Perfluorooctanoic acid (PFOA) and its direct precursors: Environment tier II assessment

24 April 2015

CAS Registry Numbers: 335-67-1, 3825-26-1.

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 perfluorooctanoic acid and its ammonium salt:

Octanoic acid, pentadecafluoro- (PFOA)
Octanoic acid, pentadecafluoro-, ammonium salt (APFO)

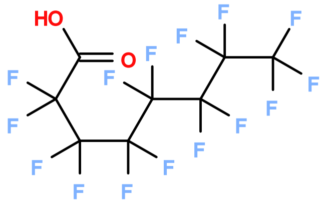
The chemicals in this group are long-chain perfluorinated chemicals containing seven perfluorinated carbons, terminated with a carboxylate group. The risk assessment of these chemicals has been conducted as a group because both chemicals are expected to dissociate into the perfluorooctanoate anion in the aquatic environment.

The chemicals in this group are predominantly used in the production of fluoropolymers. Perfluorooctanoic acid and its precursors are of concern internationally due to their similarity to perfluorooctanesulfonic acid. This long-chain perfluorinated acid and certain related substances containing the perfluorooctanesulfonate (PFOS) moiety have recently been identified as Persistent Organic Pollutants under Annex B 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, 2015c).

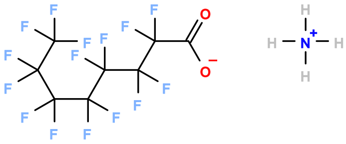
The assessment of these chemicals as a group also provides additional relevant information for the risk assessment of other long-chain per- and poly-fluorinated industrial chemicals which may degrade to PFOA in the environment.

Chemical Identity

In this assessment, "PFOA" is used to denote perfluorooctanoic acid and its conjugate base anion (i.e. the perfluorooctanoate anion). Further, "APFO" is used to denote the ammonium salt of perfluorooctanoic acid (Buck, et al., 2011).

CAS RN	335-67-1
Chemical Name	Octanoic acid, pentadecafluoro-
Synonyms	PFOA perfluorooctanoic acid pentadecafluorooctanoic acid
Structural Formula	
Molecular Formula	$C_8HF_{15}O_2$
Molecular Weight (g/mol)	414.07
SMILES	C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(=O)O

CAS RN	3825-26-1
Chemical Name	Octanoic acid, pentadecafluoro-, ammonium salt
Synonyms	APFO

	ammonium PFOA ammonium perfluorooctanoate ammonium pentadecafluorooctanoate
Structural Formula	
Molecular Formula	$C_8H_4F_{15}NO_2$
Molecular Weight (g/mol)	431.10
SMILES	[O-]C(=O)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)F.[NH4+]

Physical and Chemical Properties

Available physical and chemical property data for PFOA and APFO are presented below (Nielsen, 2012; OECD, 2008):

Chemical	PFOA	APFO
Physical Form	Solid	Solid
Melting Point	55°C (exp.)	165°C (exp.)
Boiling Point	189°C (exp.)	Decomposes (exp.)
Vapour Pressure	4.2 Pa (exp.)	≤ 0.012 Pa (exp.)
Water Solubility	3727 mg/L (exp.)	14 200 mg/L (exp.)

Perfluorooctanoic acid and its ammonium salt are both solids under ambient conditions. A study by Kaiser et al. showed that both solid substances sublime, although the mass loss to air for PFOA at 45°C is significantly greater than it is for APFO (Kaiser, et al., 2010). The sublimation temperature for PFOA is reported to be 40°C (Nielsen, 2012).

Perfluorooctanoic acid is known to be surface-active (OECD, 2008). The water solubility values reported for both PFOA and APFO were determined at the critical micelle concentration (Nielsen, 2012), as is appropriate for surface-active substances. The octanol-water partition coefficient parameter (K_{OW}) is not considered to provide a reliable indicator of the partitioning behaviour of surface-active perfluorinated chemicals in the environment (OECD, 2002) and has not been reported.

