Egypt PFAS situation report

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Summary

This study made an effort to understand regulations, inventory information and scientific studies on per- and polyfluoroalkyl substances (PFAS) in Egypt. However, currently there is very little information available about these substances. The Stockholm Convention listing of PFOS and evaluations of PFOA raise concerns about these substances and reinforce the need for regulatory action. Key findings of this study are:

PFAS are unregulated in Egypt

Egypt became a Party to the Stockholm Convention in 2004. The amendment listing PFOS came into force for Egypt in 2010 and the deadline for delivering Egypt's updated National Implementation Plan for PFOS and other substances listed at COP4 in 2009 was August 2012. However, Egypt has not delivered the updated National Implementation Plan. This is why information is still lacking on many aspects of PFOS and other PFAS substances.

Food contact paper is contaminated with PFAS substances

A 2016 study found PFOA in 79% of food contact papers analyzed. The highest levels were found in two food paper wrappers at 65 ng/g and 94 ng/g and these same samples also showed higher levels of PFHxA, PFNA, PFDA and PFUnA. PFOS was found in 58% of the food contact samples with a median concentration of 0.29 ng/g. PFAS precursors, 6:2 monoPAPs and 8:2 monoPAPs were detected in a French fries cardboard box and two sandwich wrapping papers respectively.

Dust is contaminated with PFAS substances

A 2016 study examined PFAS substances in dust from 17 homes, 5 workplaces and 9 cars in Cairo. PFAS levels in dust ranged from 1.09 to 55.2 ng/ng and included FTOHs > FOSEs > FOSAs > FTAs. The 8:2 FTOH substance was the dominant substance followed by 6:2 FTOH and 10:2 FTOH. Similar levels and substances were observed in workplaces and cars. The authors note that the prevalence of FTOHs could reflect their use in consumer products. PFOS (4.09 ng/g) and PFOA (2.16 ng/g) were also dominant substances in dust and PFHxA (21% of samples), PFNA (13% of samples), and PFDA (29% of samples) were also detected. PFAS levels in dust in Egypt are lower than in other countries and the authors note that imported wall to wall carpeting is typically not used in Egyptian homes while locally manufactured carpets and furniture which are typically not treated with PFAS substances are commonly employed.

PFAS elimination contributes to achievement of the Sustainable Development Goals (SDGs)

Actions to control and phase-out PFAS as a class contribute to achievement of several key Sustainable Development Goals (SDGs) due to the impacts of the substances on health and ecosystems including water pollution. These include SDGs 3, 6, 9, 12, 14, 15, and 16.

What are per- and polyfluoroalkyl substances (PFAS)?

PFAS is a large class of more than 4,500 persistent fluorinated chemicals. PFAS are both hydrophobic and lipophobic in nature and extremely persistent due to the strength of the carbon-fluorine bond. They are widely distributed in the global environment due to their high solubility in water, low/moderate sorption to soils and sediments and resistance to biological and chemical degradation. The properties of PFAS have resulted in extensive use as surfactants and surface-active agents in products. Two widely-used members of this class have been perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). As these two substances have come under regulatory pressure, the industry has shifted to other PFAS with similar properties.

Human exposure to PFAS is mainly by ingestion of contaminated food or water. These substances bind to proteins (not to fats) and persist in the body where they are mainly detected in blood, liver and kidneys. Studies indicate that PFOA and PFOS can cause reproductive and developmental, liver and kidney, and immunological effects in laboratory animals. Both chemicals cause tumors in animal studies along with a variety of other effects on infant birth weight, growth, learning, infant behavior, pregnancy, endocrine system, increased cholesterol, and thyroid function. Recent studies have linked a variety of PFAS substances to many human health effects: cardiovascular disease, markers of asthma, damage to semen quality, ovarian insufficiency, altered glucose metabolism, lower testosterone levels in male adolescents, association with shorter birth length in girls, elevated blood pressure, abnormal menstruation, lower birth weight in infants, possible increased risk of female infertility due to endometriosis, and decreased lung function in children with asthma.

The manufacture and use of PFAS and their use in a multitude of products has caused widespread pollution. PFAS are found in wildlife, accumulating in the blood, liver and kidneys of wildlife such as dolphins, polar bears, seals, birds, fish, and other marine wildlife. PFAS substitutes for PFOS and PFOA have been identified as potential global surface water contaminants and they have been found in more than 80% of 30 surface seawater samples from the North Pacific to Arctic Ocean. PFAS use in firefighting foams at military bases and airports is responsible for water pollution and contaminated communities in many countries, including Australia, Canada, China, Germany, Italy, Japan, Netherlands, New Zealand, South Korea, and Sweden.

