Indirect precursors to perfluorooctanoic acid (PFOA): Environment tier II assessment

8 March 2019

CAS Registry Numbers: 678-39-7, 1996-88-9, 93705-98-7, 121065-52-9, 254889-67-3, 68187-42-8, 167289-73-8, 253683-00-0, 53515-73-4

Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit: www.nicnas.gov.au.

Disclaimer

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Acronyms & Abbreviations

Grouping Rationale

This Tier II assessment considers the environmental risks associated with the industrial uses of nine polyfluoroalkyl substances (PFASs) which are all indirect precursors to perfluorooctanoic acid (PFOA).

Eight of the chemicals in this group are structurally related compounds in that they all contain a chain of eight perfluorinated carbons linked to another group through an ethylene unit. One chemical is a polymer with side chains that contain seven perfluorinated carbons linked through a methylene unit to a methacrylate co-polymer backbone. The chemicals in this group are of concern because they have the potential to degrade to extremely persistent perfluorinated carboxylic acids, including PFOA (OECD, 2007).

NICNAS has developed an action plan to assess and manage chemicals which may degrade to perfluorinated carboxylic acids, perfluoroalkyl sulfonates and similar chemicals (NICNAS, 2018). The primary assumption outlined in this action plan is that chemicals with a perfluorinated carbon chain terminated with an alkyl or aryl group will degrade to form a mix of perfluorocarboxylic acids, with both the original perfluorinated chain length and one less perfluorinated carbon atom.

Most chemicals in this group contain a chain of eight perfluorinated carbons linked to another functional group or polymer chain through an ethylene unit. Under the action plan, these chemicals are assumed to have the potential to degrade either to perfluorononanoic acid or PFOA. However, PFOA is expected to be the major product of environmental biodegradation of these precursors (Butt, et al., 2014). The ester linkage in the ninth chemical is assumed to be susceptible to hydrolysis, which would

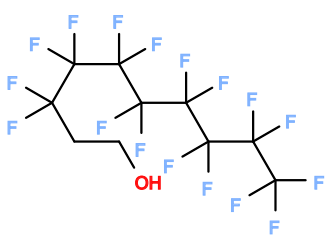
release a fluoroalcohol that has the potential to be oxidised to PFOA (OECD, 2007). Therefore, potential environmental degradation of the chemicals in this group to PFOA is the principal focus of this assessment.

Perfluorooctanoic acid has been identified as a Persistent, Bioaccumulative and Toxic (PBT) chemical (NICNAS, 2015a). Long-chain perfluoroalkyl acids such as PFOA and perfluorooctanesulfonic acid are of concern internationally due to their PBT properties. Perfluorooctanesulfonic acid and certain related substances containing the perfluorooctane sulfonate (PFOS) moiety are Persistent Organic Pollutants listed under Annex B (Restriction) of the *Stockholm Convention on Persistent Organic Pollutants*. These substances are also listed on Annex III of the *Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade*. Further information on perfluorooctanesulfonic acid and related substances can be found in the Environment Tier II Assessment of the Direct Precursors to Perfluorooctanesulfonate (PFOS) group (see NICNAS, 2015b).

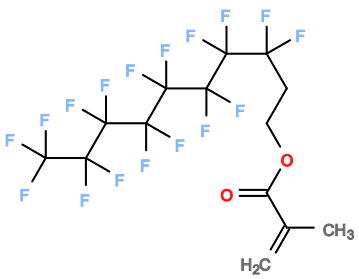
The degradation of PFOA is very slow compared with its rate of formation from degradation of the precursors and PFOA will be the final degradant from multiple precursors. Therefore, the amount of PFOA in the environment (general or local) is expected to be higher than that of any of the precursors. It will therefore be assumed for the purposes of this assessment that the primary risk posed by the chemicals in this group results from release of PFOA to the environment. The IMAP Environment Tier II assessment for Perfluorooctanoic Acid and its Direct Precursors (see NICNAS, 2015a) has been used as a reference assessment.

Chemical Identity

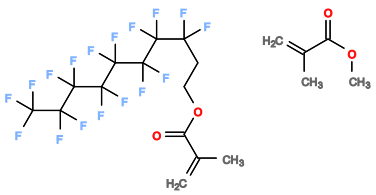
In this assessment, “PFOA” is used to denote perfluorooctanoic acid and its conjugate base (i.e. the perfluorooctanoate anion) (Buck, et al., 2011).