There has been some uncertainty in regards to the acid dissociation constant (pK_a) of PFOA. Some have reported the pK_a to be as high as 3.8, while others have suggested it may be less than one (De Voogt, 2010). The current weight of evidence suggests that PFOA should be considered a strong acid ($pK_a < 1$) in aqueous solution at environmentally relevant concentrations (De Voogt, 2010; Vierke, et al., 2013).

Import, Manufacture and Use

Australia

Data collected by NICNAS indicate that the chemicals in this group are not currently imported or manufactured in Australia (NICNAS, 2013a).

It is noted that the chemicals in this group may be present in the environment due to historic use, release from pre-treated articles, or the use of other chemicals. In particular, the use of fluoropolymers (which may contain PFOA residues) has previously been reported in the manufacture of non-stick metal cookware, in paints, in fire-fighting foams, and in textile and carpet protection (NICNAS, 2013a). However, release from these uses is beyond the scope of this assessment.

International

Internationally, PFOA itself is generally not used as a chemical substance. Instead, APFO is used to introduce PFOA into manufacturing processes. This ammonium salt is used as a processing aid in the production of fluorotelomers and fluoropolymers, such as polytetrafluoroethylene (PTFE) and fluorinated ethylene propylene copolymers. These polymeric products are used in paints, non stick cookware, surface treatments, and in the building and construction industries (OECD, 2008).

Other minor applications include use as an antistatic agent in multi-layer medical films, and in the production of a polymer used in circuit boards (OECD, 2008). It is not clear whether these uses refer to PFOA or APFO.

Environmental Regulatory Status

Australia

The import and use of PFOA and PFOA related substances in Australia is monitored by NICNAS (NICNAS, 2015b).

In 2007, a factsheet published by NICNAS provided advice that industry should actively seek alternatives to PFOA and chemicals that may degrade to PFOA, and ultimately aim to phase out use of these substances (NICNAS, 2013a).

United Nations

The chemicals in this group are not currently identified as Persistent Organic Pollutants (UNEP, 2001), ozone depleting substances (UNEP, 1987), or hazardous substances for the purpose of international trade (UNEP & FAO, 1998).

OECD

The two chemicals in this group were sponsored for assessment under the Cooperative Chemicals Assessment Programme (CoCAP) by Germany and the United States of America (USA). The 26th Screening Information Dataset (SIDS) Initial Assessment Meeting (SIAM 26) found that both chemicals were candidates for further work (OECD, 2008).

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

Perfluorooctanoic acid, its salts and substances with a perfluoroheptyl or perfluorooctyl moiety are listed under Schedule 1 (the Toxic Substances List) of the *Canadian Environmental Protection Act 1999* (CEPA 1999) (Environment Canada, 2012a; Government of Canada, 2013). A proposal to prohibit the import, manufacture and use of these chemicals has been released, and is expected to be finalised by January 2016 (Environment Canada, 2012b).

During the Categorization of the Canadian Domestic Substances List (DSL), APFO was found to be Persistent (P) and Inherently Toxic to the Environment (iT_E). The bioaccumulation potential of the chemical was unable to be determined (Environment Canada, 2013b). A subsequent screening assessment found evidence that the chemical accumulates and biomagnifies in terrestrial and marine mammals, but that it does not meet the criteria set out in the *Persistence and Bioaccumulation Regulations* under CEPA 1999 (Environment Canada, 2012a). Perfluorooctanoic acid is not listed on the DSL (Environment Canada, 2013a).

European Union

The two chemicals in this group have been identified as persistent, bioaccumulative and toxic substances, and designated as Substances of Very High Concern under the European Union Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation. Both chemicals are currently listed on the Candidate List for Authorisation (ECHA, 2014). When listed on the Annex XIV to REACH (the Authorisation List), authorisation must be obtained to use these chemicals (ECHA, 2013).

In addition, a proposal to restrict the use of PFOA, its salts, and substances that may degrade to PFOA under REACH is currently open for consultation. The proposal covers manufacture, sale and use of the substance if present in concentrations greater than two parts per billion (ECHA, 2015).