Safer cost competitive non-fluorinated alternatives for PFAS use in firefighting foams have been adopted by an increasing number of major airports, including Auckland, Copenhagen, Dubai, Dortmund, Stuttgart, London Heathrow, Manchester, and all 27 major airports in Australia. Increasing awareness about the negative characteristics of PFAS has driven efforts to identify and market safer substitutes for other uses. Increasing awareness about the negative characteristics of PFAS has driven efforts to identify and market safer substitutes for other uses.

Due to the complexity and negative characteristics of PFAS, there is increasing interest in regulating PFAS as a class rather than as individual substances.

PFOS

PFOS and its related substances have been used in a variety of products and processes including firefighting foams, carpets, leather goods, upholstery, packaging, industrial and household cleaning products, pesticides, photographic applications, semiconductor manufacturing, hydraulic fluids, catheters and metal plating. PFOS is extremely persistent and has shown no degradation under any environmental condition that has been tested. It is toxic to mammals and high concentrations have been found in Arctic animals, far from anthropogenic sources. PFOS is regularly detected in human blood and breast milk. For example, in one study of 299 infants, PFOS was found in the blood of 297 of them and PFOA was found in all of them.

PFOA

PFOA has been used to make non-stick pans, and is found in textiles, fire-fighting foams, and medical devices, and is used in many other products and processes. In 2017, the Stockholm Convention POPs Review Committee noted the link between PFOA and serious illnesses in humans, including diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension. PFOA has contaminated the global environment, including wildlife and people of remote regions such as the Arctic and Antarctic.

For more information about recent research on the impacts of PFAS, including fluorinated substitutes for PFOS and PFOA, please see Annex 1. Information about the high cost of PFAS pollution cleanup is available in Annex 2. Global regulation of PFAS through the Stockholm Convention and evaluations of its expert committee is discussed in Annex 3.

Actions on PFAS and the Sustainable Development Goals

Actions to control and phase-out PFAS as a class contribute to achievement of several key Sustainable Development Goals (SDGs) due to the impacts of the substances on health and ecosystems including water pollution. These include

Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages. Targets under SDG3 include:
3.4: *"reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being"*
3.9: *"substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination."*

Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all. Targets under SDG6 include:
6.3: *"improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."*

Sustainable Development Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. Targets under SDG9 include:
9.4: *"greater adoption of clean and environmentally sound technologies and industrial processes."*

Sustainable Development Goal 12: Ensure sustainable consumption and production patterns. Targets under SDG12 include:
12.4: *"By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frame works, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment."*
12.5: *"substantially reduce waste generation through prevention, reduction, recycling and reuse."*
12.6: *"Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle."*
12.7: *"Promote public procurement practices that are sustainable, in accordance with national policies and priorities."*

Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. Targets under SDG14 include:
14.1: *"By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution."*

Sustainable Development Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. Targets under SDG15 include:
15.1: *"By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements."*
15.5: *"Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species."*
15.9: *"By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts."*

Sustainable Development Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. Targets under SDG16 include:
16.7: *"Ensure responsive, inclusive, participatory and representative decision-making at all levels."*
16.10: *"Ensure public access to information…"*

PFAS production, use, and waste management

Egypt is located in the northeast tip of Africa at the junction between Africa, Asia, and Europe, covering an area about 1 million km^2. Egypt's distinguished role in the geopolitics is mostly based on its strategic geographical position, with the Suez Canal connecting the Red Sea to the

Mediterranean. Egypt has always been an influential actor in the region, because of its strong ties with the Arab world and sheer size of its population, being the most populous country in the area, and the 16th worldwide with about 100 million people.

The mid-1950s marked a new stage of Egyptian industry that expanded from well-established industries such as textiles and food processing, to other industries such as pharmaceuticals, pesticides, fertilizers, paints and dyes, cement, pulp and paper, and petrochemicals.

Despite the long history of using, importing, and exporting chemicals in Egypt, there seems to be a significant gap in awareness, and technical and logistic support in chemicals management. The national chemical profile in Egypt has identified major hurdles that impact sound chemicals management in Egypt:

- Inadequate capabilities to assess the potential toxicity and to control the nature and purity of imported or domestically produced chemicals.
- Handling of chemicals by inadequate informed or trained personal especially operators in small- scale enterprises.
- Shortage of management skills needed to deal safely with technology transfer and with the storage, transport, use or disposal of chemicals.
- Lack of effective mechanism or coordinating the work of those responsible for different aspects of chemical safety.
- Lack of means of coping with chemicals accidents including the treatment of victims and the subsequent rehabilitation of the environment.
- Inadequate proper management of chemicals and enforcement of regulations.
- Lack of reliable information sources to establish properly coordinated infrastructures, controls and procedures to deal properly with chemical safety.

Currently there is no information available on production, import, use or management of PFAS substances in Egypt. This is an area that needs attention, particularly for substances dispersed directly into the environment such as PFAS-containing firefighting foams.

PFAS impacts

There is no current information on PFAS impacts or contaminated sites in Egypt. This information should be developed as soon as possible. One scientific study on PFAS in Egypt was identified as described below.