CAS RN	678-39-7
Chemical Name	1-Decanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluoro-
Synonyms	8:2 FTOH 8:2 fluorotelomer alcohol 2-(perfluorooctyl)ethanol 1,1,2,2-tetrahydroheptadecafluorodecanol
Structural Formula	
Molecular Formula	$C_{10}H_5F_{17}O$

Molecular Weight (g/mol)	464.12
SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)CCO

CAS RN	1996-88-9
Chemical Name	2-Propenoic acid, 2-methyl-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl ester
Synonyms	8:2 FTMAC 8:2 fluorotelomer methacrylate 2-(perfluorooctyl)ethyl methacrylate
Structural Formula	
Molecular Formula	$C_{14}H_9F_{17}O_2$
Molecular Weight (g/mol)	532.19
SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)CCOC(=O)C(=C)C

The substance represented by CAS RN 93705-98-7 is a polymer. The constituent monomers of this side-chain fluorinated co-polymer are presented below. Due to the typically variable size and structure of polymer molecules, the molecular formula and molecular weight are not presented.

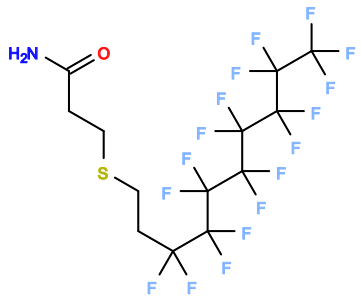
CAS RN	93705-98-7
Chemical Name	2-Propenoic acid, 2-methyl-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl ester, polymer with methyl 2-methyl propenoate
Synonyms	8:2 fluorotelomer methacrylate, polymer with methyl methacrylate
Structural Formula	
SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)CCOC(=O)C(=C)C.COC(=O)C(=C)C

CAS RN	121065-52-9
Chemical Name	2-Propenoic acid, 2-methyl-, methyl ester, polymer with 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl 2-propenoate, block

CAS RN	254889-67-3
Chemical Name	1-Decanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluoro-, reaction products with [(trimethylsilyl)oxy]-modified silica

The substance represented by CAS RN 68187-42-8 is expected to be a mixture of discrete chemicals. Representative chemical identity information is provided below. However, it should be noted that this substance is expected to include a mixture of chemicals with perfluorinated chains between two and eight carbons in length (OECD, 2007).

CAS RN	68187-42-8
Chemical Name	Propanamide, 3-[(.gamma.-.omega.-perfluoro-C4-10-alkyl)thio] derivatives

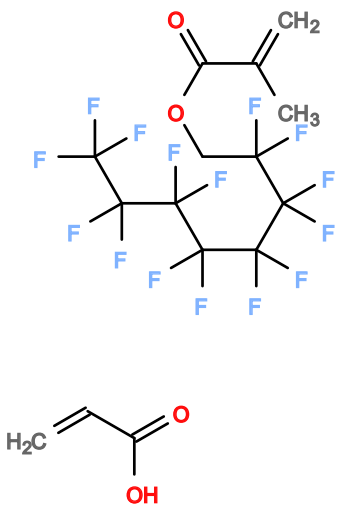
Synonyms	3-[(.gamma.-.omega.-perfluoro-C4-10-alkyl)thio] propanamide derivatives
Representative Structural Formula	
Representative Molecular Formula	$C_{13}H_{10}F_{17}NOS$
Representative Molecular Weight (g/mol)	551.26
Representative SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)CCSCCC(=O)N

CAS RN	167289-73-8
Chemical Name	9-Octadecenoic acid (9*Z*)-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl ester

CAS RN	253683-00-0
Chemical Name	Butanedioic acid, monopolyisobutylene derivs., 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl ester

The substance represented by CAS RN 53515-73-4 is a polymer. The constituent monomers of this side-chain fluorinated co-polymer are presented below. Due to the typically variable size and structure of polymer molecules, the molecular formula and molecular weight are not presented.

CAS RN	53515-73-4

Chemical Name	2-Propenoic acid, 2-methyl-, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-pentadecafluorooctyl ester, polymer with 2-propenoic acid
Synonyms	7:1 fluoroalcohol methacrylate, polymer with acrylic acid
Structural Formula	
SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)COC(=O)C(=C)C.OC(=O)C(=C)

Physical and Chemical Properties

Available physical and chemical property data for 8:2 FTOH are presented below (ECHA, 2014a):

Physical Form	solid
Vapour Pressure	31 Pa at 25°C (exp.)
Water Solubility	0.14 mg/L (exp.)

