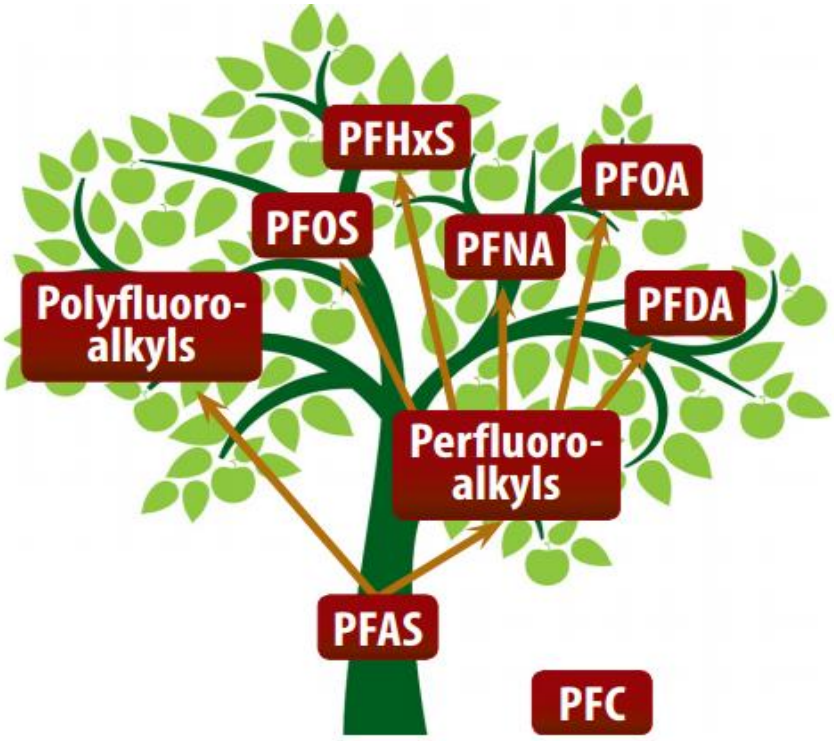
PFAS Situation Report: Indonesia



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a toxics-free future

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For more information, please contact:

balifokus@balifokus.asia

ipen@ipen.org

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ABBREVIATIONS

BPOM	*Badan Pengawas Obat dan Makanan*/Food and Drugs Administration
BPPT	*Badan Pengembangan dan Pengkajian Teknologi*/Technology Development and Assessment Agency
BPS	*Badan Pusat Statistik*/Indonesia Statistics Bureau
BSN	*Badan Standardisasi Nasional*/National Standardization Agency
KLHK	*Kementerian Lingkungan Hidup dan Kehutanan*/Ministry of Environment and Forestry
LIPI	*Lembaga Ilmu Pengetahuan Indonesia*/Indonesian Institute of Sciences
NIP	National Implementation Plan
PFASs	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanoic sulphate
POPs	Persistent Organic Pollutants
US EPA	United States Environmental Protection Agency

Executive summary

Indonesia is a large country (population 261 million – world's fourth most populous) with a rapidly growing manufacturing sector and abundant raw materials to support the chemical industry. From 2009 – 2014, mining occupied the number one rank for foreign direct investment and chemicals number six. However, the country plans to move away from importing petrochemicals and move towards production in Sumatra and West Papua. The chemical industry grew 8.6% in 2016 and an increased compound annual growth rate of 11% from 2016 – 2021 is expected.

Indonesia's 2014 update to the Stockholm Convention National Implementation Plan (NIP) notes that PFOS and related substances are not regulated in Indonesia. The NIP notes that, *"information on the quantitative data of POPs, stockpiles and contaminated soil in Indonesia is still limited."* Preliminary assessment of PFAS priority sectors included specialized paper industries, firefighting foam, textile/apparel and synthetic carpets and synthetic carpet manufacturers. The NIP acknowledges that PFOS-containing firefighting foams are present, but the total volume is not known.

Key findings of this report are:

PFAS substances are poorly controlled in Indonesia
Indonesia became a Party to the Stockholm Convention in 2009 and the treaty added PFOS to its global restriction list in 2009. This amendment went into legal force in Indonesia in 2010. However, PFAS are essentially unregulated and not currently included in monitoring programs.

Breast milk is contaminated with PFAS substances
A 2008 study found PFAS in breast milk in women from Jakarta and Purwakarta. PFAS substances included PFOS, PFHxS, PFNA and PFHpA. PFOS was found in all twenty women and PFHxS was found in 45% of them. Overall, PFOS levels in Indonesian breast milk averaged 84 ppt – more than 4 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 PFOS exposure in Indonesian breast milk was more than 12 times greater than this drinking water health advisory limit.

Fire extinguishers containing PFAS are available on the market for consumer use
In Indonesia, fire extinguishers containing PFAS (AFFF) are readily available for consumer purchase. In fact, vendors mention that the fire extinguisher contains PFOA and PFOS as a hydrocarbon-based surfactant and claim that the product is, "Not harmful to plants, animals, especially humans."

Soccer shoes and coats manufactured in Indonesia contain high PFAS levels.
A 2014 Greenpeace investigation found five types of soccer shoes manufactured in Indonesia that contained PFOA and PFBS. The levels ranged from 5.28 – 14.5 µg/m^2 for PFOA and 14.5 – 37.9 µg/m^2 for PFBS. A study from the German Federal Environmental Agency found a coat made in Indonesia with a variety of PFAS substances at a total level of 42.9 µg/m^2. To illustrate how significant these levels are, note that the EU regulates PFOS at 1 µg/m^2 in textiles.

PFAS contaminates coastal sediments
A 2012 study found PFOS and PFOA in Jakarta Bay sediments collected in 2004. PFOS was found in all samples. PFOA ranged up to 6.1 ug/kg dry weight – approximately ten times higher than the highest level observed in San Francisco Bay in the USA.

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.

Recommendations

- National recommendations

1. PFAS and its derivatives used in textiles, textile products, fire-fighting foams, papers, and in the electronics industries need to be regulated and controlled as a class.
2. Industry shall disclose PFAS content in their products and provide clear warning sign/label/icon on their products placed on the market.
3. An inventory of PFOS and other PFAS substances, including activities at the upstream level and the downstream level, needs to be conducted to identify how much and in which sector that PFAS chemicals are currently being used in Indonesia.
4. When a product containing PFAS is withdrawn from the market, it is essential to plan to designate the disposal site and promote safer alternatives or substitutes.
5. To prevent PFAS pollution and subsequent costly remediation, Indonesia should make an inventory of firefighting foam stocks and promptly and replace PFAS-containing foams and fire extinguishers with fluorine-free foams as soon as possible.
6. Monitoring of POPs chemicals is essential to prevent chronic and acute exposures and the adverse effects of PFAS, PFOS, PFOA, and other POPs chemicals to vulnerable populations.
7. NGOs can conduct public awareness-raising and data gathering to alert the public about the hidden pollution and harms posed by PFAS substances .

- 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 labelling new products that contain PFOA so that Parties can fulfil 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 colour printers and colour 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.

PFAS Situation in Indonesia

1. Introduction

1.1. What are per- and polyfluoroalkyl substances (PFAS)?

Per- and polyfluoroalkyl substances (PFAS) are groups of anthropogenic chemicals that includes PFOA, PFOS, Genx, and many other fluorinated chemicals.[1] 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.