Scientific studies on PFAS

Shoeib T, Hassan Y, Rauert C, Harner T (2016) Poly- and perfluoroalkyl substances (PFASs) in indoor dust and food packaging materials in Egypt: Trends in developed and developing countries, Chemosphere 144 :1573-1581

This study examined PFAS substances from 17 homes, 5 workplaces and 9 cars in Cairo along with paper and cardboard food contact materials purchased from retailers and grocery stores in Cairo. Paper and cardboard materials included fast food sandwiches wrappers for burgers; paper boxes for French fries, pizzas and sandwiches; non-stick baking cups; microwave bags for pop-corn and soup cups.

PFAS levels in dust ranged from 1.09 to 55.2 ng/ng and included FTOHs > FOSEs > FOSAs > FTAs. The 8:2 FTOH substance was the dominant substance followed by 6:2 FTOH and 10:2 FTOH. Similar levels and substances were observed in workplaces and cars. The authors note that the prevalence of FTOHs could reflect their use in consumer products. PFOS (4.09 ng/g) and PFOA (2.16 ng/g) were also dominant substances in dust and PFHxA (21% of samples), PFNA (13% of samples), and PFDA (29% of samples) were also detected.

PFAS levels in dust in Egypt are lower than in other countries and the authors note that imported wall to wall carpeting is typically not used in Egyptian homes while locally manufactured carpets and furniture which are typically not treated with PFAS substances are commonly employed.

The researchers analyzed for a variety of polyfluoroalkyl phosphates esters (PAPs) that are PFAS substances commonly used in food contact paper. There was a low detection frequency of these substances in packaging, but the 6:2 monoPAPs and 8:2 monoPAPs were detected in a French fries cardboard box and two sandwich wrapping papers respectively. PFOA was found in 79% of the food contact samples with a median concentration of 2.4 ng/g. The highest PFOA levels were found in two food paper wrappers at 65 ng/g and 94 ng/g. These two particular samples also showed higher levels of PFHxA, PFNA, PFDA and PFUnA. PFOS was found in 58% of the food contact samples with a median concentration of 0.29 ng/g.

Press reports on PFAS

No press reports on PFAS substances were found.

PFAS regulations

PFAS regulations in Egypt

The most important Egyptian law concerning the environment is Law 4 of 1994 which was amended by Law 9 of 2009. Two executive Prime Ministerial Decrees (PMD) have been issued to explain how this law shall be executed. These PMDs are: two of PMD number 338 of 1995 amended by PMD number 1741 of 2005 which was also amended by PMD number 1095 of 2011 and PMD number 710 of 2012. These final amendments took into consideration Egypt's regulation of hazardous chemicals.

These laws and their executive guidelines and decrees and their amendments outlines chemicals considered as an extra source of hazard. They demonstrate lists of those hazardous chemicals, their maximum limits in environmental media and workplace. Section 2 of chapter of the amended law 9 of 2009 in article 25 indicates that all hazardous chemicals shall not be handled without a license from designated authorities as follow:

1. Pesticides and fertilizers by the Ministry of Agriculture.
2. Industrial hazardous chemicals by the Ministry of Trade and Industry.
3. Petroleum hazardous chemicals by the Ministry of Petroleum.

4. Hazardous health-related materials such as hospital waste and household pesticides by the Ministry of Health and Population.
5. Ionized radiated hazardous materials by the Ministry of Electricity and Energy and the National Atomic Energy Agency.
6. Explosive materials by the Ministry of Interior.
7. Hazardous chemicals used in research by Ministry of Higher Education and Scientific Research.

Up till now, there is no decree about PFAS, but according to the Egyptian constitution, any agreement that ratified is considered by the constitution as national law. Therefore, the Stockholm Convention will be the primary route for PFAS regulation in Egypt until a special decision is issued by the National Committee.

Egypt became a Party to the Stockholm Convention in 2004. The amendment listing PFOS came into force for Egypt in 2010. The deadline for delivering Egypt's updated National Implementation Plan for PFOS and other substances listed at COP4 in 2009 was August 2012. However, at this date, Egypt has not delivered the updated National Implementation Plan. This is why information is still lacking on many aspects of PFOS and other PFAS substances.

PFAS regulations in other countries

Most PFAS are not regulated, but PFOA and PFOS have come under regulatory scrutiny, particularly in the US where a large number of contaminated drinking water sites have been identified. In 2016, the US established a federal health advisory limit in drinking water of 70 ppt (parts per trillion) for PFOA and PFOS combined. This advisory limit is not enforceable but is used as a guideline. A recent US government review by the Agency for Toxic Substances and Disease Registry has proposed tightening exposures which would translate to drinking water limits of 7 ppt for PFOS and 11 ppt for PFOA.

