previously exposed, rather than PFOA in the DWR and/or moisture barrier on the turnout gear. Furthermore, it is not clear that treated gear would be a significant source of PFOA exposure since this would require PFOA volatilization from the final product.

Perfluorooctane sulfonic acid (PFOS), a closely related chemical to PFOA, was used to make aqueous film forming foam (AFFF) for Class B flammable liquid fires. PFOA was also present in AFFF initially.[18] From 2000-2002, production of PFOS was phased out in the US and manufacturers switched to AFFF formulas that contain other fluorocarbon surfactants. However, PFOA may be an impurity in these foams.[19,20] PFOAs from foam may also have contaminated not only water sources but other sites as well. One study has showed that concrete slabs that firefighters used as training pads and were exposed to AFFF foams had measurable levels deep into the concrete and could be sources of PFASs in the future[21]. The current manufacturing trend is towards AFFFs that contain fluorocarbon surfactants with fewer than six carbons which cannot have PFOA as an impurity as well as non-fluorine foams. A biomonitoring study of 149 Australian fire fighters observed PFOA levels that were similar to those of the general populations in Australia and Canada.[19] However, years of foam exposure were significantly associated with PFOA serum levels. Another study done in Finland in firefighters that were exposed to newer AFFF formulas also showed a possible elevation of PFAS, but the sample was too small to determine statistical significance[22]. These foams are complex mixtures of various fluorinated

[‡] See, for example: Globe Manufacturing Company. Technical Data Statement Regarding the Use of PFOA. April 14, 2017; Dupont. DuPont Position Statement on PFOA. 2017. Available at: http://www.dupont.com/corporate-functions/our-company/insights/articles/position-statements/articles/pfoa.html ; and GORE. GORE completes elimination of PFOA from raw material of its functional fabrics. January 10, 2014. Available at: http://news.gorefabrics.com/en_gb/enterprise/innovation/gore-completes-elimination-of-pfoa-from-raw-material-of-its-functional-fabrics.

[§] Personal communication, May 5, 2017

chemicals.[23] In fact, one study that measured perfluorinated chemicals in serum from fire fighters found higher levels of another fluorinated chemical in those exposed to Class A fire foams which have not been thought to contain these chemicals.[13]

Does PFOA affect the health of humans?

The health risks of PFOA are the focus of current research. Uncertainty remains about which health effects are caused by PFOA exposure in humans.[24] A 2010 review noted that few data on the human health effects of PFOA had been published. They found consistent associations between exposure to PFOA and increases in cholesterol levels and uric acid, markers of increased risk for heart disease and hypertension, respectively.[25] However, at that time, data were too limited to determine if PFOA exposure increased the risk of heart disease. The authors also concluded that while PFOA may be associated with changes in liver function tests, the significance of this association to health was also unclear.

During 2005-2013, these same authors as part of the C8 Science Panel (PFOA is also referred to as C8 due to its eight carbon structure), carried out exposure and health studies in the Mid-Ohio Valley communities where PFOA had been used at the Washington Works plant in Parkersburg, West Virginia since the 1950s. The Science Panel concluded that it was more likely than not that PFOA exposure in these communities was connected to high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension.[5] However, this study was not able to make a connection with heart disease or hypertension (other than in pregnancy).

A recent review by the EPA noted that the following effects have been reported in animal studies: liver and kidney toxicity, developmental and immune system effects and liver, testicular, and pancreatic cancer.[26] This review also noted associations in humans including high cholesterol, increased liver enzymes, decreased vaccination response, thyroid disorders, pregnancy-induced hypertension and preeclampsia, and cancer (testicular and kidney).

PFOA is categorized by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans (group 2B). This is based on data in humans and animals that IARC considered to be limited.[1] IARC concluded that the data in humans were most consistent for testicular and, possibly, kidney cancer.[1]

Biological monitoring

As noted above, blood tests for PFOA and related compounds are available and results have been reported in the general US and Canadian populations,[2,4] in populations with contaminated water sources,[5] and in fire fighters.[12,13,14,1927] A PFOA calculator was recently published for use when a contaminated water source has been identified and remediated (by use of bottled water or at the water source). Serum PFOA level and water level prior to remediation are entered into the calculator which then predicts decline in serum PFOA levels in the future. It is available at http://www.ics.uci.edu/~sbartell/pfoacalc.html. Biological monitoring outside of research

studies is recommended for specific exposures such as contaminated water. It may also be of use for fire fighters with current or past exposure to older Class B firefighting foams. However, such monitoring is not routinely recommended for the general public or other fire fighters.

What PFOA regulations exist?

In addition to the voluntary US efforts to phase out PFOA and recent Canadian regulations, governments in the European Union (EU) have been pursuing regulation to formally restrict the manufacture and use of PFOA in new products. Based on EU regulatory submissions first made by Germany and Norway in 2014,[**] it was concluded that "an unacceptable risk to human health and the environment arises from the manufacture, use or placing on the market of PFOA, its salts and PFOA-related substances on their own, as a constituent of other substances, in mixtures and in articles". Draft EU regulations would now prohibit the use of PFOA in the production of textiles, including in consumer products, 6 years after the draft regulation comes into effect.[††]

Conclusions

Exposure to PFOA is very common in US and Canadian populations due to its extensive past use in a wide range of products from carpets to stain and water resistant fabrics and upholstery to nonstick cookware**. Importantly, PFOA use has been almost completely phased out in the US under the PFOA Stewardship Program and in Canada through recent regulation.**

Fire fighters may have additional PFOA exposure sources such as older Class B firefighting foams. If PFOA is a combustion product of PFOA-containing consumer products made prior to phasing out use of this chemical, fire fighters will be exposed in fire suppression activities. However, the data are too limited at present to determine this. PFOA is unlikely to be a component in recently US manufactured turnout gear. However, if PFOA is a combustion product, it may be present as a contaminant on turnout gear. PFOA may also be present as a component of outer shell treatments or within the moisture barrier on legacy turnout gear, or in turnout gear manufactured in other jurisdictions. The exposure contribution from any such PFOA content is likely to be minimal since volatilization from the manufactured product would be required.

Recommendations

At this time, IAFF does not recommend that legacy turnout gear be replaced outside of its lifecycle. Fire fighters wishing to minimize PFOA exposure should continue to wear their PPE,

[**] See, for example: ChemicalWatch. Germany and Norway intend to propose PFOA for restriction. ChemicalWatch. March 10, 2014. Available at: https://chemicalwatch.com/18674/germany-and-norway-intend-to-propose-pfoa-for-restriction; and European Chemicals Agency. *Information Note Germany and Norway Propose a Restriction on Perfluorooctanoic Acid (PFOA), Its Salts and PFOA-Related Substances*.; 2014. Available at: https://echa.europa.eu/documents/10162/3b6926a2-64cb-4849-b9be-c226b56ae7fe.

[††] See, for example: Buxton L. PFOA restriction gets green light from REACH Committee. *ChemicalWatch*. December 15, 2016. Available at: https://chemicalwatch.com/51663/pfoa-restriction-gets-green-light-from-reach-committee

including SCBA, and regularly decontaminate their turnout gear. IAFF does not routinely recommend blood testing for PFOA for fire fighters in the absence of older Class B foam exposure. IAFF will continue to monitor developments and update this fact sheet should new information become available.

References

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