Land and Human to Advocate Progress
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Jordan PFAS Situation Report

Land and Human to Advocate Progress
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Summary

This report summarizes regulations, inventory information and scientific studies on per- and polyfluoroalkyl substances (PFAS) in Jordan. The country ratified the Stockholm Convention in 2004 and the amendment listing PFOS went into legal force in 2010.

The updated Stockholm Convention National Implementation Plan, scientific studies of PFAS and examination of regulatory policy in Jordan raise concerns about these substances and reinforces the need for regulatory action. Key findings of this study are:

PFAS are poorly regulated in Jordan

While PFOS has been banned as a result of the Stockholm Convention listing, other PFAS substances are not regulated. PFOS has been banned under three relevant laws:

- Environmental law 52/2006 in article 6, which regulates importing and exporting of hazardous wastes.
- Import, export and management of hazardous substances is banned by the bylaws no. 24, 2005 articles 7 and 8.
- Amended import Instruction no 1, 2012 by Ministry of Industry and Commerce allows for the import of used computers not more than three years old.

Breast milk is contaminated with PFAS substances

A 2015 study found significant levels of PFOS and PFOA in both breast milk and fresh cow milk. Overall, PFOA levels in Jordanian breast milk averaged 144 ppt – seven times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest level of PFOA exposure in Jordanian breast milk was more than 60 times higher than this drinking water health advisory limit and the highest PFOS level was nine times greater than this standard. The highest levels of PFOS and PFOA in cow milk were and 1.45 and 8 times higher than this limit.

Firefighting foams are a likely major source of PFAS

According to the Revised National Implementation Plan under the Stockholm Convention firefighting foams are the likely major source of PFAS in the country. Use of fluorine-containing fluoroprotein firefighting foams by the Civil Defense Directorate between 2010 and 2013 ranged from 16,524 – 22,744 liters. The Directorate has large stockpiles of PFAS-containing foams including more than 292,000 liters of fluoroprotein foam and 28,000 liters of an alcohol-resistant fluoroprotein foam. Use of PFAS-containing firefighting foams by the Jordan Petroleum Refining Company and electrical generation companies such as the AL Hussein thermal station are not currently known.

Wastewater treatment methods can remove some PFAS but many remain
A 2019 study examined the potential use of biochar filters to remove PFAS in lab experiments. The study found that biochar without biofilm remove 90% - 100% of PFOA, PFNA, PFUnDA, PFDoDA, PFOS, and FOSA by adsorption. However, shorter-chain PFAS, which represent the industry trend, were not effectively removed using this method. For example, removal of PFBA, PFPeA, and PFHxA averaged 20%, 30%, and 40% respectively. PFHxS removal averaged only 60%.

PFAS elimination contributes to achievement of 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 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. 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 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.
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 clean up 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

Information on PFAS is lacking in Jordan. However, Jordan has conducted a preliminary inventory on uses of PFOS due to its listing in the Stockholm Convention.

PFOS

In May 2019, Jordan updated its Stockholm Convention National Implementation Plan with a focus on the nine new POPs added to the treaty in 2009, including PFOS.

The updated Plan notes that PFOS has been banned under three relevant laws:

- Environmental law 52/2006 in article 6, which regulates importing and exporting of hazardous wastes.
- Import, export and management of hazardous substances is banned by the bylaws no. 24, 2005 articles 7 and 8.
- Amended import Instruction no 1, 2012 by Ministry of Industry and Commerce allows for the import of used computers not more than three years old.

The Plan describes a preliminary inventory of PFOS which noted the following findings:

There is a high likelihood that PFOS-containing firefighting foams are present including AFFF, ALCOSEAL, high expansion foam, and fluoroprotein foams. Principal potential users include the Civil Defense Directorate, Jordan Petroleum Refining Company, and electrical generation companies such as the AL Hussein thermal station. Only the Civil Defense Directorate responded to the inventory request, noting the following information on PFOS-containing firefighting foams.

Quantities of fluorinated firefighting foams consumed by the Civil Defense Directorate (liters)

Type of foam	2010	2011	2012	2013
Fluoroprotein	16,524	23,740	18,154	22,744
AFFF	1	1	3	1
ALCOSEAL	300	600	125	1000
High expansion	-	-	-	2,680

Source: Jordan Updated Stockholm Convention National Implementation Plan, May 2018

Note that all four of these types of foams contain fluorinated surfactants or polymers. Fluoroprotein foams are protein foams that have fluorosurfactants added to them. AFFF foams are aqueous film-form foams containing fluorinated chemicals. ALCOSEAL is a type of fluoroprotein foam that is alcohol-resistant. High expansion foams are fluorinated foams used in enclosed spaces such as airplane hangars to quickly fill an area. Expandol 3% is used at liquified natural gas facilities and contains 200 ppt PFOS and 560 ppt PFOA. Petroseal 6% is a film-forming fluoroprotein foam.