In the absence of federal regulations, individual US states (California Colorado, Minnesota, Michigan, New Jersey, New Mexico, Texas, Vermont, and Washington) have moved forward to regulate PFAS in drinking water, firefighting foam, personal protective equipment and wastes. Another 11 states are considering or have already proposed similar regulatory actions. Information about individual state proposals can be obtained here.

In 2018, state regulators in California set interim notification limits of 13 ppt for PFOS and 14 ppt for PFOA in drinking water. Regulators noted that both substances were listed by the state as developmental toxicants and that the National Toxicology Program concluded that both substances are "presumed to be an immune hazard to humans." Colorado uses a 70 ppt combined limit of PFOS and PFOA as a groundwater quality standard. Colorado also regulates PFOS and PFOA as hazardous waste. Massachusetts sets a 70 ppt limit for PFOA, PFOS, PFHxS, PFNA and PFHpA combined. Michigan uses the federal 70 ppt combined PFOS and PFOA standard as a limit for drinking water. The Minnesota Department of health recommends the following guidance values: 2000 ppt for PFBS, 27 ppt for PFHxS, 27 ppt for PFOS, 7000 ppt for PFBA, and 35 ppt for PFOA. New Jersey added PFNA to its hazardous substances list and set a limit for PFNA of 13 ppt in drinking water. New Jersey proposed limits of 14 ppt for PFOA and 13 ppt for PFOS. Vermont sets a drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined. In 2018, Washington banned PFAS in firefighting foams and personal protective equipment and began a rulemaking process to established drinking water limits. The New York Department of Health has proposed 10 ppt for PFOS and 10 ppt for PFOA. The proposal considered the fact that people already have exposure to these substances from other sources.

Recommendations

National recommendations

1. The updated National Implementation Plan for PFOS and other substances listed at COP4 should be prepared and delivered as soon as possible.

2. A complete inventory of PFAS (including PFOA and PFOS) needs to be carried out including in suspected products and process in order to develop a regulatory, institutional framework for sound management of these chemicals. There is hardly any information available in the country on the use of the chemical in various sectors and this data is needed for control of use and waste management.

3. To prevent PFAS pollution and subsequent costly remediation, Egypt should promptly make an inventory of firefighting foam stocks and replace PFAS-containing foams with fluorine-free foams as soon as possible.

4. PFAS monitoring should be conducted to identify hotspots near industrial areas and other relevant locations.

5. Specific regulations are needed to prohibit PFAS production, use, import, and export (including PFOA and PFOS). To avoid costly mistakes, PFAS should be banned as a class.

Recommendations for Stockholm Convention COP9

1. PFOA should be listed in Annex A with no specific exemptions. If exemptions are granted, they should be for specific products and the listing should require labeling new products that contain PFOA so that Parties can fulfill requirements under Article 6 as done previously for HBCD (SC-6/13).

2. Due to the costly, highly polluting nature of firefighting foams, and the availability of cost-effective, technically feasible non-fluorinated alternatives, no specific exemptions should be adopted either for PFOS or PFOA production and/or use in firefighting foams.

3. Specific exemptions or acceptable purposes for the following 11 uses of PFOS should be ended: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; photo masks in semiconductor and LCD industries; hard metal

plating; decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production.

4. The following 3 acceptable purposes should be converted into specific exemptions: metal plating (hard metal plating only in closed loop systems); firefighting foams; insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. Sulfluramid should be named in the PFOS listing and its use sharply limited to cultivation of specific crops.

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Annex 1. PFAS toxicity

The Stockholm Convention expert committee (please see Annex 3) evaluated the toxicity characteristics of PFOS in 2007 and PFOA in 2017. Since then, more scientific information has emerged for both these substances along with some of the shorter-chain PFAS aggressively promoted by the industry as substitutes.

Recent research shows the harmful impacts of PFAS

Recent studies have linked PFAS substances to a variety of human health effects: cardiovascular disease, markers of asthma, damage to semen quality, ovarian insufficiency, altered glucose metabolism, lower testosterone levels in male adolescents, association with shorter birth length in girls, elevated blood pressure, abnormal menstruation, lower birth weight in infants, possible increased risk of female infertility due to endometriosis, and decreased lung function in children with asthma.

The chemical industry promoted perfluorohexane sulfonate (PFHxS) as a substitute for PFOS. In 2018, the Stockholm Convention expert committee concluded that it "warrants global action." PFHXS is found in 2 – 4 month-old infants and associated with damage to semen quality. The Stockholm Convention expert committee found that PFHxS has been detected in human blood and breast milk in many regions, and is together with perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) one of the most frequently detected and predominant PFASs in human blood. The Committee noted that the fetus is exposed to PFHxS via umbilical cord blood and that animal studies show impacts on reproduction, liver function, thyroid hormone levels, and lipid and lipoprotein metabolism.