United States of America

The United States Environmental Protection Agency (US EPA) proposed a Significant New Activity Rule for the chemicals in this group in January 2015. Under the Rule, approval must be sought for new uses of these chemicals after December 2015. The US EPA understands that existing uses of these chemicals will be phased out by this date 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

The chemicals in this group are reported to not be in use in Australia. Therefore, direct release of these chemicals to the environment as a result of their current industrial uses is considered unlikely.

Perfluorooctanoic acid may be released to the environment from disposal of other chemicals manufactured using APFO, or the disposal of imported articles treated with these substances. However, this exposure route is beyond the scope of this assessment. Indirect releases of PFOA as a result of environmental degradation of other long-chain fluorinated chemicals are considered under the Environment Tier II Assessment of the Indirect Precursors of Perfluorooctanoic Acid (PFOA) group (NICNAS, 2015a).

The ammonium cation present as a counterion in the salt of this group is a ubiquitous, naturally occurring inorganic species that is essential for many biological functions. The environmental fate and effects of this cation is not further considered in this assessment.

Environmental Fate

Dissolution, Speciation and Partitioning

The dissolved perfluorooctanoate anion is the dominant form of these substances in the aquatic compartment.

Perfluorooctanoic acid is a strong acid and it can be assumed that dissolution of the acid in water will involve dissociation into the perfluorooctanoate conjugate base anion. This will be the predominant species in water under typical environmental conditions (De Voogt, 2010; Vierke, et al., 2013). As the salt of a strong acid, the ammonium salt of PFOA will dissociate into its constituent ions in water. The partitioning behaviour (and speciation) of the acid and its salts in the aquatic compartment will be influenced by the surface activity of the perfluorooctanoate anion. For example, perfluorooctanoate anions concentrate at surfaces and may also self-aggregate in water at concentrations below the critical micelle concentration (Vierke, et al., 2013).

The perfluorooctanoate anion does not volatilise into the air compartment from water and is generally expected to remain in the water compartment under typical environmental conditions. However, the acid and the ammonium salt have appreciable vapour pressures as solids and may consequently be released to the air compartment. Sublimation of particulate APFO, and release of the more volatile free acid into the air compartment, has also been discussed (Prevedouros, et al., 2006; Vierke, et al., 2013).

Degradation

PFOA is highly resistant to degradation in the environment.

Studies conducted using APFO have demonstrated that PFOA is resistant to biodegradation, hydrolysis and aqueous photolysis (Hekster, et al., 2002). No biodegradation has been observed in a range of aerobic and anaerobic studies (OECD, 2008). The hydrolysis half life of PFOA has been estimated to be more than 92 years (Hekster, et al., 2002).

The estimated atmospheric lifetime for PFOA based on indirect photo-oxidation by hydroxyl radicals is 130 days. The main pathway for removal of PFOA from the atmosphere is expected to be as the result of particle-mediated wet and dry deposition (OECD, 2008).

Bioaccumulation

PFOA has the potential to biomagnify in marine and terrestrial mammals.

Perfluorinated chemicals have been observed to bioaccumulate by binding to proteins in plasma and liver, rather than the more conventional partitioning to fatty tissue (Ng and Hungerbühler, 2014). Bioconcentration factors (BCFs) less than 50 are available for PFOA in a range of tissues, including the blood and liver, for multiple fish species. Similarly, low bioaccumulation factors (BAFs) have also been obtained for fish and two wild turtles (*Trachemys scripta elegans* and *Mauremys reevesii*) (OECD, 2008). These values indicate low bioconcentration and bioaccumulation potential in aquatic organisms.

However, it has been noted that marine and terrestrial mammals may be less efficient in eliminating PFOA, and therefore be more susceptible to bioaccumulation of this substance (OECD, 2008). This is supported by the two food web biomagnification studies available, which both identified biomagnification factors (BMFs) greater than one in the carnivorous marine mammals which occupied higher trophic levels (OECD, 2008). A Canadian assessment of the chemicals in this group further noted that polar bears have the highest PFOA concentrations among Arctic terrestrial organisms (Environment Canada, 2012a). These findings indicate potential for biomagnification of PFOA in the top predators of marine and terrestrial food webs.