The 8:2 fluorotelomer alcohol is reported to be a white waxy solid under ambient conditions. The substance is volatile under ambient conditions, although the measured vapour pressure is reported to be dependent on the method employed. For example, some measurements provide a vapour pressure as high as 254 Pa at 25°C (ECHA, 2014a).

No experimental physical and chemical property data were located for the remaining chemicals in this group. However, the chemicals in this group will have a wide range of physical and chemical properties given differences in chemical structure. For

example, the polymers in this group are not expected to be volatile. In contrast, 8:2 FTMAC is expected to be volatile based on its structural similarity to 8:2 FTOH. This is supported by a reported measured vapour pressure of 8.6 Pa for the analogue chemical 6:2 FTMAC (CAS RN 2144-53-8) (ENVIRON, 2014). The propanamide may also experience a degree of volatility.

The reported measured water solubility values available for 8:2 FTOH and 6:2 FTMAC (0.378 mg/L) (ENVIRON, 2014) indicate that some chemicals in this group will have slight solubility in water. When considered alongside the volatility of these chemicals, these data suggest that the lower molecular weight discrete chemicals in this group will be highly volatile from water (calculated Henry's law constants = 102 800 and 9833 Pa-m^3/mol for 8:2 FTOH and 6:2 FTMAC, respectively).

Import, Manufacture and Use

Australia

In July 2006, NICNAS collected information on manufacture, importation and uses of perfluorinated chemicals including PFOA-related substances and products/mixtures containing these substances for the calendar years 2004 and 2005. Information provided to NICNAS indicated that no PFOA related chemicals are manufactured in Australia. An antifoam product containing <10% of a PFOA-related chemical (CAS RN not specified) was imported in 2005 for use in a dyeing process with sulfur dyes. The total quantity imported was approximately 10 kg (NICNAS, 2013).

It is noted that the chemicals in this group may be present in the environment due to historic use, release from pre-treated articles imported into Australia, or the use of other chemicals. However, release from these uses is beyond the scope of this assessment.

International

Two chemicals in this group are reported to have use in the manufacture of other fluorochemicals. The reactive methacrylate, 8:2 FTMAC, is used as a monomer in the production of polymers with fluorinated side-chains. The 8:2 fluorotelomer alcohol is used mainly in the manufacture of fluorinated surfactants and surface protection products (Buck, et al., 2011). The latter chemical may be found in final products as residual unreacted starting material, in some cases at measurable levels (ECHA, 2013, SFT, 2007).

Polymers with fluorinated side-chains, and surface protection products, are used to treat surfaces to repel water, grease, dirt and oil. Commonly treated articles include sports and outdoor clothing, home textiles and upholstery, carpets and medical garments. These chemicals can also be used in products such as paints and lacquers, and waxes and polishes (ECHA, 2014a).

The fluorotelomer based chemicals also have commercial uses in non-stick coatings on cookware, in anti-foam formulations, in silicone rubber products as well as uses in analytical laboratories and in the automotive, mechanical, aerospace, chemical, electrical, medical, and building and construction industries (OECD, 2006, 2008).

In 2007, 8:2 FTOH was reported to be produced at a volume greater than 1000 tonnes per annum in at least one OECD member country (OECD, 2013). Results from an OECD survey conducted in 2009 found 8:2 FTOH and 8:2 FTMAC to be produced in two countries. However, the response rate for this survey was very low and data may not be representative (OECD, 2011).

No specific volume or production data were located for the polymers in this group. However, it was recently estimated that approximately 1000 tonnes of PFOA-related substances for textile and leather treatment are introduced per annum in the European Union. It was estimated that a further quantity of between 1000 and 10 000 tonnes of PFOA-related substances was imported into the European Union contained in textile articles (ECHA, 2014a).

No use data were identified for the propanamide.

Four chemicals in this group (CAS RNs 121065-52-9, 253683-00-0, 167289-73-8, and 254889-67-3) were not identified as being listed on the chemical inventories of any other country, and therefore appear to have limited use internationally.

Environmental Regulatory Status

Australia

A factsheet published by NICNAS recommends that industry seek alternatives to PFOA and chemicals that may degrade to PFOA, and ultimately aim to phase out use of these substances (NICNAS, 2016).