Studies showing the toxicity, environmental fate, and occurrence of PFAS in current use include:

Perfluorobutanoic acid (PFBA)

- Effects on thyroid and developmental delays in offspring exposed during pregnancy
- Similar toxicity to liver as PFOA
- Associated with damage to semen quality
- Found in home-produced eggs
- Found in the Arctic
- Efficiently translocated into plants
- Taken up by corn
- Found in fruits and vegetables
- Contaminates fish
- Found in humans in a community with known drinking water contamination
- Found in consumer products

Perfluorobutane sulfonate (PFBS)

- Associated with damage to semen quality
- Disrupts pancreas formation in zebrafish
- Associated with cardiovascular disease in humans
- Associated with markers of asthma in humans
- Increases fatty tissue formation in laboratory studies

- Impairs visual function in fish
- Damages thyroid function in fish in subsequent generations
- Induces reproductive toxicity in animal studies
- Found in 2 – 4 month-old infants
- Found in humans in community with known drinking water contamination
- Found in children
- Found in the Arctic
- Found in consumer products

Perfluorohexanoic acid (PFHxA)

- Similar toxicity to liver as PFOA
- Associated with damage to semen quality
- Negatively associated with testosterone levels in adolescent humans
- Alters zebrafish behavior
- Modulates immune response in vitro
- Contaminated drinking water linked to human body burden
- Alters amphibian embryogenesis
- Exposes the human fetus vis presence in amniotic fluid
- Found in human milk
- Found in house dust
- Found in US wildlife preserves
- Found in the Arctic
- Contaminates fish
- Found in Indo-Pacific humpback dolphins and finless porpoises
- Efficiently translocated into plants
- Resistant to sewage treatment
- Found in US wastewater treatment plants

Perfluoroheptanoic acid (PFHpA)

- Alters amphibian embryogenesis
- Exposes the human fetus via presence in amniotic fluid
- Found in human milk
- Manufacturing sites, military fire training, and wastewater treatment plants are predictors of pollution
- Use in airport firefighting foams pollutes groundwater, lakes, soils, and fish
- Found in remote mountain snow
- Bioaccumulates in plankton
- Contaminates fish
- Efficiently translocated into plants

PFAS in people

Numerous studies show PFAS contamination in people. For example, in one study of 299 infants, PFOS was found in the blood of 297 of them and PFOA was found in all of them.

The Stockholm Convention conducts global monitoring of substances listed in the treaty as part of its effectiveness evaluation. The most recent data is from a series of regional monitoring reports published in 2015.

In Africa, the treaty monitoring study noted that PFOS was detected in mothers' milk from all 11 countries that submitted samples with levels varying from 1 – 34 ppt. The report notes that, *"Assuming that there is no industrial production of PFOS in the region, exposure of humans to PFOS and related chemicals might probably come from different kinds of waste, releases from industrial applications in firefighting and the various consumer products."*

The monitoring report for the Asia-Pacific region notes that only a few countries reported data. The report shows PFOS in air in Fiji, Hong Kong, Japan and in blood including maternal plasma in Japan. PFOS was also measured in marine areas in China, Hong Kong, Japan, Macao and rivers and lakes in Philippines, South Korea, and Thailand.

In Central and Eastern Europe, the Stockholm Convention monitoring report notes that data on water monitoring are scarce and data for the presence of PFOS in human tissues is even more limited.

Stockholm Convention monitoring in Latin America and the Caribbean showed that only Uruguay reported data on PFOS in air and the report notes that at this time (2015) there was no formal monitoring program in the region for determination of PFOS.

In Western Europe and Other States, monitoring data also includes the Arctic where PFOS and PFOA in air were measured. The report notes that phaseouts of PFOS and PFOA are reflected in declining concentrations but that fluorinated substitutes show increasing levels in Arctic air. The study also reveals that of all the measured POPs, PFOS was the predominant substance in human plasma, with the highest level of 470 ppt reported in an Inuit resident of the Arctic.

Recent scientific studies show the widespread presence PFAS in humans. Data include the following:

- Perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and perfluorotridecanoate (PFTrDA) in human milk in Sweden
- PFOS, PFOA, PFNA, PFDA, PFUnA and PFHxS in maternal sera, placentas, and fetuses.
- PFOS, PFOA, PFHxS, and PFNA in New Zealand adults
- PFOS, PFDoDA, PFUnDA and PFTrDA in pregnant Japanese women
- PFOS, PFOA, PFHxS in >94% of community residents with drinking water contaminated by a former US Air Force base.
- 10 long-chain PFAS in California women.
- PFOS< PFOA< PFHxS, PFNA, PFUnDA, PFHpS found in maternal plasma in Norway.
- PFAS in amniotic fluid in Denmark.
- Prenatal exposure to PFOS, PFHxS, PFHpS, PFNA, and PDFA in Denmark.
- Prenatal exposure to PFBS, PFHxS, PFUA in China.