1.2. Exposure and health impacts

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 mostly detected in blood, liver, and kidneys. The health impacts of PFOS/PFOA are actively being studied and discussed among scientists. Research shows that PFOA-exposed communities from nearby chemical plants are correlative with occurrences of cancer, especially positively associated with kidney and testicular cancer.[2] Impacts have also been observed on the immune system.[3] Various studies have shown relatively consistent evidence of modest positive associations of PFAS with lipid profiles (i.e., cholesterol and triglycerides) and less compatible with metabolic diseases (i.e., diabetes, obesity, heart disease).[4] Another review paper reported that despite some inconsistencies, most studies

[1] US.EPA: Basic Information on PFAS

[2] Barry, V.; Winquist, A.; Steenland, K. (2013) *Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers among Adult Living Near a Chemical Plant*. Environmental Health Perspectives Vol 121 No. 11-12. DOI: 10.1289/ehp.1306615

[3] DeWitt, J.C.; Blossom, S.J.; Schaider, L.A. (2018) *Exposure to perfluoroalkyl and poly-fluoroalkyl substances leads to immunotoxicity: epidemiological and toxicological evidence.* Journal of Exposure Science & Environmental Epidemiology DOI: 10.1038/s41370-018-0097-y

[4] Sunderland, Elsie, et.al. (2019). A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. Journal of Exposure Science & Environmental Epidemiology, volume 29, pages131–147 (2019) https://doi.org/10.1038/s41370-018-0094-1

suggested that PFASs have the impact to birth outcomes and pre- and postnatal growth, for instance, birth weight (PFOS)[5,6], body mass index among girls[7,8], obesity among females but not males[9], and low IQ scores.[10] Airport firefighters found to have higher levels of the substances in their blood and regularly use PFAS-containing firefighting foams and protective gear containing the substances.[11]

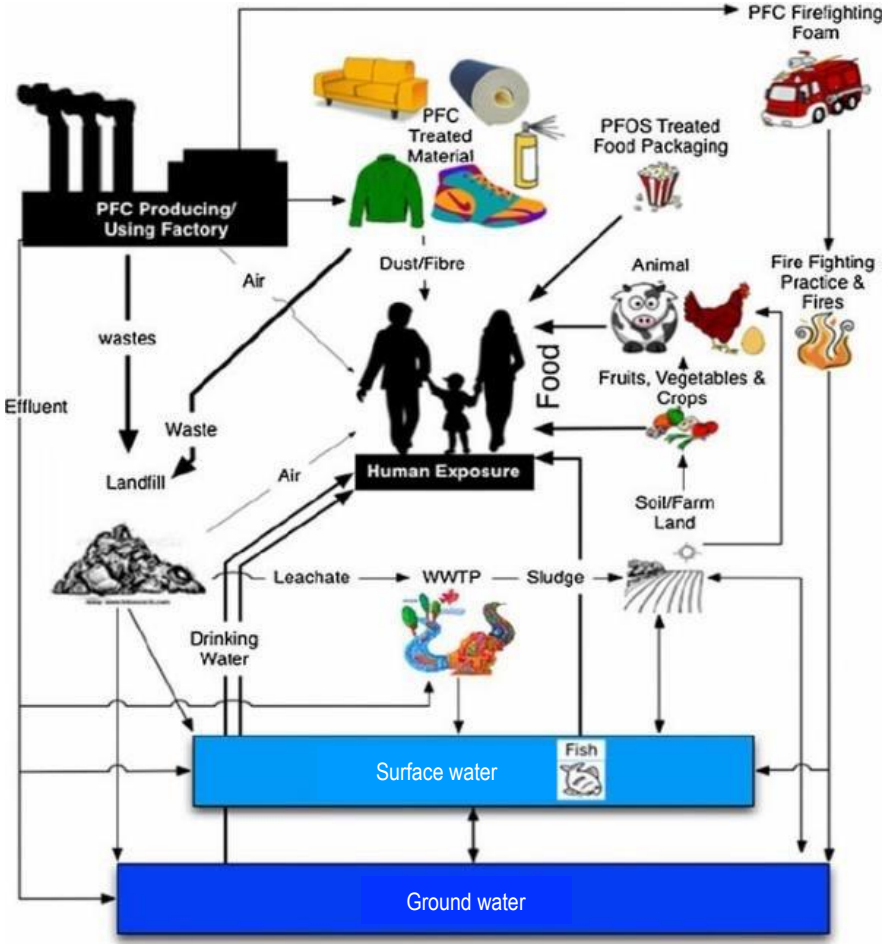


Figure 1. PFC release from the technosphere and contamination pathways in the environment and exposure pathways to humans. Source: Fardin Oliaei, et.al. (2012)

[5] Washino N.; Saijo, Y.; Sasaki, S; Kato, S; Ban, S; Konishi, K; Ito, R; Nakata, A; Iwasaki, Y; Saito, K; Nakazawa, H; Kishi, R (2009). *Correlations between prenatal exposure to Perfluorinated chemicals and reduced fetal growth*. Environ Health Perspect. 2009;117(4):660–7. DOI: 10.1289/ehp.11681

[6] Kishi, R.; Nakajima, T; Goudarzi, H; Kobayasi, S; Sasaki, S; Okada E; Miyashita, C; Itoh, S; Araki, A; Ikeno, T; Iwasaki, Y; Nakazawa H (2015) *The Association of Prenatal Exposure to Perfluorinated chemicals with maternal essential and long-chain polyunsaturated fatty acids during pregnancy and the birth weight of their offspring: the Hokkaido study*. Environ Health Perspect. 2015;123(10):1038–45. DOI: 10.1289/ehp.1408834

[7] Mora, AM.; Oken, E; Rifas-Shiman, S; Webster, T; Gillman, M; Calafat, A; Ye, X; Sagiv, S (2017) *Prenatal exposure to Perfluoroalkyl substances and adiposity in early and mid-childhood*. Environ Health Perspect. 2017;125(3):467–73. DOI: 10.1289/EHP246

[8] Chen MH, et al. *The impact of prenatal perfluoroalkyl substances exposure on neonatal and child growth.* Sci Total Environ. 2017;607-608:669–75.

[9] Halldorsson TI.; Rytter, D; Haug, LS; Bech BH.; Danielsen, I; Bacher G; Henriksen, TB; Olsen, SF. (2012). *Prenatal exposure to perfluorooctanoate and risk of overweight at 20 years of age: a prospective cohort study*. Environ Health Perspect. 2012;120(5):668–73.