Quantities of firefighting foams available in 2014 in the Civil Defense Directorate (liters)

Type of foam	Quantity (liters)
Fluoroprotein	46,490
Synthetic foam	3,307
ALCOSEAL	28,425
Protein foam	2,621
High expansion foam	8,203
Fluoroprotein foam	292,064
Foam of solid material fires (no. of cans)	393
AFFF foam (no. of cans)	198
Expandol 3% foam	4,932
Petroseal foam 6%	3,017
Mechanical foam	67
AFFF foam 6% (no. of cans)	3
AFFF foam 6%	280

Source: Jordan Updated Stockholm Convention National Implementation Plan, May 2018

The Plan states that "brands manufactured by Chemguard do not contain PFOS or its related substances." However, Chemguard foams are fluorinated with shorter-chain C6 substances that raise similar concerns as PFOS. Similar statements are made about Tyco foams, but the company sells a variety of PFAS-containing foams. The document claims that Lodyne brand Ciba foams stopped including PFOS in 2003, but the foams contain fluorotelomers that are persistent and appear to accumulate.

The Plan also illustrates a common problem faced by government and corporate procurement offices; the lack of information. The Civil Defense Directorate in Jordan noted that they deal with different suppliers of firefighting foams and that they have no information about they contain PFOS or presumably any other PFAS substance.

The Plan update also investigated the leather and garments sector which includes 1,054 manufacturing facilities and facilities using chromium plating processes. The largest factories using chrome plating include army operating maintenance, aircraft maintenance, and other heavy industries. None of the factories said that they were using PFOS in textile, leather, carpets or chrome plating. Most of the textile factories import textiles and then use it for sewing. The ministry assessment notes that PFOS is expensive and would increase the cost of manufacturing and that it could be possible that the companies were not aware of their own use or were not cooperative.

PFOA and other PFAS

PFOA, its salts and PFOA-related compounds are used widely in the production of fluoroelastomers and fluoropolymers, for the production of non-stick kitchen ware, food processing equipment. PFOA-related compounds, including side-chain fluorinated polymers, are used as surfactants and surface treatment agents in textiles, paper and paints, firefighting foams. PFOA has been detected in industrial waste, stains resistant carpets, carpet cleaning liquids, house dust, microwave popcorn bags, water, food and Teflon, Unintentional formation of PFOA is created from inadequate incineration of fluoropolymers from municipal solid waste incineration with inappropriate incineration or open burning facilities at moderate temperatures.

Jordan permits the production, import and use of Perfluorooctanoic acid (PFOA) (CAS No. 335-67-1), PFOA salts (CAS no 3825-26-1) and the PFOA-related compounds (CAS no 27905-45-9). Therefore, these products and other PFAS substances are not banned or restricted (production, import and use) by the Ministry of Environment according to Regulation NO. 24/2005 “Management, Transportation, and Handling of Harmful and Hazardous Substances” nor prohibited or restricted according to public health law No. 47/2008.

However, Jordan is in a position to ban and restrict their use once these chemicals are listed in Stockholm Convention annexes. In addition, Jordan has no data on the volume and quantities either imported or used in the country. As far as export of these chemicals, Jordan does not export any of them.

It is worth mentioning that PFAS is a big family of chemicals that has one HS code, but the related salts or compounds (family members such as the ones mentioned above) have no HS codes. Therefore, the Customs Department is not able to identify the HS Code for these chemicals by the CAS number, so it is difficult to determine the quantities imported from these materials. In conclusion, since these chemicals are not known to the Customs Department or to producers and users, then it is assumed that their wastes are not treated. This piece of information would mean that Jordan is not able even to calculate and figure out the quantities imported and used in Jordan.

PFAS impacts

PFOA is identified as a substance of very high concern with a persistent, bio accumulative and toxic structure for the environment and living organisms. PFOA-related compounds are released into the air, water, soil and solid waste, and degrade to PFOA in the environment and in organisms. Major health issues such as kidney cancer, testicular cancer, thyroid diseases, pregnancy induced hypertension, a high cholesterol have been linked to PFOA.

Since production, import, and use are not banned or restricted and these chemicals cannot be identified by the Custom Department, and PFAS wastes could end up in the domestic solid waste disposal sites. This may mean that domestic solid waste dumping sites could be potential contaminated sites with these chemicals, something that requires further study and update of national laws. In addition, no official reports of pollution have been prepared noting any possible effects on humans and the environment. This also means that an extended study is required at the level of the country targeting people and their environment.

Scientific studies on PFAS in Jordan

The Stockholm focal point in the Ministry of Environment noted that these chemicals are new to them as they are not restricted by the Ministry of Environment and Ministry of Health legislation. As a result, no studies have been conducted. However, there are some peer-reviewed studies on PFAS substances in Jordan.