Transport

PFOA is a globally distributed pollutant.

Numerous studies have identified PFOA in various locations worldwide. The chemical has been measured in various locations and depths in the Atlantic Ocean, in the North Polar Sea, and in the livers of Arctic polar bears (OECD, 2008). The global distribution of PFOA as an environmental contaminant has been difficult to rationalise in terms of conventional long range transport pathways. It has been hypothesised that such distribution may occur through atmospheric transport of the acid, transport of the anion in surface water or oceanic currents, and/or atmospheric transport of volatile PFOA precursors (e.g. fluorotelomer alcohols) (OECD, 2008).

The relative contribution of chemicals in this group to the total load of PFOA in the environment, especially in remote locations, is still unclear and subject to ongoing research. However, the exceptional environmental persistence and the ubiquity of PFOA as a contaminant in oceans does indicate at least a potential for long range transport of this perfluorinated acid through oceans.

Predicted Environmental Concentration (PEC)

The chemicals in this group are not expected to have current industrial use in Australia and PEC values have therefore not been calculated.

Nevertheless, PFOA may be present in the environment due to past industrial use of other fluorinated chemicals contaminated with this substance, use in articles, or from the use of per- and poly-fluorinated chemicals which degrade to this substance in the environment. In Australia, PFOA was recently detected in 100% of samples taken from the Parramatta River (main tributary of Sydney Harbour), with a mean concentration of 5.7 nanograms per litre (ng/L) (Thompson, et al., 2011b). A study published in 2010 found concentrations of PFOA to be as high as 9.7 ng/L in Australian drinking water (Thompson, et al., 2011a). Sampling of the Brisbane River catchment following a major flooding event in 2011 also revealed the presence of PFOA in water at Somerset Dam, Wivenhoe Dam, Jindalee, Oxley Creek, West End, Bulimba and Moreton Bay. The chemical was detected in all samples obtained at these sites in mean concentrations ranging between 0.13 and 6.1 ng/L (Gallen, et al., 2014).

Environmental Effects

Effects on Aquatic Life

The chemicals in this group are expected to have long-term toxic effects in aquatic organisms.

Acute toxicity

A range of acute data is available for PFOA and its salts, with large variations in toxicity values observed. It has been suggested that these variations may result from differences in the purity of the test substance or testing methods (Environment Canada, 2012a). The following representative measured median effective concentration (EC50) and median lethal concentration (LC50) values for model organisms across three trophic levels for (a) PFOA and (b) APFO were reported in the OECD SIDS Dossier for ammonium perfluorooctanoate and perfluorooctanoic acid (OECD, 2008). Both chemicals are expected to dissociate into the perfluorooctanoate anion in water and therefore these data are used to characterise the toxicity of both chemicals in this group:

Taxon	Endpoint	Method

Taxon	Endpoint	Method
Fish	(b) 96 h LC50 = 301 mg/L	Experimental *Pimephales promelas* (Fathead minnow) Static; pH 7.7-8.0 Nominal concentrations
Invertebrates	(a) 48 h EC50 = 360 mg/L	Experimental *Daphnia magna* (Water flea) US EPA 797.1300; static; pH 7.5-8.0 Nominal concentrations
Algae	(b) 96 h EC50 = 396 mg/L	Experimental *Selenastrum capricornutum* (Green algae) OECD TG 201; static; pH 7.4-7.6

Chronic toxicity

A range of chronic data is available for PFOA and its salts, with large variations in toxicity values observed. It has been suggested that these variations may result from differences in the purity of the test substance or testing methods (Environment Canada, 2012a). The following representative no-observed-effect-concentration (NOEC) values for model organisms across three aquatic trophic levels for APFO were reported in the OECD SIDS Dossier for ammonium perfluorooctanoate and perfluorooctanoic acid (OECD, 2008). Both PFOA and APFO are expected to dissociate into the perfluorooctanoate anion in water, and therefore these data are used to characterise the toxicity of both chemicals in this group:

Taxon	Endpoint	Method
Fish	85 d NOEC = 40 mg/L	Experimental *Oncorhynchus mykiss* (Rainbow trout) OECD Draft TG 210; flow-through; pH 6.0-8.5 Measured concentrations

Taxon	Endpoint	Method
Invertebrates	21 d NOEC = 20 mg/L	Experimental *Daphnia magna* (Water flea) OECD TG 211; semi-static; pH 7.6-8.3 Measured concentrations
Algae	96 h NOEC = 12.5 mg/L	Experimental *Pseudokirchneriella subcapitata* (Green algae) EU 92/69/EEC C.3; static; pH 6-9 Reduced growth rate and biomass observed

While standard ecotoxicity testing results for aquatic organisms suggest low chronic toxicity, concerns regarding the long-term and intergenerational toxicity of PFOA in other organisms have been raised (NICNAS, 2015b). The relevance of these concerns to aquatic organisms has been explored by Ji et al. (2008), who identified high chronic intergenerational toxicity in the fish *Oryzias latipes*(Japanese medaka). No statistically significant effects in regards to mortality or condition factors were identified in exposed adult fish at PFOA concentrations of 10 mg/L for 14 days. However, cumulative mortality of the offspring after 100 days was significantly increased when both the parent and F_1 generation were exposed to 0.1 mg/L PFOA (Ji, et al., 2008). This study adds to emerging evidence demonstrating potential for high chronic toxicity of PFOA in aquatic organisms that is not detected by standard test protocols.

Additional studies have also suggested that PFOA may have some endocrine activity. Exposure of fish to PFOA has been found to cause vitellogenin induction in male tilapia (*Oreochromis niloticus)*, induction of (o)estrogen-responsive genes in the rare minnow (*Gobiocypris rarus*), and inhibition of thyroid hormone biosynthesis (Environment Canada, 2012a).

Effects on Sediment-Dwelling Life

Based on available data, the chemicals in this group are not expected to have toxic effects on sediment-dwelling life.

The toxicity of PFOA to the midge *Chironomus tentans* has been studied, with a 10 d NOEC of 100 mg/L obtained (Environment Canada, 2010; OECD, 2008).

Effects on Terrestrial Life

Based on available data, the chemicals in this group are expected to have long-term toxic effects in some terrestrial organisms.

Acute toxicity

Exposure to concentrations of PFOA has been found to cause toxic effects in the nematode *Caenorhabditis elegans*, with a 48 h EC50 of 973 mg/L determined (Environment Canada, 2012a; OECD, 2008).

Studies in terrestrial plants have found PFOA to inhibit seed germination in lettuce (*Lactuca sativa*) and pak choi (*Brassica rapa chinensis*), with EC50 values of 1734 mg/L and 579 mg/L, respectively. Root growth in these species was almost completely inhibited at concentrations at or above 1000 mg/L. An additional study found visible abnormalities, such as necrosis, yellowing and diminished growth, in spring wheat, oats, potatoes and perennial ryegrass when exposed to soil concentrations above 10 mg/kg (Environment Canada, 2012a).

Chronic toxicity

Limited data available on developmental toxicity in birds indicate no adverse effects when PFOA is injected into the air cell of eggs at a concentration of 10 mg/kg body weight, or when male one-day old chickens are exposed to concentrations up to 1 mg/kg body weight for three weeks (Environment Canada, 2012a).

A multi-generational test using *C. elegans* found decreases in worm abundance and egg production by the fourth generation in a group exposed to 0.004 mg/L PFOA, but no concentration-response relationship was observed (Environment Canada, 2012a; OECD, 2008). Nevertheless, studies conducted in rats and mice support the findings of intergenerational toxicity in fish and nematodes. While one study found no significant effects on reproduction parameters throughout mating, pregnancy and lactation in rats dosed orally with APFO, increased mortality and time to sexual maturation were observed in the F_1generation. An additional study has observed increased F_1 generation mortality when pregnant mice were orally dosed with APFO at 10 mg per kilogram body weight per day (mg/kg bw/day) (NICNAS, 2015b). Further information on these studies can be found in the IMAP Tier II Human Health Assessment for Perfluorooctanoic Acid (PFOA) and its Direct Precursors (NICNAS, 2015b).