- Six PFAS in middle-aged US women.
- PFNA, PFDA, PFUnDA, PFHxS, PFOA, and PFOS in more than 99% of sampled pregnant Swedish women.
- PFAS in maternal and cord blood in mothers exposed to the US World Trade Center disaster during pregnancy.
- PFOA, PFOS, PFNA, PFHxS in cord blood of Slovak infants.
- PFOS, PFOS and 6:2 CL-PFESA in cerebrospinal fluid in China indicating ability to cross the blood-CSF barrier.
- PFOS, PFOA, PFNA, and PFHxS in children.
- PFOA, PFOS< PFNA, and PFHxS in pregnant US women.
- PFOS< PFOA< PFHxS and PFNA in maternal serum in the UK.
- PFOA, PFOS, and PFHxS in Chinese women.
- PFOA and PFNA in US children.
- PFAS in Alaska Natives.
- PFHxS, PFOA< PFOA, PFNA, PFDA, PFUdA, PFDoA, and PFTrDA in >85% of sampled pregnant women in China.
- PFAS in pregnant Chinese women.

Manufacturers knew PFAS were harmful

Recently obtained documents indicate that the original manufacturers of PFOS and PFOA knew about the harmful characteristics of both substances decades ago.

A lawsuit filed by the US State of Minnesota against 3M produced internal company documents that demonstrated that the company knew PFOS and PFOA were accumulating in people for more than 40 years. 3M had previously withheld required documents from US regulators which resulted in a USD$1.5 million fine in 2006. In 1975, university researchers found a fluorinated substance in human blood and 3M confirmed that it was PFOS. Subsequent company testing found PFOS levels in 3M personnel at levels 50 – 1000 times higher than normal levels. In 1978, tests on monkeys feed PFOS resulted in all the animals dying and those given PFOA developed lesions on their spleen, lymph nodes, and bone marrow, all relevant to a functioning immune system. By 1989, the company knew that PFOS suppressed the immune system, caused tumors in animals, and that rates of cancers of the digestive organs and prostate were elevated in its own workers. The company proceeded to produce the substance anyway.

Internal company documents reveal that DuPont knew decades ago that PFOA affected the livers of dogs and humans, encouraged the growth of testicular tumors in rats, and appeared to result in endocrine disorders and kidney cancer in workers. In 1978, the company documented immunotoxicity and other adverse effects in tests on monkeys exposed to PFOA and PFOS. By 1984, DuPont knew that PFOA was toxic, didn't break down, accumulated in blood, transferred from mothers to the fetus, and polluted drinking water supplies. DuPont decided to keep producing it anyway as it became incorporated into a multitude of products and processes. The company's real attitude about the consequences of PFOA production is revealed in its internal documents as "the material 3M sells us that we poop to the river and into drinking water."

DuPont was fully aware of PFOA's hazards, but a study of the company's decision-making processes noted that DuPont made a calculated, rational decision to pollute anyway. The authors estimate that for DuPont, “it was value-maximizing to pollute if the probability of getting caught was less than 19%.” In reality the probability was much less than that and now communities and governments bear the burden of that private sector decision.

Annex 2. The high cost of PFAS cleanup

PFAS manufacturing and use in a multitude of products such as firefighting foams has resulted in widespread pollution – especially in water due to the solubility of PFAS substances. PFAS-contaminated sites have been identified in Australia, Canada, China, Germany, Italy, Japan, Netherlands, New Zealand, South Korea, Sweden, and the US, including a large number of military bases that contribute to 172 PFAS contamination sites in 40 states. In 2018, the US State of Minnesota entered into an agreement with 3M for the company to pay the state USD$850 million for costs associated with cleanup of PFAS including PFHxS due to manufacturing and releases by the company.

Clean up of PFAS pollution is difficult and costly. According to the Polluter Pays Principle, and sound economic policy, these types of external costs should not be borne by taxpayers, the state or national treasury, or by any other third party. Rather, these costs should be internalized within producer industries to avoid market distortion. As noted by UN Environment in 2012, "The vast majority of human health costs linked to chemicals production, consumption and disposal are not borne by chemicals producers, or shared down the value-chain. Uncompensated harms to human health and the environment are market failures that need correction."