[10] Wang, Y; Rogan, WJ.; Chen, H; Chen, P; Su, P; Chen, H; Wang, S (2015) Prenatal exposure to perfluoroalkyl substances and children's IQ: The Taiwan maternal and infant cohort study. International Journal of Hygiene and Environmental Health 218 (2015) 639-644. DOI: 10.1016/j.ijheh.2015.07.002

[11] https://www.theguardian.com/australia-news/2017/oct/19/airport-firefighters-demand-their-blood-be-tested-for-toxic-chemicals

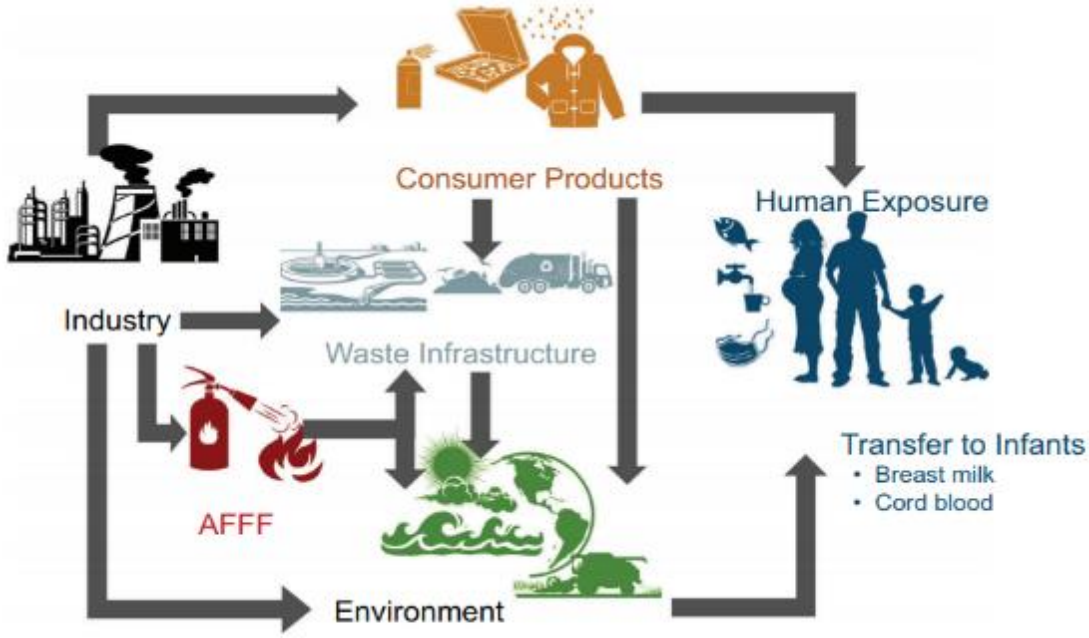


Figure 2. the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs).

Source: Sunderland, et.al. (2019)

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 behaviour, 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.

1.3. PFAS pollution

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.

1.4. PFAS use in products

PFAS have been detected in consumer products (i.e. textiles, carpets, cleansers, paints, etc.), as well as drinking water, seafood, biosolids, and agriculture. Since the first manufacture in 1940s, PFAS have been used in a variety of industry sectors. PFAS can be found in several products:

a. Food packaging
b. Commercial household products, including stain and water repellent fabrics, non-stick products, waxes, paints, cleaning products
c. Fire-fighting foams.
d. Workplace (e.g. chrome plating, electronics manufacturing or oil recovery)

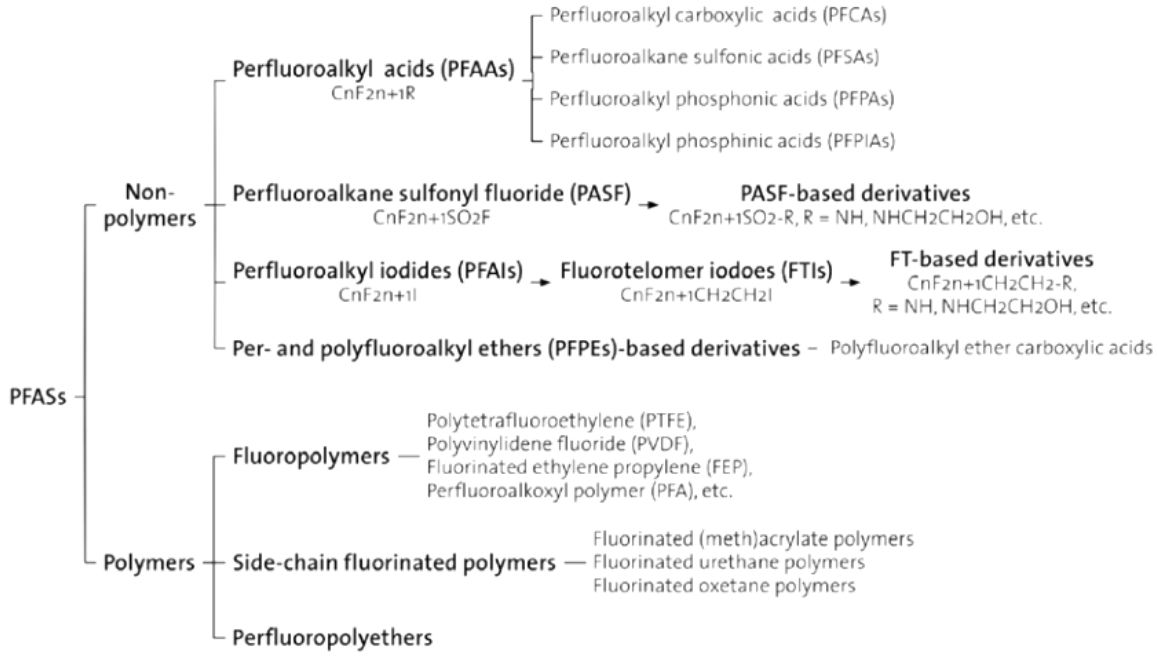


Figure 3. Per- and polyfluoroalkyl substances (PFAs)
Source: Buck, et.al. (2011)[12] in OECD (2013)[13]

[12] Buck, R.C.; Franklin, J.; Berger, U.; Conder, J.M.; Cousins, I.T; Voogt, P.d.; Jensen, A.A.; Kannan, K.; Mabury, S.A; Leeuwen, S.P.v (2011) *Perfluoroalkyl and Polyfluoroalkyl Substances in the Environment: Terminology, Classification, and Origins.* Integr.Environ.Assess.Manag Vol. 7 No. 4 pg. 513-541.

[13] OECD, 2013, OECD/UNEP Globl PFC Group, Synthesis paper on per- and polyfluorinated chemicals (PFCs), Environment, Health and Safety, Environment Directorate, OECD. (http://www.oecd.org/env/ehs/risk-management/PFC_FINAL-Web.pdf, retrieved: 19 Mar 2019

PFAS used in textiles as finishing agents to achieve water, oil and dirt repellency of the materials while at the same time maintain the breath-ability of the fabric. PFAS used in textile production accounts for about 50% of the global consumption of PFAS. Safer alternatives are available. Paraffin and silicone-based chemistries for water repellent finishing agents are available in the market for a long time. These finishing agents can be used where the materials only need water repellency and not against oil, alcohol, and oil.[14]

Existence of new PFAS have been reported as the industry has replaced PFOS and PFOA with shorter chain PFAS. These substances can be difficult to detect using existing methods, and information is lacking on their toxicity for ecosystems and humans. One known PFOA alternative is the ammonium salt of perfluoro-2-propoxypropanoic acid, a PFEC that has been produced since 2010 with the trade name of "GenX'. GenX was recently reported to have higher toxicity than PFOA considering its toxicokinetic differences.[15,16]

Figure 4. PFOA largely used in non-stick frying pan and firefighting foam.

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.