Predicted No-Effect Concentration (PNEC)

Use of the chemicals in this group will result in the environmental release of PFOA, which is bioaccumulative and persistent. These two hazard characteristics combined have the potential to result in a range of long-term effects on organisms exposed to these chemicals which cannot be readily identified through standard ecotoxicity tests. For such chemicals, it is not currently possible to estimate a safe exposure concentration using standard extrapolation methods based on laboratory screening level tests. Predicted no-effects concentrations have therefore not been derived for the chemicals in this group.

Categorisation of Environmental Hazard

The categorisation of the environmental hazards of octanoic acid, pentadecafluoro- (PFOA) and octanoic acid, pentadecafluoro-, ammonium salt (APFO) according to domestic environmental hazard thresholds is presented below (EPHC, 2009; NICNAS, 2013b):

Persistence

Persistent (P). Based on the non-degradability of PFOA, all chemicals in this group are categorised as Persistent.

Bioaccumulation

Bioaccumulative (B). Based on the measured BMF values available for PFOA and evidence of biomagnification in top predators, all chemicals in this group are categorised as Bioaccumulative.

Toxicity

Toxic (T). Based on the long-term intergenerational toxicity of PFOA, all chemicals in this group are categorised as Toxic.

Summary

Octanoic acid, pentadecafluoro- and octanoic acid, pentadecafluoro-, ammonium salt are categorised as:

- P
- B
- T

Risk Characterisation

The chemicals in this group have been identified as PBT substances. It is not currently possible to derive a safe environmental exposure level for such chemicals and it is therefore not appropriate to characterise the environmental risks for these chemicals in terms of a risk quotient.

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. As a result, these chemicals are considered to be of high concern for the environment.

Key Findings

Available data indicate that the chemicals in this group are not currently used in Australia. Internationally, the salt of this group is used as a processing aid in the manufacture of fluorotelomers and fluoropolymers. Perfluorooctanoic acid may be present as a residual contaminant in these end products, which are used in a range of consumer and industrial applications, including paints, non stick cookware, surface treatments, and in the building and construction industries.

The chemicals in this group release PFOA in the environment, and this is highly persistent. The chemical has become a globally distributed pollutant, and available data indicate potential for biomagnification in marine and terrestrial mammals. Emerging data also suggest that PFOA may have chronic intergenerational toxicity that is not detected by standard test protocols.

This assessment establishes that octanoic acid, pentadecafluoro- (PFOA) and octanoic acid, pentadecafluoro-, ammonium salt (APFO) are PBT substances according to domestic environmental hazard criteria. Therefore, these chemicals are considered to be high concern substances.

Recommendations

The chemicals in this group have been assessed as having the potential to give rise to adverse outcomes for the environment. These chemicals are currently listed on the Australian Inventory of Chemical Substances (the Inventory), 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

In addition to the categorisation of environmental hazards according to domestic environmental thresholds presented above, the classification of the environmental hazards of octanoic acid, pentadecafluoro- (PFOA) and octanoic acid, pentadecafluoro-, ammonium salt (APFO) according to the third edition of the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) is presented below (UNECE, 2009):

Hazard	GHS Classification (Code)	Hazard Statement
Acute Aquatic	-	Not classified
Chronic Aquatic	Category 1 (H410)	Very toxic to aquatic life with long lasting effects

The classification of the hazards posed by these chemicals has been performed based on the ecotoxicity data presented in this assessment. Acute data demonstrate aquatic toxicity greater than 100 mg/L. Adequate chronic toxicity data were considered to be available for these chemicals, which demonstrate toxicity less than or equal to 0.1 mg/L. The chronic categorisation of these chemicals also considered the non-rapid ultimate degradation of these substances (UNECE, 2007).

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Last update 24 April 2015

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