Examples of estimated and actual cleanup costs for PFAS pollution include:

- Recent US government agency estimates for the cost PFAS clean-ups and associated monitoring due to use of firefighting foams at US military bases are more than USD$2 billion. There are also expensive clean up costs and estimates in a variety of US states including Alaska, New Jersey, New York (see also here and here), Vermont, Virginia, and Washington.
- The World Bank estimates that if just 20% of fluorinated firefighting foam in China is used for training or fire extinguishing, remediation costs would exceed USD$800 million.
- Remediation of PFAS-containing firefighting foam at the Düsseldorf Airport in Germany will take years or even decades. Cleanup costs cited by the European Chemicals Agency exceed €100 million. There are additional documented remediation costs due to PFAS pollution in Germany – see here, here, and here.
- Clean up due to use of 3M's "Light Water" firefighting foam containing PFOS and PFHxS at 18 military bases in Australia is estimated to cost hundreds of millions of dollars. The cleanup of just a single firefighting training college in Australia is estimated to cost AUS$80 million.
- To clean up groundwater polluted by PFAS around firefighting areas in Norway costs €3.5-5.5 million per training site.
- Firefighting training sites are the main sources of PFAS pollution in Sweden leading to €1 million in annual costs for charcoal filtering of water in Uppsala and a new water supply in Ronne costing €3 million. Extrapolated estimates for advanced cleaning of all waste water treatment plants in Sweden would only moderately remove fluorinated compounds but still cost USD$230 million per year.
- New Zealand has budgeted NZE$1 million to investigate cleanup of PFAS associated with firefighting foam use by military bases.

Annex 3. PFAS and the Stockholm Convention

The Stockholm Convention objective is to protect human health and the environment from persistent organic pollutants. Persistent organic pollutants (POPs) are a class of highly hazardous chemical pollutants that are recognized as a serious, global threat to human health and to ecosystems. Substances can be added to the Stockholm Convention after evaluation and recommendation by the POPs Review Committee (POPRC). Egypt became a Party to the treaty in 2004.

PFOS

Governments added PFOS to the treaty list at the 4th Conference of the Parties in 2009 and subsequently adopted a series of guidance documents on PFOS alternatives.

When PFOS was listed in Annex B of the treaty in 2009, a very large number of loopholes accompanied its listing that permitted continued production and use. At COP9 in April/May 2019, Parties will determine if these loopholes are still needed or if some can be ended. The decision will focus on 6 time-limited ones (specific exemptions) and 8 time-unlimited ones (known as acceptable purposes). The POPRC recommended the following changes to the PFOS listing in the Convention:

End loopholes for 11 PFOS uses: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; photo masks in semiconductor and LCD industries; hard metal plating; decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production.

Convert two time-unlimited exemptions to time-limited exemptions: metal plating (hard metal plating only in closed loop systems) and firefighting foams. This gets the clock running on ending these uses in five years. On the firefighting foams, the Committee recommended stopping production and only allowing use for class B fires (ones involving solvents, oil etc.) and only in installed systems. The Committee also noted that, *"a transition to the use of short-chain per- and polyfluoroalkyl substances (PFASs) for dispersive applications such as fire-fighting foams is not a suitable option from an environmental and human health point of view…"* This is extremely important since the fluorinated alternatives are persistent, toxic and readily pollute drinking water.

Continue time-unlimited exemption for one use: insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. This vaguely-worded listing actually refers to a pesticide called sulfluramid that degrades to PFOS. The POPRC recommended naming sulfluramid in the treaty under the PFOS listing and narrowing its use to agriculture.

IPEN recommendations for PFOS

Specific exemptions or acceptable purposes for the following 12 uses of PFOS should be ended: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; firefighting foams, photo masks in semiconductor and LCD industries; hard metal plating;

decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production. If a specific exemption is allowed for use in firefighting foams, the POPRC recommendations should be adopted.

The following 2 acceptable purposes should be converted into specific exemptions: metal plating (hard metal plating only in closed loop systems); and insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. Sulfluramid should be named in the PFOS listing and its use sharply limited to cultivation of specific crops.

PFOA

PFOA is extremely persistent and does not degrade under relevant environmental conditions. It bioaccumulates in air-breathing land and marine mammals, including humans. PFOA is found in water, snow, air, sediment and biota at remote locations including the Arctic. In 2017, the Stockholm Convention POPs Review Committee noted the link between PFOA and serious illnesses in humans, including diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension. PFOA is transferred to the fetus through the placenta and to infants via breast milk. PFOA-related compounds such as fluorotelomer alcohols, fluoropolymers and fluorotelomer-based polymers must be included in actions designed to eliminate PFOA releases since they can degrade to PFOA.

In 2018, the POPRC recommended that governments list PFOA and related substances in Annex A of the Stockholm Convention for global elimination.

Ten time-limited exemptions accompany the PFOA listing recommendation, however, many of these are not justified.

Proposed PFOA Exemption	**Comment**
5 years	
3 exemptions connected to semiconductor manufacturing (equipment or plant infrastructure, legacy equipment, photo-lithography, etch process)	Alternatives without PFOS or PFOA are available for photolithography and etch processes. For example, IBM eliminated both in 2010. The other proposals are not sufficiently defined.
Photographic coatings applied to films	Obsolete use of PFOA replaced by digital imaging, including in developing and transition countries.
Textiles for oil and water repellency for workers	Proposal relies on industry claims and does not state what specific products the exemption would cover or how worker protection can be achieved without relying on a toxic chemical-impregnated textile.