Dalahmeh SS, Alziq N Ahrens (2019) Potential of biochar filters for onsite wastewater treatment: Effects of active and inactive biofilms on adsorption of per- and polyfluoroalkyl substances in laboratory column experiments, Environ Pollut 247:155-164

This study examined methods to remove PFAS in wastewater treatment systems. Traditional methods do not remove these substances and the effluent can contain even higher PFAS concentrations than the influent due to degradation of PFAS precursors. This study investigated the potential use of biochar filters to remove PFAS in lab experiments to test whether it might be used as a replacement or complement for sand filters. Biochar is produced by low temperature heating of plant residue or lignocellulosic organic material under low oxygen concentrations. The biochar used in this study was produced by burning a mixture of pine and spruce wood at 800C. Previous work has examined how the filtration properties of biochar compare with activated carbon, which is more expensive.

The study found that biochar without biofilm could efficiently remove C7 – C11 PFCAs (PFOA, PFNA, PFUnDA, PFDoDA), C6 and C8 PFSAs (PFHxS, PFOS), and FOSA by adsorption. Average removal percentages were 90% - 100% compared to removal by sand active biofilm which ranged from 0% - 70% depending on the substanc. The results showed that it was most effective if applied after organic material has been removed. Shorter-chain PFAS, which represent the industry trend, were not effectively removed using this method. For example, removal of PFBA, PFPeA, and PFHxA averaged 20%, 30%, and 40% respectively. PFHxS removal averaged only 60%.

Coperchini F, Awwad O, Rotondi M, Santini F, Imbriani M, Chiovato L (2017) Thyroid disruption by perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), J Endocrinol Invest 40:105-121

This study represents a collaboration between researchers in Jordan and Italy and reviews the effects of PFOS and PFOA on the thyroid. The review notes that PFOS and PFOA appear in thyroid cells and cause toxicity at high concentrations in vitro. In humans exposed in communities, the authors note that, *"the most consistent effect of exposure to PFOA, and to a less extent to PFOS, is the occurrence of hypothyroidism."* Hypothyroidism means an underactive thyroid that does not produce enough of certain critical hormones. In infants, this can lead to severe mental and physical retardation. The authors note that, *"Women and children appear to be more at risk of developing mild thyroid failure. Pregnant women with circulating thyroid antibodies might be at risk of developing subclinical hypothyroidism, mainly when exposed at high doses of PFOS."* The study did not address increasingly-used shorter chain PFAS substances.

Al-sheyab NA, Al-Qudah KM, Tahboub YR (2015) [Levels of perfluorinated compounds in human breast milk in Jordan: the impact of sociodemographic characteristics](), Environ Sci Pollut Res Int 22 :12415-12423

This study measured PFOS and PFOA in 79 samples of breast milk and 25 samples of fresh cow milk. PFOS was found in all the breast milk samples and PFOA was found in 94% of them.

PFOA levels ranged from 24 – 1220 ng/L (ppt) with an average level of 144 ng/L (ppt). PFOS levels ranged from undetected to 178 ng/L (ppt) with an average level of 35 ng/L (ppt). The average PFOA levels in breast milk were seven times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest PFOA level was more than 60 times higher than this limit. The average PFOS levels in breast milk were 1.75 times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest PFOS level was nine times higher than this limit.

In cow milk, PFOS and PFOA were found in 96% of the samples. PFOA levels ranged from 9 – 160 ng/L (ppt) and average levels were 86 ng/L (ppt). The average PFOA level in cow milk was more than four times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest PFOA level in cow milk was eight times higher than this limit. PFOS levels ranged from 6 – 178 ng/L (ppt) and average levels were 29 ng/L (ppt). The average PFOS level in cow milk was 1.45 times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest PFOS level was almost eight times higher than this limit.

Press reports on PFAS

There are no press reports specifically about PFAS chemicals, however, some press reports could be found about POPs in general.

PFAS regulations

PFAS substances are largely unregulated. However, there are regulations governing PFOS due to its listing in the Stockholm Convention. PFOS has been banned under three relevant laws:

- Environmental law 52/2006 in article 6, which regulates importing and exporting of hazardous wastes.
- Import, export and management of hazardous substances is banned by the bylaws no. 24, 2005 articles 7 and 8.
- Amended import Instruction no 1, 2012 by Ministry of Industry and Commerce allows for the import of used computers not more than three years old.

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 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. Jordan should seek financial and technical support to conduct a study through which it will do the following:
    a. Calculate the national inventory of these chemicals.
    b. Identify potential contaminated sites.
    c. Conduct a study addressing the impacts of these chemicals on people’s health and environment.
    d. Develop an action plan on how to collect the chemicals waste, how to dispose of and treat contaminated wastes in the country.

2. The capabilities program for Customs Control and related stockholders should be improved to control imports of these chemicals.

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

4. Enact specific regulations to prohibit PFAS production, use, import, and export. To avoid costly mistakes, PFAS should be banned as a class.

5. Create awareness among workers and the general population regarding dangers of PFAS.

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). Jordan 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. The amendment listing PFOS went into effect for Jordan in 2010.

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.

Due to the costly, highly polluting nature of firefighting foams, and the availability of technically feasible, high-performing non-fluorinated alternatives, no exemption should be granted for this use.

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 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 firefighting foams, and the availability of technically feasible, high-performing non-fluorinated alternatives, no exemption should be granted for this use.

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.