[14] Carsten Lassen, Allan Astrup Jensen, Marlies Warming. (2015). Alternatives to perfluoroalkyl and polyfluoroalkyl substances (PFAS) in textiles. The Danish Environmental Protection Agency. ISBN 978-87-93352-16-2. https://www2.mst.dk/Udgiv/publications/2015/05/978-87-93352-16-2.pdf accessed by 30 March 2019

[15] op.cit, Sunderland, E. et al (2018)

[16] Gomis MI, Vestergren R, Borg D, Cousins IT. Comparing the toxic potency in vivo of long-chain perfluoroalkyl acids and fluorinated alternatives. Environ Int. 2018;113:1–9.

1.5. PFOS

Perfluorooctane sulfonate (PFOS) is an extremely persistent chemical with a long carbon strain structure and hydrophobic.[17] 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.

1.6. 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.

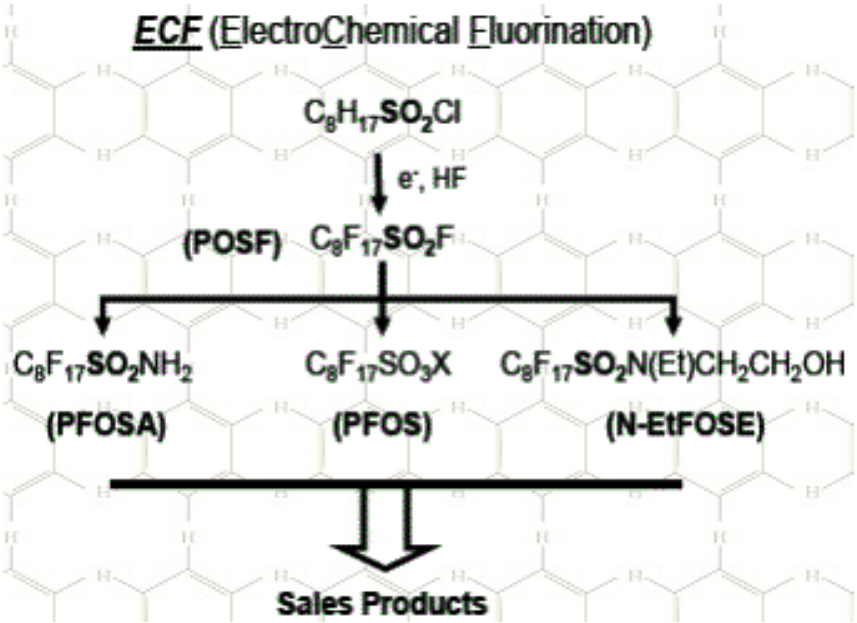


Figure 5. Electrochemical fluorination diagram flow process. Source: Ministry of Environment and Forestry of Indonesia & BPPT (Technology Development and Assessment Agency).

[17] KLHK & BPPT: Sistem Informasi B3 dan POPs Bahan Berbahaya Beracun dan Pencemar Organik yang Persisten (http://kelair. bppt.go.id/sib3pop; Retrieved 28 January 2019)

1.7. PFAS properties and production

Due to the unique amphiphilic properties, PFOS and PFOA are used as coatings in products with the application of high temperatures and extreme pH. Asia is the largest producer of PFAS substances in the world, but little is known about public reports of pollution and the state of play on policies to address the substances. China has been the largest producer and emitter of PFOA and its salts. In 2010, total production of perfluoroalkyl carboxylic acids (PFCAs) was 80 tons, most of which was PFOA. In 2012, approximately 90 tons was produced.[18,19,20]

PFOS and PFOA are produced through Electrochemical Fluorination (ECF) process with the initial materials of 1-octane-sulfonyl-fluoride, resulting products of perfluorooctanesulfonyl fluoride (POSF). These chemical salt products are later produced after these processes.

Due to the complexity and negative characteristics of PFAS, there is increasing interest in regulating PFAS as a class rather than as individual substances.[21,22]

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.

2. 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:

Figure 6. Relevant sustainable development goals and actions on PFAS

Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages. Targets under SDG3 include:

[18] Meng, J; Lu, Y; Wang, T; Wang, P; Giesy J; Sweetman A.; Li Q, (2017) Life cycle analysis of perfluorooctanoic acid (PFOA) and its salts in China. Environ Sci Pollut Res (2017) 24:11254-11264. DOI: 10.117/s11356-017-8678-1

[19] China Association of Fluorine and Silicone Industry (CAFSI) (2011) National 12th Five-year plan for Fluorine Chemical Industry (in Chinese). http://wenku.baidu.com/link?url=B5oOahlxcvirTPm-UrVQDvQBCr4XjEvJRR6rUBnWKtC7gU_2_F9UBZvt7Ry9PbsNksex14D6dMK3Avawu1kfl2xFrGs_jcMjHiZvkBe9A6C

[20] Li L; Zhai, Z.; Liu, J.; Hu J. (2015) Estimating industrial and domestic environmental releases of perfluorooctanoic acid and its salts in China from 2004 to 2012. Chemosphere 129:100-109

[21] op.cit, Sunderland, E et al (2018)

[22] Blum A, Balan SA, Scheringer M, Trier X, Goldenman G, Cousins IT, et al. The Madrid statement on poly-and perfluoroalkyl substances (PFASs). Environ Health Perspect. 2015;123:A107.

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…"*

3. PFAS in Indonesia

3.1. Regulatory framework related to PFAS

Indonesia is a party of Stockholm Convention by issuing Law No. 19 in 2009 (Law No. 19 year 2009 regarding the ratification of Stockholm Convention on Persistent Organic Pollutants) as the umbrella of regulating POPs in the state.

PFOS have been elaborated further in ministerial decrees to be regulated in several products, for instance, pesticide and textile industry processes since 2015, creating the mandatory status of PFOS to be regulated in those products. The Ministry of Agriculture prohibits PFOS to be used in active and additive ingredients for pesticides, by including PFOS in the list of Annex II in the ministry decree.[23]

The Ministry of Industry includes the obligation to acknowledge PFOS concentration in textile production process (i.e. dyeing, printing, and finishing) for companies to be labelled as green textile industry standards.[24] The National Standard Body (*Badan Standar Nasional* or BSN) have released standard on PFOS and PFOA monitoring on several products.[25]

However, there is no obligatory environmental monitoring of PFAS, since it has not been acknowledged in any regulatory frameworks for environmental monitoring. PFAS also cannot be

[23] Peraturan Menteri Pertanian No. 39/Permentan/SR.330/7/2015 tentang Pendaftaran Pestisida (http://perundangan.pertanian.go.id/admin/file/Permentan%2039-2015%20Pendaftaran%20Pestisida.pdf)

[24] Peraturan Menteri Perindustrian No. 515/M-IND/Kep/12/2015 tentang Penetapan Industri Hijau untuk Industri Tekstil Pencelupan, Pencapan, dan Penyempurnaan (http://jdih.kemenperin.go.id/site/download_peraturan/2148)

[25] Keputusan Kepala Badan Standardisasi Nasional No. 84/KEP/BSN/3/2017 tentang Penetapan Standar Nasional Indonesia 8360:2017 Tekstil - Cara Uji Penetapan Kadar PFOS dan PFOA pada Bahan (http://jdih.bsn.go.id/public_assets/file/f788d446e963015521d3f26ebe170335.pdf)

included in the hazardous material and waste list due to its stability, despite its persistence properties. There is also limited official public information on PFAS in Indonesia.