United Nations

The chemicals in this group or discrete chemical constituents of the chemicals in this group are compounds that can degrade into PFOA according to the Persistent Organic Pollutant Review Committee of the *Stockholm Convention on Persistent Organic Pollutants* (UNEP, 2017b). The Committee has defined any chemicals which can degrade into PFOA to be 'PFOA-related compounds'. It has recommended that PFOA, its salts and PFOA-related compounds be listed under Annex A (Elimination) or Annex B (Restriction) of the Convention with specific time-limited exemptions for specialised uses in the manufacture of semiconductors, photographic films, and certain textiles for use in the protection of workers from exposure to dangerous liquids (UNEP, 2017a). If this recommendation is adopted, uses of these chemicals may be severely restricted globally, in advance of their eventual elimination from production and use (UNEP, 2001).

The chemicals in this group are not currently identified as ozone depleting substances (UNEP, 1987) or hazardous substances for the purpose of international trade (UNEP & FAO, 1998).

OECD

The chemicals in this group have not been sponsored for assessment under the Cooperative Chemicals Assessment Programme (CoCAP) (OECD, 2013).

One chemical in this group (8:2 FTOH) has been identified as a High Production Volume (HPV) chemical by the OECD, indicating that more than 1000 tonnes of the chemical are produced per year in at least one member country (OECD, 2013).

The OECD has been leading an international collaboration on the scientific assessment of, and surveys of, perfluorinated chemicals. Since July 2000, Australia has been actively involved in this work through NICNAS.

Canada

Substances with a perfluoroheptyl or perfluorooctyl moiety are listed under Schedule 1 (the Toxic Substances List) of the *Canadian Environmental Protection Act 1999* (CEPA) (Government of Canada, 2018c), which prohibits their manufacture, import, use or sale. Exemptions for certain uses of these chemicals where developments are underway or where there are currently no known alternatives are currently in force, but a proposal to further restrict the manufacture, import, use or sale of these chemicals has been released and is expected to be finalised by winter 2020 (Government of Canada, 2018a, b).

During the Categorization of the Canadian Domestic Substances List (DSL), 8:2 FTOH was found to be Persistent (P), Bioaccumulative (B) and Inherently Toxic to the Environment (iT_E). Three further chemicals in this group were categorised, with the propanamide and 7:1 fluoroalcohol methacrylate co-polymer both found to be P. The propanamide was found to be not B and not iT_E, while the polymer was found to be iT_E. The bioaccumulation potential of the polymer could not be determined. Similarly, the bioaccumulation potential and inherent toxicity of 8:2 FTMAC could not be determined. However, 8:2 FTMAC was found to be not P (Environment and Climate Change Canada, 2019). The remaining chemicals in this group are not listed on the DSL (Environment Canada, 2013).

European Union

In October 2014, a proposal to restrict the use of PFOA, its salts, and substances that may degrade to PFOA under the European Union Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation was published. The proposal covers manufacture, sale and use of PFOA, its salts, and substances that may degrade to PFOA if present in concentrations greater than two parts per billion (ECHA, 2014a, 2015b).

Three chemicals in this group (8:2 FTOH, 8:2 FTMAC and the propanamide) have been pre-registered for use in the European Union under the REACH legislation (ECHA, 2015a). However, no chemicals in this group have undergone the full registration process (ECHA, 2014b).

United States of America

In January 2006, the United States Environmental Protection Agency (US EPA) launched a global PFOA stewardship program. The eight major companies that manufacture fluoropolymers and telomers committed to reduce facility emissions of all PFOA, PFOA precursors and related chemicals by 95% by no later than 2015 (compared to 2000 baseline) (US EPA, 2009).

Three chemicals in this group (8:2 FTOH, 8:2 FTMAC and the propanamide), are listed on the inventory of chemicals manufactured or processed in the USA, as published under the *Toxic Substances Control Act 1976* (TSCA)(US EPA, 2018). The United States Environmental Protection Agency (US EPA) proposed a new Significant New Activity Rule for these chemicals in January 2015. Under the Rule, approval must be sought for new uses of these chemicals. The US EPA understands that existing uses of these chemicals will be phased out by December 2015 under a voluntary stewardship programme (US EPA, 2015).

The US EPA published an action plan on long-chain perfluorinated chemicals, covering the chemicals in this group, in 2009. All chemicals were identified as persistent, bioaccumulative and toxic (US EPA, 2009).