Invasive medical devices	Alternative medical devices made without PFOA have passed all regulatory requirements, are available on the market, and in use.
Implantable medical devices	Alternative medical devices made without PFOA have passed all regulatory requirements, are available on the market, and in use.
Firefighting foams	Cost-effective non-fluorinated alternatives are in use at major airports and military installations and perform as well as PFAS-containing foams.
10 years For manufacture of semiconductor or related electronic devices; refurbishment parts containing fluoropolymers and/or fluoroelastomers with PFOA for legacy equipment or legacy refurbishment parts	See above for manufacturing. Legacy equipment proposal is not specific and include thousands of unnamed parts. Retrofitting with parts that do not contain PFOA should be utilized, instead of continuing PFOA production and use.
Until 2036 To use PFOI (a PFOA-related substance) to make PFOB for producing pharmaceutical products *"with a review of continued need for exemptions."*	In 2015, more than 100 governments agreed that environmentally persistent pharmaceutical products are an emerging policy issue of global concern in the SAICM process. A global exemption should not be adopted on behalf of a single company (Daikin) and exemptions for environmentally persistent pharmaceutical products should not be recommended.

IPEN recommendations for PFOA

PFOA should be listed in Annex A with no specific exemptions. If exemptions are granted, they should be for specific uses or products and the listing should require labeling new products that contain PFOA so that Parties can fulfill requirements under Article 6 as done previously for HBCD (SC-6/13). In addition, due to the costly, highly polluting nature of PFAS-containing firefighting foams and the availability of effective fluorine-free foams, no exemption should be granted. If a specific exemption is allowed for this use, the POPRC recommendations on firefighting foams should be adopted.

PFHxS

PFHxS and related compounds are persistent in water, soil and sediment and unlikely to undergo degradation in the environment including hydrolysis, aqueous photolysis or under anaerobic conditions. PFHxS biomagnification factors (BMF) greater than 1 have been observed in food chains including Arctic bird/fish, Arctic polar bear/ringed seal, dolphin/fish, and fish/zoo plankton among others, indicating bioaccumulation. PFHxS has the longest half-life in humans determined for any PFAS. PFHxS undergoes long-range transport and is found in Arctic air, sediment, snow, ice, soil, sediment and biota (including humans) and in Antarctic biota and snow. *In vivo* and epidemiological studies show that PFHxS negatively affects liver function, thyroid, and the developing immune system resulting in reduced effects of vaccines and higher incidences of infections and asthma in children. A significant association between PFHxS exposure and breast cancer has been found in Greenlandic Inuit women. PFHxS is widely found in breast milk and is one of the most frequently detected and predominant PFAS in human blood, including maternal and infant cord blood. In September 2018, the POPRC determined that PFHxS "warrants global action" and moved the substance to the third and final evaluation during 2018 – 2019.

PFAS use in firefighting foams

There are many uses of PFAS, but one of the most highly polluting is in firefighting foams. This pollution occurs where the foam is used and quickly contaminates water and moves. Airports and military bases are common sources of PFAS pollution.

PFOS and PFOA were the original components in firefighting foams, but after regulatory pressure in the US, many companies switched to shorter-chain substances such as PFHxS, PFBA, PFBS, PFHxA, and PFHpA. These substances also are persistent and have hazardous properties. Some are found in the Arctic, suggesting ability to undergo long-range transport. Recently, IPEN assembled a group of fire safety experts who produced a detailed report on issues involving firefighting foams and the technical feasibility of fluorine-free firefighting foams. Safer cost competitive non-fluorinated alternatives to PFAS in firefighting foams have been adopted by major airports, including Auckland, Copenhagen, Dubai, Dortmund, Stuttgart, London Heathrow, Manchester, and all 27 major airports in Australia.

In September 2018, the POPRC recommended severe restrictions on the use of PFOS and PFOA in firefighting foams. In addition, the Committee also made an extremely important recommendation **not** to use the fluorinated alternatives to PFOA and PFOS, *"due to their persistency and mobility as well as potential negative environmental, health and socioeconomic impacts."*

The recommended restrictions on firefighting foams containing PFOA, PFOA-related substances, or PFOS include:

- No production.
- Use for 5 years only for liquid fuel vapor suppression and liquid fuel fires (Class B fires) already in installed systems.
- No import or export, except for environmentally-sound disposal.
- No use for training or testing purposes.
- By 2022, restrict use to sites where all releases can be contained.

- Ensure that all firewater, wastewater, run-off, foam and other wastes are managed in accordance with the treaty.

IPEN recommendations on PFAS use firefighting foams

Due to the costly, highly polluting nature of firefighting foams, and the availability of technically feasible, high-performing alternatives, no exemption should be granted for this use. IPEN supports the POPRC recommendation that fluorinated alternatives to PFOA and PFOS should not be used.