Table 1. Regulatory framework in Indonesia on PFAS and relevant chemicals

Leading Sector	Details on Regulation Doc.
Ministry of Agriculture	MoA Decree No. 39/Permentan/SR.330/7/2015, Annex II Prohibited active ingredients and additives for pesticides: - Perfluorooctane sulfonic acid (PFOS) and its salt; - Perfluorooctane sulfonyl fluoride
Ministry of Industry	MoI Decree No. 515/M-IND/Kep/12/2015 SIH 13132.1:2015 - Textile Industry: dyeing, printing, and finishing products have to provide Material Safety Data Sheet (MSDS) or specific material ingredient from accredited lab as accordingly to ISO/IEC 17025, containing PFOS concentration.
Ministry of Labour	Ministry of Labour Decree No. 5 year 2018 regarding Environmental Health and Safety in Work Place
National Standardization Agency (BSN)	Head of BSN Decree No. 84/KEP/BSN/3/2017 concerning National Standard 8360:2017 - Textile Standard Testing on PFOS and PFOA

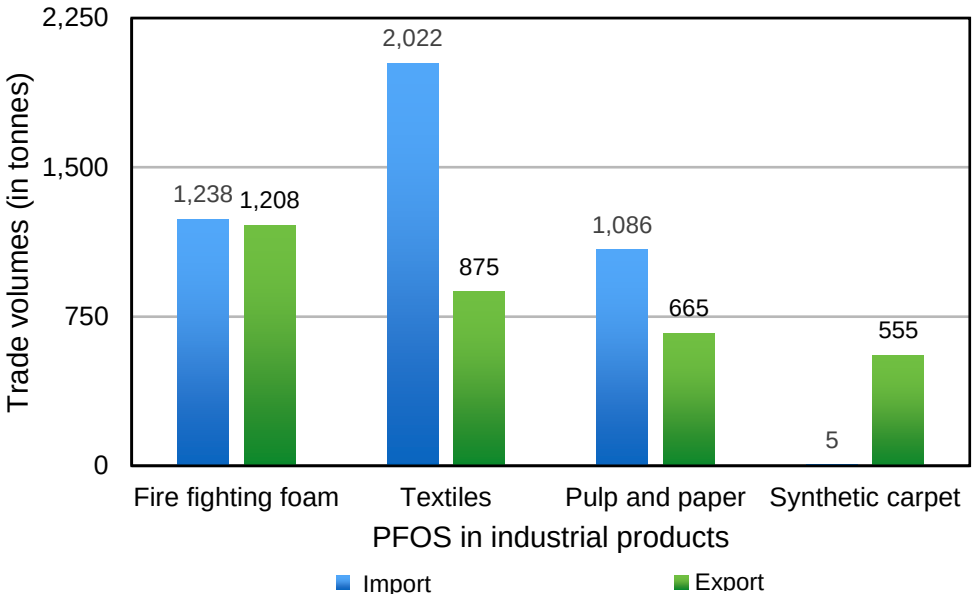


Figure 7. Trade flow of PFOS/PFOA in Indonesia in various products period of 1999-2012 (in tonnes). Source: Indonesia's Stockholm Convention updated NIP 2014.

The Indonesian FDA (BPOM), KLHK, and BPPT have issued information on several hazardous chemicals related to food products for PFOA,[26,27] however none of the national agencies in Indonesia have any program for environmental monitoring of PFOS, nor human biomonitoring. Reasons for this could include lack of regulations, low capacity of laboratory infrastructure and human resources and the high cost of laboratory sampling and analysis. However, the presence of PFOS in humans and biota from Indonesia have been noted by monitoring studies of foreign researchers.[28]

3.2. Indonesia's Stockholm Convention National Implementation Plan (NIP)

The National Implementation Plan reported to the Stockholm Convention secretariat in 2014 reported estimated amounts of PFOS import and export in commodities the previous year (2013), which include pulp and paper, firefighting foams, textiles and synthetic carpets.

3.3. PFAS in Indonesia's products

There is only limited information on PFAS from research, as well as in product labels from Indonesia. As mentioned, PFAS most commonly used in several non-stick products and firefighting foams. This report covers public information on products that are manufactured in Indonesia, imported, or used domestically.

Having only green-textile industries obligated to determine PFAS concentration in their textile products, there were several apparel products manufactured in Indonesia that contained PFAS. Greenpeace reported soccer shoes containing PFAS for their World Cup release in 2014. They also stated that outdoor apparel from Indonesia containing PFOS in

[26] Badan Pengawas Obat dan Makanan (2010) Informasi Penanganan Pangan Berbahaya

[27] op.cit, KLHK & BPPT

[28] Republic of Indonesia (2014) Review and Update of National Implementation Plan for Stockholm Convention on Persistent Organic Pollutants in Indonesia

2011 (see Table 2). To illustrate how significant the PFAS levels are in Table 2, note that the EU regulates PFOS at 1 μg/m² in textiles.

Table 2. Reported products from Indonesia containing PFAS

No.	Samples	Source	PFOS	PFOA	Other PFAS
Apparel					
1	Soccer shoes	Cobbing, et al (2014)			PFBS: 37.9 μg/m²
		Cobbing, et al (2014)		14.5 μg/m²	
		Cobbing, et al (2014)		5.28 μg/m²	
		Cobbing, et al (2014)			PFBS: 37.9 μg/m²
		Cobbing, et al (2014)			PFBS: 14.5 μg/m²
2	Outdoor apparel	Santen, et al (2011)			
3	Outdoor apparel	Knepper, et al (2014)	n.d.	2.31 μg/m²	*Total PFAS: 42.9 μg/m²
Food					
1	Canned fish	Hrádková, et. al (2010)	7.5 μg/kg	1.8 μg/kg	

*Note: *Total PFAS, including PFOS, PFOA, PFBA, PFPeA, PFHxA, PFNA, PFDA, PFUnA 8:2-FTOH, 10:2-FTOH, and N-EtFOSE.*

PFAS are also used to make non-stick cookware. Some companies such as Maxim Teflon claim that their products are PFOA-free and are widely available on the Indonesian market. However, the PFAS content in the products or use in production is not known. Lack of information for consumers is a significant problem.

In Indonesia, fire extinguishers containing PFAS (Aqueous Film-Forming Foams or AFFF) are readily available for consumer purchase. In fact, vendors mention that the fire extinguisher contains PFOA and PFOS as a hydrocarbon-based surfactant and claim that the product is "Not harmful to plants, animals, especially humans." Products containing PFAS substances include fire extinguishers from Dexter, Servvo, and Sonick. These products contain fluoroprotein foam or aqueous film forming foam. Other products do not even provide content information, for example extinguishers from GuardALL, Solingen, and Starvvo.

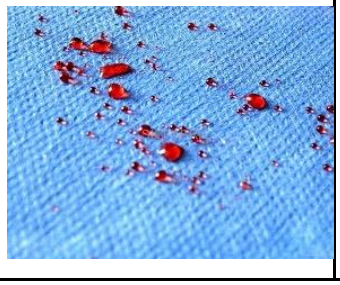


Figure 8. Water repellent, blood repellent and fire-resistant textiles are widely manufactured and sold in Indonesia.