Environmental Exposure

Based on international data, the polymers in this group may have use in a wide range of applications in Australia. Release to the environment may occur during the use and disposal of the chemical, including the use and disposal of products containing the chemical, and that of articles treated with commercial and domestic surface treatment products. Both 8:2 FTOH and 8:2 FTMAC are not expected to have industrial use in Australia, as data collected by NICNAS indicate that PFOA related chemicals are not manufactured in Australia (NICNAS, 2013). Any use of the remaining chemicals is also expected to be limited.

The environmental degradant of primary concern for the chemicals in this group is PFOA. This chemical is purely of anthropogenic origin and has been identified as a PBT substance (NICNAS, 2015a).

Multiple studies have demonstrated the potential for 8:2 FTOH to degrade to PFOA. Biotransformation of 8:2 FTOH to PFOA has been proposed to occur by a mechanism which involves the defluorination of one perfluorinated carbon atom. Atmospheric degradation of 8:2 FTOH occurs through oxidation by chlorine or hydroxyl radicals, resulting in a so-called ‘unzipping’ cycle that forms perfluorinated carboxylic acids of various lengths, including PFOA (Butt, et al., 2014, De Voogt, 2010, Dinglasan, et al., 2004, Ellis, et al., 2004).

A number of recent studies have further demonstrated potential for biodegradation of 8:2 acrylate and methacrylate fluorotelomer derivatives (including commercial polymers with acrylate–linked fluorotelomer side-chains) in soil and water to yield PFOA (Butt, et al., 2014, Rankin, et al., 2014, Royer, et al., 2015, Washington, et al., 2015). Hydrolysis of the ester bond is expected to release 8:2 FTOH, which degrades to PFOA as described above. Less data are available for the 7:1 fluoroalcohol methacrylate co-polymer, although degradation to PFOA has been assumed to occur (OECD, 2007).

Monitoring data have identified 8:2 FTOH and PFOA in the environment. The volatile 8:2 FTOH is routinely found in outdoor air, with detections made in locations remote as Antarctica and in the livers of Arctic polar bears (Del Vento, et al., 2012, OECD, 2008). Typical outdoor air concentrations in regions more densely populated by humans appear to range between 5 and 275 picograms per cubic metre (pg/m^3) (Barber, et al., 2007, Jahnke, et al., 2007). Concurrently, international studies have identified PFOA in various media, including surface and drinking waters. In Australia, PFOA has been identified in the Parramatta and Brisbane river catchments. The chemical has been found in Australian drinking water at concentrations up to 9.7 nanograms per litre (ng/L) (NICNAS, 2015a).

It is noted that there are multiple potential sources of 8:2 FTOH and PFOA in the environment including past industrial use of other fluorinated chemicals contaminated with these substances, use in articles, or from the use of other fluorinated chemicals which degrade to these substances in the environment.

Environmental Effects

The currently available ecotoxicity data for PFOA are summarised in the IMAP Environment Tier II assessment for Perfluorooctanoic Acid (PFOA) and its Direct Precursors. Data currently available for PFOA indicate low acute aquatic toxicity (median lethal/effective concentration values > 300 mg/L) and chronic aquatic toxicity (no-observed-effect concentration values ≥ 12.5 mg/L) in standard ecotoxicity tests. However, data from a growing number of non-standard ecotoxicity tests have identified intergenerational toxicity in the F_1 generation when both the parent and offspring are exposed to concentrations as low as 0.1 mg/L (NICNAS, 2015a).

The chemicals in this group contain a range of functional groups and moieties which are correlated with acute toxic effects in aquatic organisms. However, these possible effects have not been considered in this assessment, as the primary risk posed by the chemicals in this group is assumed to result from the cumulative release of PFOA into the environment.

Categorisation of Environmental Hazard

Insufficient data are presented in this assessment to categorise the chemicals in this group according to domestic environment hazard thresholds (EPHC, 2009).

It is noted that direct precursors to PFOA are categorised as Persistent, Bioaccumulative and Toxic (PBT) substances according to domestic environmental hazard criteria (NICNAS, 2015a).

Risk Characterisation

The chemicals in this group may degrade to a PBT substance. It is not currently possible to derive a safe environmental exposure level for such chemicals and it is therefore not appropriate to characterise the environment risks for these chemicals in terms of a risk quotient.

The recalcitrant degradant assumed to be formed from each of the chemicals in this group (PFOA) has been identified as a PBT chemical. Due to their persistence, PBT chemicals have the potential to become widely dispersed environmental contaminants. Once in the environment, persistent chemicals that are also highly bioaccumulative pose an increased risk of accumulating in exposed organisms and of causing adverse effects. They may also biomagnify through the food chain resulting in very high internal concentrations, especially in top predators. Importantly, it is difficult or impossible to reverse the adverse effects of PBT chemicals once they have been released to the environment.

Key Findings

Based on international data, the polymers in this group may have current industrial use in a wide range of formulations in Australia, including paints, polishes, and surface treatments for various textile products. The remaining chemicals in this group are not expected to be significantly used in Australia. Some chemicals, especially 8:2 FTOH, may be present as residual contaminants in chemical products containing the polymers and in pre-treated articles. However, the risks posed by these contaminants have not been considered in this assessment.

Available data indicate that chemicals in this group have the potential to degrade to PFOA. Therefore, the principal risk posed by the chemicals in this group if emitted to the environment is assumed to result from cumulative releases of the degradation product, PFOA. This perfluorinated chemical has been identified as a PBT chemical and is therefore of high concern to the environment.

The chemicals in this group have not been categorised according to domestic environmental hazard criteria. This finding does not indicate a lack of potential hazard for some parent chemicals in this group, but rather a lack of suitable data in this assessment to characterise these hazards for each individual chemical.

It is noted that significant volumes of the chemicals in this group may also be imported into Australia as a component of finished articles. However, release from these articles and the associated environmental risks are beyond the scope of this assessment.

The assessment of the risks from these chemicals to human health, including public health, has been considered in the IMAP-Human Health Tier II assessment for Indirect Precursors to Perfluorooctanoic Acid (PFOA) (NICNAS, 2015c).

Recommendations

The chemicals in this group have been assessed as having the potential to give rise to adverse outcomes for the environment and public health. These chemicals are currently listed on the Australian Inventory of Chemical Substances (AICS), and are available to be introduced into Australia without any further assessment by NICNAS. Other chemicals with reduced potential for adverse outcomes are becoming available but, given the properties of these chemicals, their assessment as new chemicals under the *Industrial Chemicals (Notification and Assessment) Act 1989* (the ICNA Act) is still required to fully characterise the human health and the environmental risks associated with their use.

It is recommended that NICNAS consult with industry and other stakeholders to consider strategies, including regulatory mechanisms available under the ICNA Act, to encourage the use of safer chemistry.

Environmental Hazard Classification

Insufficient data are presented in this assessment to classify the aquatic hazards of chemicals in this group according to the third edition of the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) (UNECE, 2009).

It is noted that direct precursors to PFOA have been classified as Chronic Aquatic Category 1 (H410) under the GHS (NICNAS, 2015a).

References

Barber JL, Berger U, Chaemfa C, Huber S, Jahnke A, Temme C and Jones KC (2007). Analysis of per- and polyfluorinated alkyl substances in air samples from Northwest Europe. *Journal of Environmental Monitoring*, **9**, pp 530-541.

Buck RC, Franklin J, Berger U, Conder JM, Cousins IT, de Voogt P, Jensen AA, Kannan K, Mabury SA and van Leeuwen SP (2011). Perfluoroalkyl and Polyfluoroalkyl Substances in the Environment: Terminology, Classification and Origins. *Integrated Environmental Assessment and Management*, **7**(4), pp 513-541.

Butt CM, Muir DCG and Mabury SA (2014). Biotransformation of fluorotelomer-based polyfluoroalkyl substances: A review. *Environmental Toxicology and Chemistry*, **33**(2), pp 243-267.

De Voogt P (2010). *Perfluorinated alkylated substances*. Springer, USA.

Del Vento S, Halsall C, Gioia R, Jones K and Dachs J (2012). Volatile per- and polyfluoroalkyl compounds in the remote atmosphere of the western Antarctic Peninsula: an indirect source of perfluoroalkyl acids to Antarctic waters? *Atmospheric Pollution Research*, **3**, pp 450-455.

Dinglasan MJA, Ye Y, Edwards EA and Mabury SA (2004). Fluorotelomer Alcohol Biodegradation Yields Poly- and Perfluorinated Acids. *Environmental Science and Technology*, **38**(10), pp 2857-2864.