Table 3. Potential products containing PFAS sold on Indonesia's market

No.	Products	Possible PFAS Family	Product currently available in the market	Figure source
1	Fire-fighting equipments	PFOA, PFOS		https://en.indotrading.com/product/apar-foam-6kg-p362281.aspx
				Firefighting foam refill https://en.indotrading.com/product/refill-jasa-isi-p500081.aspx
				https://www.satriapemadam.com/baju-tahan-panas/
2	Outdoor apparel	PFOA, PFHxA, PFBS, FTOH		http://www.koran-jakarta.com/teknologi-mutakhir-kain-anti-air/

3	Rain coats and jackets	PFCA, FTOH		https://www.plevia.id/jas-hujan-anak-plevia/
No.	**Products**	**Possible PFAS Family**	**Product currently available in the market**	**Figure source**
4	Soccer shoes	PFOA, PFBS,		https://www.greenpeace.de/sites/www.greenpeace.de/files/detox_2014_11_englisch.pdf
5	Kitchen utensils	PFOA		https://www.scientificamerican.com/article/are-nonstick-pans-safe/
6	Waterproof fabric / cloth	Short-Fluorinated iVCD		http://www.koran-jakarta.com/teknologi-mutakhir-kain-anti-air/
7	Hijab	perfluorooctanesulfonamide (PFOSA)		https://www.dream.co.id/fresh/hijab-tahan-air-untuk-hijabers-aktif-150903k.html

8	Bed linen	perfluorooctanesulfonamide (PFOSA)		http://www.cendrawasihtextile.com/2018/05/pakai-sprei-anti-air.html?m=1
9	Food packaging	Fluorinated compouinds (Total F)		http://jualkertasnasi.com/
No.	**Products**	**Possible PFAS Family**	**Product currently available in the market**	**Figure source**
10	Children's apparel	perfluorooctanesulfonamide (PFOSA)		https://www.bukalapak.com/p/hobi-koleksi/koleksi/koleksi-lainnya/bm08b0-jual-sepatu-anak-anti-air-waterproof-merah-motif-bunga-harga-termurah
11	Water repellent sprays	perfluorooctanesulfonamide (PFOSA), a PFOS precursor		https://www.tokopedia.com/tokoadiamitra/scotchgard-pembersih-noda-pada-tekstil-kain-furniture
12	Hospital/health care facilities	fluoropolymer		http://linen-company.com/linenrumahsakit/

13	Carpets	PFAS, PFOS, PFOA		https://shopee.co.id/Karpet-Alas-Lantai-dengan-Bahan-Anti-Slip-dan-Tahan-Air-Gambar-Motif-Binatang-Laut-i.39148124.1140544859

Figure 9. AFFF product catalogue offered in the e-procurement website of the Indonesian Institute for Policy and Public Procurement (LKPP). Source: e-katalog LKPP https://e-katalog.lkpp.go.id/backend/katalog/list_produk/43

An example of a seller statement:

> *AFFF (Aqueous Film Forming Foam) is water based and often contains hydrocarbon-based surfactants such as sodium alkyl sulfate, fluorosurfactants such as fluorotelomers, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS). They have the ability to spread on the surface of hydrocarbon-based liquids. Alcohol-resistant aqueous film forming foams (AF AFFF) are foam/foam that is resistant to the reaction of alcohol, can create a protective layer/segment when used or sprayed. Not harmful to plants, animals, especially humans.*

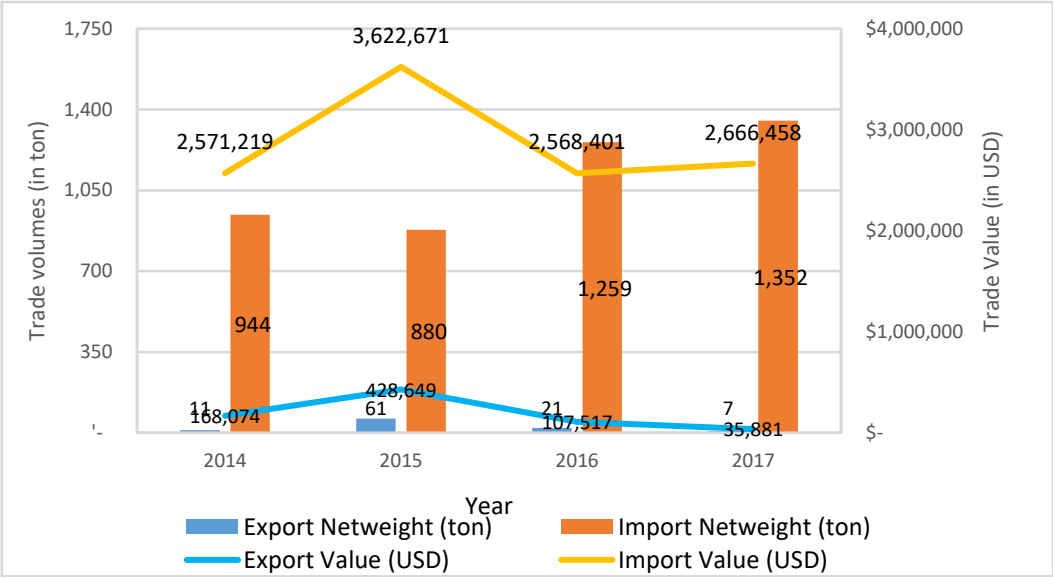


Figure 10. Import and export of fire extinguishers (HS 842410) as reported by Indonesia period of 2014-2018. Source: UN Comtrade database

As the Indonesian NIP to Stockholm Convention reported, PFOS should also be available to be traced through its international trade HS Code (Harmonized System Code), namely:

- 290431 - Derivatives of hydrocarbons; perfluorooctane sulphonic acid, whether or not halogenated;
- 290433 - Derivatives of hydrocarbons; lithium perfluorooctane sulphonate, whether or not halogenated;
- 290434 - Derivatives of hydrocarbons; potassium perfluorooctane sulphonate, whether or not halogenated.

These three HS Codes matched with the detailed derivation of PFOS in the Stockholm Convention, which should make them a useful tool to monitor the movement of PFOS. However, acquired data both from UN Comtrade Database and BPS shows that there have been no imports and exports of HS 290431, 290433, and 290434 either reported by Indonesia or by reports from other countries. Monitoring trade activity through HS Code 290431, 290433 and 290434 should be further explored as a tool for PFAS monitoring in the future.

3.4. PFAS pollution in Indonesia

Several studies of PFAS pollution have been conducted in Indonesia; however, they are only available from foreign researchers/reports/journals. The lack of local laboratory capacity in Indonesia might be a contributing factor to the small amount of PFAS-related research.

Further, the updated National Implementation Plan of the Stockholm Convention already identified PFOS contaminated sites to be considered are fire-fighting training areas with AFFF and similar foam use (historically most of them were PFOS containing foams), such as in airports, refineries, oil storages, military sites, and oil drilling areas. Other sites for consideration are disposal areas of wastes and sludges of industries, including textiles and textiles product sector, that have used and still use PFOS and its related substances.

Table 4. Studies regarding PFAS pollution in Indonesia

No.	Year	Location	Samples	Source
1	2008	Jakarta, Purwakarta	Breastmilk	Tao, et. al. (2008)
2	2012	Jakarta	Seabed sediments	Harino, et. al. (2012)
3	2013	Rancaekek	River and wastewater	Brigden, et. al. (2013)

3.5. PFAS in human breast milk

A research study on perfluorinated compounds examined PFAS in human breast milk from Cambodia, India, Indonesia, Japan, Malaysia, Philippines, and Vietnam.[29] Samples from 20 women in Jakarta and Purwakarta collected in 2001 tested for a variety of PFAS substances. The results were sobering. Additionally, infant formula from five US manufacturers and 11 brands of dairy milk also tested.