ECHA (2013). *Committee for Risk Assessment: Annex 2 Response to comments document (RCOM) to the Opinion proposing harmonised classification and labelling at EU level of 8:2 fluorotelomer alcohol (8:2 FTOH)*. European Chemicals Agency, Helsinki, Finland. Accessed 17 April 2015 at https://echa.europa.eu.

ECHA (2014a). *Annex XV Restriction Report for Perfluorooctanoic acid (PFOA), PFOA salts and PFOA-related substances*. European Chemicals Agency, Helsinki, Finland. Accessed 13 March 2013 at http://echa.europa.eu.

ECHA (2014b). Registered Substances. European Chemicals Agency, Helsinki, Finland. Accessed 9 May 2014 at http://echa.europa.eu.

ECHA (2015a). Pre-registered substances. European Chemicals Agency, Helsinki, Finland. Accessed 1 April 2015 at http://echa.europa.eu.

ECHA (2015b). *Germany and Norway propose a restriction on Perfluorooctanoic acid (PFOA), its salts and PFOA-related substances*. European Chemicals Agency, Helsinki, Finland. Accessed 25 February 2015 at http://echa.europa.eu.

Ellis D, A., Martin JW, De Silva AO, Mabury SA, Hurley MD, Sulbaek Andersen MP and Wallington TJ (2004). Degradation of Fluorotelomer Alcohols: A Likely Atmospheric Source of Perfluorinated Carboxylic Acids. *Environmental Science and Technology*, **38**(12), pp 3316-3321.

ENVIRON (2014). *Assessment of POP Criteria for Specific Short-Chain Perfluorinated Alkyl Substances*. ENVIRON International Corporation, Arlington, USA. Accessed 13 March 2013 at https://fluorocouncil.com.

Environment and Climate Change Canada (2019). Categorization Results from the Canadian Domestic Substances List. Provided by OECD. https://canadachemicals.oecd.org.

Environment Canada (2013). Search Engine for Chemicals and Polymers. Environment Canada, Gatineau, Canada. Accessed 1 May 2014 at https://pollution-waste.canada.ca.

EPHC (2009). *Environmental Risk Assessment Guidance Manual for Industrial Chemicals*. Environment Protection and Heritage Council, Canberra, Australia. Accessed 9 December 2013 at http://www.nepc.gov.au.

Government of Canada (2018a). Canada Gazette, Part I, Volume 152, Number 41: Government Notices. Accessed February 2019 at http://gazette.gc.ca.

Government of Canada (2018b). Toxic substances list: long-chain perfluorocarboxylic acids. Accessed February 2019 at https://www.canada.ca.

Government of Canada (2018c). Toxic Substances List - Schedule 1. Government of Canada, Gatineau, Canada. Accessed February 2019 https://www.canada.ca.

Jahnke A, Ahrens L, Ebinghaus R and Temme C (2007). Urban versus Remote Air Concentrations of Fluorotelomer Alcohols and Other Polyfluorinated Alkyl Substances in Germany. *Environmental Science and Technology*, **41**(3), pp 745-752.

NICNAS (2013). PFC Derivatives and Chemicals on which they are based: Alert Factsheet. National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. Accessed 11 November 2014 at https://www.nicnas.gov.au.

NICNAS (2015a). Environment Tier II Assessment of Perfluorooctanoic Acid (PFOA) and its Direct Precursors. National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. https://www.nicnas.gov.au.

NICNAS (2015b). Environment Tier II Assessment for Direct precursors to perfluorooctanesulfonate (PFOS). National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. https://www.nicnas.gov.au.

NICNAS (2015c). IMAP Human Health Tier II Assessment for Indirect Precursors to Perfluorooctanoic Acid (PFOA). National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. https://www.nicnas.gov.au.

NICNAS (2016). Per- and poly-fluorinated alkyl substances (PFAS). National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. Accessed 13 December 2018 at https://www.nicnas.gov.au.

NICNAS (2018). Data requirements for notification of new chemicals containing a perfluorinated carbon chain. National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. Accessed 4 April 2018 2018 at https://www.nicnas.gov.au.

OECD (2006). *Results of the 2006 Survey on Production and Use of PFOS, PFAS, PFOA, PFCA, their Related Substances and Products/Mixtures Containing these Substances*. Organisation for Economic Cooperation and Development, Paris, France. Accessed 21 November 2014 at http://www.oecd.org.

OECD (2007). *Lists of PFOS, PFAS, PFOA, PFCA, Related Compounds and Chemicals That May Degrade to PFCA*. Organisation for Economic Cooperation and Development, Paris, France. Accessed 23 March 2015 at http://www.oecd.org.

OECD (2008). *SIDS Initial Assessment Report for Ammonium Perfluorooctanoate and Perfluorooctanoic Acid*. Organisation for Economic Cooperation and Development, Paris, France. Accessed 25 February 2015 at https://hpvchemicals.oecd.org.

OECD (2011). *PFCS: Outcome of the 2009 Survey on the Production, Use and Release of PFOS, PFAS, PFOA, PFCA, Their Related Substances and Products/Mixtures Containing These Substances*. Organisation for Economic Cooperation and Development, Paris, France. Accessed 9 January 2015 at http://www.oecd.org.

OECD (2013). OECD Existing Chemicals Database. Organisation for Economic Cooperation and Development, Paris, France. Accessed 13 November 2013 http://webnet.oecd.org.

Rankin K, Lee H, Tseng PJ and Mabury SA (2014). Investigating the Biodegradability of a Fluorotelomer-Based Acrylate Polymer in a Soil-Plant Microcosm by Indirect and Direct Analysis. *Environmental Science and Technology*, **48**(21), pp 12783-12790.

Royer LA, Lee LS, Russell MH, Nies LF and Turco RF (2015). Microbial transformation of 8:2 fluorotelomer acrylate and methacrylate in aerobic soils. *Chemosphere*, **129**, pp 54-61.

SFT (2007). *PFOA in Norway*. Norwegian Pollution Control Authority (Norwegian: Statens forurensningstilsyn), Oslo, Norway. Accessed at https://www.miljodirektoratet.no.

UNECE (2009). *Globally Harmonised System of Classification and Labelling of Chemicals (GHS), 3rd Revised Edition*. United Nations Economic Commission for Europe, Geneva, Switzerland. Accessed 12 November 2013 at http://www.unece.org

UNEP (1987). *The Montreal Protocol on Substances that Deplete the Ozone Layer*. United Nations Environment Programme, Ozone Secretariat, Nairobi, Kenya. Accessed 12 November 2013 at http://ozone.unep.org.

UNEP (2001). *The Stockholm Convention on Persistent Organic Pollutants*. United Nations Environment Programme, Secretariat of the Stockholm Convention, Châtelaine, Switzerland. Accessed 12 November 2013 at http://www.pops.int.

UNEP (2017a). Report of the Persistent Organic Pollutants Review Committee on the work of its thirteenth meeting: Risk management evaluation on pentadecafluorooctanoic acid (CAS No: 335-67-1, PFOA, perfluorooctanoic acid), its salts and PFOA-related compounds. United Nations Environment Programme Persistent Organic Pollutants Review Committee, Châtelaine, Switzerland. Accessed 26 February 2018 http://www.pops.int.

UNEP (2017b). Draft risk managment evaluation, PFOA, its salts and PFOA-related compounds: Non-exhaustive list of substances covered or not covered by the risk management evaluation. UNEPPOPR Committee. Accessed 26 February 2018 http://chm.pops.int.

UNEP & FAO (1998). *The Rotterdam Convention on the Prior Informed Consent procedure for Certain Hazardous Chemicals and Pesticides in International Trade*. United Nations Environment Programme and Food and Agriculture Organization of the United Nations, Châtelaine, Switzerland. Accessed 12 November 2013 at http://www.pic.int.

US EPA (2009). *Long-Chain Perfluorinated Chemicals (PFCs) Action Plan*. United States Environmental Protection Agency, Washington DC, USA. Accessed 10 December 2014 at https://www.epa.gov.

US EPA (2015). Significant New Use Rules: Long-Chain Perfluoroalkyl Carboxylate and Perfluoroalkyl Sulfonate Chemical Substances. United States Environmental Protection Agency, Washington DC, USA. Accessed 25 February 2015 at https://www.federalregister.gov.

US EPA (2018). TSCA Chemical Substance Inventory. United States Environmental Protection Agency, Washington DC, USA. Accessed February 2019 at http://www.epa.gov.

Washington JW, Jenkins TM, Rankin K and Naile JE (2015). Decades-Scale Degradation of Commercial, Side-Chain, Fluorotelomer-Based Polymers in Soils and Water. *Environmental Science and Technology*, **49**(2), pp 915-923.

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