Table 5. PFAS levels in Indonesian breast milk from Jakarta and Purwakarta

Substance	Range (ppt)	Fraction of samples containing (%)
PFOS	25 – 256	100
PFHxS	<2 – 6	45
PFNA	<9 – 135	5
PFHpA	<4 - 7	5
n = 20; overall mean PFOS level = 84 ppt. Source: Lin Tao, et. al. 2008		

[29] Lin Tao, Jing Ma, Tatsuya Kunisue, E. Laurence Libelo, Shinsuke Tanabe, and Kurunthachalam Kannan. (2008). Perfluorinated Compounds in Human Breast Milk from Several Asian Countries, and in Infant Formula and Dairy Milk from the United States. Environmental Science & Technology 2008 42 (22), 8597-8602
DOI: 10.1021/es801875v
http://www.environmentportal.in/files/Perfluorinated%20Compounds%20in%20Human%20Breast%20Milk.pdf

Every woman sampled from Indonesia had PFOS in her breast milk and 45% of them contained PFHxS – a toxic substance the industry proposed as a substitute for PFOS. The results showed significant PFAS levels for PFNA.

Overall, average PFOS levels in Indonesian breast milk were 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 level of PFOS was approximately 12 times higher than this drinking water health advisory limit.

Finally, the study found that PFAS levels in US infant formula and dairy milk were approximately 10-fold lower than levels in Asian breast milk. This resulted in a daily intake of PFOS by Asian infants that was 7–12 times higher than the dietary intakes previously reported for adults in Canada, Germany and Spain.

3.6. PFAS in coastal sediments and waters

A 2011 study examined PFAS in sediment samples taken in 2004 from Jakarta Bay. PFOA ranged up to 6.1 µg/kg dry weight – approximately ten times higher than the highest level observed in San Francisco Bay in the USA. The highest PFOA level in Jakarta Bay was similar to the level found in Tokyo Bay (6.8 µg/kg dry weight). PFOS ranged from 0.90 – 3.7 µg/kg dry weight and found in all samples. These PFOS levels were similar to those observed in San Francisco Bay but significantly higher than levels in Tokyo Bay (0.3 to 0.9 l µg/kg dry weight). Other PFAS not found in these 2004 samples.

3.7. Textile factory releases of PFAS

Indonesia's textiles and textiles products export reached its highest record in 2011, hit USD 13.2 billion. After that, the export values decreased to USD 11.9 billion and then up again in 2017 to USD 12.4 billion. The main trade partners of Indonesia are the ASEAN countries, Japan, China, and the USA. Among the manufacturing sector in Indonesia, the

textile industry employed about 2.7 million workers, ranked third after the food and beverages industry and automotive industry.

Greenpeace International investigated hazardous chemical releases from the PT Gistex

Figure 11. Wastewater from textile industry in Rancaekek, West Java, discharged without treatment to the nearby river polluting communities' rice field and agriculture land. Photo: Greenpeace Indonesia.

and PT Kahatex facilities located near Bandung in West Java.[30] PFOA at 12 ppt was found in one sample from the PT. Kahatex factory in the wastewater discharging into the main discharge channel.

The updated NIP report identified waste water and sludge discharged from textile industries could be considered as PFOS hotspots.

4. Challenges of managing PFAS in Indonesia

4.1. Testing PFAS in Indonesia

Laboratory services that are available for PFASs testing are private laboratories, under the umbrella of a multinational laboratory company. Samples delivered to these laboratories for PFAS analysis will require sending them out to a laboratory within their parent company in another country; usually Australia or Singapore, creating high costs to test PFAS.

[30] Brigden, K.; Labunska, I.; Santillo, D.; Wang, M.; Johnston, P. (2013). Organic chemical and heavy metal contaminants in wastewaters discharged from two textile manufacturing facilities in Indonesia: Greenpeace Research Laboratories Technical Report 02/2013 (https://storage.googleapis.com/planet4-international-stateless/2013/04/11272426-technical-report-02-2013.pdf. Retrieved Feb 4th 2019)

The national bureau has the capacity and laboratory equipment but does not have the standards needed to measure PFAS. Only qualitative parameters for PFAS are available.

Table 6. Laboratories in Indonesia to analyse PFAS/PFOS

No.	Laboratories	Samples and methodology
1	PT. Testex (Testing and Certification) Graha KADIN Bandung, 4th Floor, Room 404, Jl. Talaga Bodas No. 31, Bandung 40262, Indonesia https://www.testex.com/id/kontakt/07-jakarta.php	Samples: Textile products Methodology: As required by Standard 100 OEKO-TEX®
2	ALS Indonesia Kawasan Industri Sentul Jl. Cahaya Raya Blok K Bogor West Java 16810 https://www.alsglobal.com/locations/asia-pacific/asia/indonesia	Samples: Water, soils/sediments, tissues Methodology: - EPA Method 537 for drinking water - In house method for other samples
3	Research Center for Chemistry, Indonesian Institute of Sciences Gd. 452 Bldg, Jl. Kw. Puspiptek, Muncul, Serpong, Banten 15314 http://kimia.lipi.go.id/news/read/kimia-lingkungan-dan-analitik	Samples: Any Products Methodology: As required by standard using liquid chromatography-mass spectrometry / LC-MS / MS)
4	Balai Besar Tekstil Jalan Jenderal Achmad Yani No. 390 Bandung, 40272 texirdti@bdg.centrin.net.id http://bbt.kemenperin.go.id/en/	Samples: Textile products Methodology: As required by Standard 100 OEKO-TEX®
5	Sucofindo Indonesia Jl. Raya Pasar Minggu Kav. 34, Jakarta, Indonesia 12780 customer.service@sucofindo.co.id https://www.sucofindo.co.id/	Samples: Any Products Methodology: As required by standard using liquid chromatography-mass spectrometry / LC-MS / MS)

4.2. Stakeholders in Indonesia involved in monitoring and/or discussing PFAS issues

As far as we know, until this study was conducted, there has been no specific project addressing PFAS substances in Indonesia. Stakeholders and their roles in addressing PFAS in Indonesia can be seen in Table 7.

4.3. Indonesian Government Documents related to PFAS

- Undang-Undang No. 19 year 2009 concerning the Ratification of the Stockholm Convention;
- Regulation of the Minister of Agriculture No. 39/Permentan/SR.330/7/2015, Appendix II; PFOS is included in the list of active ingredients and additional ingredients for pesticides which are designated as prohibited pesticides.
- Decree of the Minister of Industry No. 515/M-IND/Kep/12/2015; In the Oeko-Tex 1000 or SNI 19/7617/amendment-2014 standard the Eco-Label Criteria requires that the PFOS content be at least known, with the verification method as follows: the industry shows the MSDS sheet of PFOS content test results from the accredited laboratory.
- National Agency of Drug and Food Control (Badan Pengawas Obat dan Makanan). (2010). Information on Dangerous Food Handling: Knowing Toxic Metals. http://www.kelair.bppt.go.id/sib3pop/Iptek/LogamBerat/logamberat.pdf

Table 7. PFAS potential Stakeholders of Indonesia

Name of Institution	Role	Remarks
Basel, Rotterdam, Stockholm Convention Regional Centre (BCRC) - South East Asia	Government body at SEA regional level; Regulator of hazardous substances including POPs chemicals	BCRC SEA Secretariat is located in Jakarta and operates since 2004.
Ministry of Environment and Forestry (*Kementerian Lingkungan Hidup dan Kehutanan/KLHK*)	Government; Regulator of hazardous substances including POPs chemicals	• Directorate General of Waste and Hazardous Waste Management • Centre of Standardization for Environmental and Forestry Affairs
Ministry of Industry (*Kementerian Perindustrian*)	Government; Regulator of business and industrial practices in Indonesia	• Directorate of Downstream Chemical Industries
Ministry of Finance (*Kementerian Keuangan*)	Government; Indonesian international trade	• Directorate General of Customs and Excise
Indonesian Institute of Science (*Lembaga Ilmu Pengetahuan Indonesia/LIPI*)	State-owned research body;	• Centre of Chemistry Research • Centre of Oceanography Research
Food and Drugs Administration (*Badan Pengawas Obat dan Makanan*)	State-owned agency	• Monitoring food and drugs • Conduct market sampling
Badan Standar Nasional/BNS (National Standard Agency)	State-owned agency	• Develop and issues new industrial standard

Name of Institution	Role	Remarks
Perdoki (Persatuan Dokter Okupasi Indonesia) - http://perdoki.or.id/public/	Occupational health professionals association	• Membership-based organisation • Profession association • Capacity building/consultant
Asosiasi Pertekstilan Indonesia (API) - http://indonesiatextile.id/	Association of textiles industries, from upstream to downstream level	• Membership-based organisation • Share informations/updates to their members
INDONESIAN FIBER and FILAMENT YARN MAKERS ASSOCIATION (Asosiasi Produsen Serat dan Benang Filament Indonesia) - http://www.apsyfi.org/	Association of fibre and filament yarn makers	• Membership-based organisation • Share informations/updates to their members • Key actors of safer alternatives
APKI (Asosiasi Pemadam Kebakaran Indonesia)	Association of profession http://www.jakartafire.net/association/detail/1286/apki-asosiasi-pemadam-kebakaran-indonesia	• Membership-based • Share informations/updates to their members
Ikatan Kebakaran Indonesia (IKI)	Professional association - http://www.jakartafire.net/association/detail/1286/apki-asosiasi-pemadam-kebakaran-indonesia	• See APKI
Masyarakat Profesi Proteksi Kebakaran Indonesia (MP2KI) or Indonesian Fire Protection Association (IFPA)	Profession association http://www.jakartafire.net/association/detail/1329/masyarakat-profesi-proteksi-kebakaran-indonesia-mp2ki	• Membership-based • Share informations/updates to their members • Certification
Trade Union Rights Centre (TURC) - http://www.turc.or.id/home7/	Labour rights advocate	• Raise employers and employees' awareness • Share informations/updates to clients • Occupational health and safety
Serikat Pekerja Nasional, Serikat Pekerja Tekstil, Sandang dan Kulit (SPTSK) https://spn.or.id/profile/	Labour union	• Raise employers and employees' awareness • Share informations/updates to clients • Occupational health and safety
4Life Indonesia - Occupational Health and Safety Services - https://4life.id/	Private company/consultant/certified OHS trainer	• Raise employers and employees' awareness • Share informations/updates to clients
BaliFokus/Nexus3 Foundation www.balifokus.asia	Public interest NGO	• Raise public awareness • Share informations/updates to public in general

		• Policy advocate
Indonesian Center for Environmental Law www.icel.or.id	Public interest NGO	• Raise public awareness • Share informations about new regulations to public in general • Policy advocate
Yayasan Lembaga Konsumen Indonesia - www.ylki.or.id	Public interest NGO	• Share informations/updates to public • Policy advocate
Name of Institution	**Role**	**Remarks**
Asosiasi Ibu Menyusui Indonesia www.aimi-asi.org	Women and babies interest NGO	• Share informations/updates to pregnant and breastfeeding mothers
WALHI (Wahana Lingkungan Hidup Indonesia) National Executive	Public interest NGO	• Raise public awareness • Policy advocate • Corporate advocacy
Greenpeace South East Asia - Indonesia www.greenpeace.org/seasia/id	Public interest NGO	• Raise public awareness • Policy advocate • Corporate advocacy

Figure 12. The textile industry employs about 3 million workers but there is a lack of information about the occupational hazards due to harmful chemical exposures including PFAS. Photo: merdeka.com.

5. Recommendations

5.1. National recommendations

1. PFAS and its derivatives used in textiles, textile products, fire-fighting foams, paper, and in the electronics industries need to be regulated and controlled as a class.
2. Industry shall disclose PFAS content in their products and provide clear warning sign/label/icon on their products placed on the market.
3. An inventory of PFOS and other PFAS substances, including activities at the upstream level and the downstream level, needs to be conducted to identify how much and in which sector that PFAS chemicals are currently being used in Indonesia.
4. When a product containing PFAS is withdrawn from the market, it is essential to plan to designate the disposal site and promote safer alternatives or substitutes.
5. To prevent PFAS pollution and subsequent costly remediation, Indonesia should make an inventory of firefighting foam stocks and promptly and replace PFAS-containing foams and fire extinguishers with fluorine-free foams as soon as possible.
6. Monitoring of POPs chemicals is essential to prevent chronic and acute exposures and the adverse effect of PFAS, PFOS, PFOA, and other POPs chemicals to vulnerable populations.
7. NGOs can conduct public awareness raising and data gathering to alert the public about the hidden pollution and harms posed by PFAS substances.

5.2. 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 labelling new products that contain PFOA so that Parties can fulfil 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 colour printers and colour 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.

***

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. PFAS toxicity 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). Indonesia signed the treaty in 2001 and ratified it in 2009. Indonesia has a Member on the POPRC Committee who supported the Committee's recommendations to list PFOA in Annex A and the removal of numerous PFOS loopholes. However, at COPs, Indonesia often has a mixed approach to policy recommendations and has even blocked Rotterdam Convention proposals that meet all Convention criteria.

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 in Indonesia in 2010 and the country has not registered any specific exemptions or acceptable purposes.

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 colour printers and colour 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 labelling new products that contain PFOA so that Parties can fulfil 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 vapour 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.

Annex 4. Fire extinguisher (foams) available in Indonesia

Brand Information	Information on PFAS	Remarks
Dexter (Fire extinguisher)	None	PFAS-containing Containing: Fluoroprotein foam Film-forming fluoroprotein (FFFP) Alcohol-resistant fluoroprotein foam (AR-FP) Alcohol-resistant film-forming fluoroprotein (AR-FFFP)
GuardALL (Fire extinguisher)	None	None
Servvo (Fire extinguisher)		PFAS-containing Foam AFFF 6% Certification: ISO 9011:2015
Solingen (Fire extinguisher)	None	Certification: SNI
Sonick (Fire extinguisher)	None	PFAS-containing Ingredients: Mixture of natrium bicarbonate and aluminium sulfate MSDS: Foam AFFF: C-303
Starvvo (Fire extinguisher) PT. Global Mitra Proteksindo	None	None

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