

Perfluoroheptanoic acid (PFHpA) and its direct precursors: Environment tier II assessment

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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 perfluoroheptanoic acid and its ammonium salt:

Heptanoic acid, tridecafluoro- (PFHpA)

Heptanoic acid, tridecafluoro-, ammonium salt (ammonium PFHpA)

The chemicals in this group contain chains of six perfluorinated carbons, terminated with a carboxylate group. They have been assessed in a group because both chemicals are expected to dissociate into the perfluoroheptanoate anion in the aquatic environment.

The two chemicals in this group have a perfluorinated carbon chain that is intermediate in length between the long-chain perfluorinated carboxylic acids (i.e. acids containing seven or more perfluorinated carbons) and the short-chain perfluorinated carboxylic acids (i.e. acids containing a chain of five, four or three perfluorinated carbons). The relative length of the carbon chain in perfluoroheptanoic acid is significant because the immediate long-chain homologue, perfluorooctanoic acid (PFOA), has been identified as persistent, bioaccumulative and toxic (PBT) according to domestic environmental hazard criteria. Chemicals with these hazard characteristics are of high concern to the environment and PFOA (and substances which may degrade to PFOA) are subject to increasingly stringent regulatory controls in other developed countries (NICNAS, 2015f).

However, the short-chain perfluorinated carboxylic acids (including the immediate short-chain homologue, perfluorohexanoic acid (PFHxA)) are not bioaccumulative and not toxic based on the available information, and they are considered to pose lower overall concerns for the environment than their long-chain homologues (NICNAS, 2015a). It is not currently clear whether the

environmental hazards for the intermediate chain-length acids are comparable to the homologous long-chain or to the short-chain perfluorinated carboxylic acids in this series.

Under the NICNAS action plan for assessing and managing chemicals that could degrade to perfluorinated carboxylic acids, perfluoroalkyl sulfonates and similar chemicals, hazard information for PFOA is used to estimate the hazard of perfluorocarboxylic acid (PFCA) degradation products (with four or more perfluorinated carbons), unless sufficient toxicological data are available to demonstrate a lower toxicity profile. More information on the plan can be found in Appendix G of the NICNAS Handbook for Notifiers on the NICNAS website (NICNAS, 2015b).

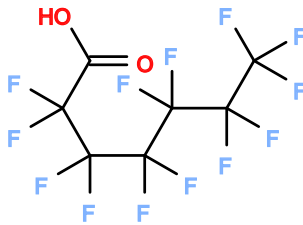
This assessment will evaluate:

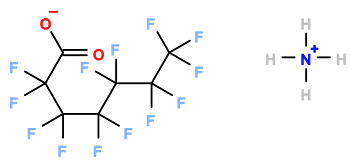
- a) the properties of the chemicals in this group and compare them with short- and long-chain homologues; and
- b) whether there are sufficient data to use in place of the default assumptions of the action plan.

The assessment of these chemicals as a group also provides additional relevant information for the risk assessment of other per- and poly-fluorinated substances containing a chain of at least six perfluorinated carbons that may degrade to PFHpA in the environment.

Chemical Identity

In this assessment, "PFHpA" is used to denote perfluoroheptanoic acid and its conjugate base anion (i.e. the perfluoroheptanoate anion) (Buck, et al., 2011).

CAS RN	375-85-9
Chemical Name	Heptanoic acid, tridecafluoro-
Synonyms	PFHpA perfluoroheptanoic acid perfluoroenanthic acid tridecafluoroheptanoic acid
Structural Formula	
Molecular Formula	C ₇ HF ₁₃ O ₂

Molecular Weight (g/mol)	364.06
SMILES	<chem>C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(=O)O</chem>
CAS RN	6130-43-4
Chemical Name	Heptanoic acid, tridecafluoro-, ammonium salt
Synonyms	ammonium PFHpA ammonium perfluoroheptanoate ammonium perfluoroenanthate ammonium tridecafluoroheptanoate
Structural Formula	
Molecular Formula	$C_7H_4F_{13}NO_2$
Molecular Weight (g/mol)	381.10
SMILES	<chem>C(F)(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(=O)[O-].[NH4+]</chem>

Physical and Chemical Properties

Available physical and chemical property data for PFHpA are presented below (LMC, 2013). Measured data for the homologous C_8 acid, PFOA, are presented for comparison (NICNAS, 2015f):

Chemical	PFHpA	PFOA
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Physical Form	Solid	Solid
Melting Point	31-36°C (exp.)	55°C (exp.)
Boiling Point	177°C (exp.)	189°C (exp.)
Vapour Pressure	17.7 Pa (exp.)	4.2 Pa (exp.)
Water Solubility	Not available	3727 mg/L (exp.)

Perfluoroheptanoic acid is a solid under ambient conditions, but it has a relatively low melting point (Huang, et al., 1987). In comparison, the C₆ homologue, PFHxA, and other short-chain perfluorocarboxylic acids are volatile liquids (NICNAS, 2015a). The C₈ homologue is also a solid under ambient conditions, although it has a relatively low sublimation temperature of 40°C (Kaiser, et al., 2010). Based on the properties of this long-chain homologue, solid PFHpA may sublime under ambient conditions.

Perfluorinated carboxylic acids are known to be surface-active (NICNAS, 2015c; 2015f; Vierke, et al., 2013). For example, the high indicated water solubility value for PFOA is the critical micelle concentration at which the dissolved acid begins to aggregate into micelles (NICNAS, 2015f). Based on the surface activity of PFOA and the close structural similarity to PFHpA, it is expected that perfluoroheptanoic acid will readily dissolve in water. It may also self-aggregate in concentrated aqueous solutions.

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 perfluorinated carboxylic acids. However, the current weight of evidence suggests that PFHxA, PFHpA and PFOA should all be considered strong acids ($pK_a < 1$) in aqueous solution at environmentally relevant concentrations (NICNAS, 2015a; 2015f ; Vierke, et al., 2013).

No experimental physical and chemical property data were located for ammonium PFHpA. However, data available for the ammonium salt of PFOA show that this chemical is a solid under ambient conditions and that it has some tendency to sublime, although not to the same extent as PFOA. It also forms micelles in aqueous solution with a measured critical micelle concentration of 14 200 mg/L (NICNAS, 2015f). Based on the properties of this homologue, ammonium PFHpA is expected to be a solid with some volatility under ambient conditions. It is also expected to readily dissolve in water and may also self-aggregate in more concentrated solutions.

Import, Manufacture and Use

Australia

Information collected by NICNAS in 2006 indicated that PFHpA and its derivatives were not manufactured, imported or used in Australia at the time. However, this information could be incomplete because the call for information did not specifically include the PFCAs group (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. However, release from these uses is beyond the scope of this assessment.

International

Limited data are available for PFHpA. Available data suggest historic use, with use reported in 1999 and 2000 in Sweden (Nordic Council of Ministers, 2015). Similarly, limited current data were identified for ammonium PFHpA. Available information suggests that it may be used intentionally as a surfactant in the manufacture of fluorocopolymers (Enokida, et al., 2000; Kanega, et al., 2008).

Environmental Regulatory Status

Australia

The use of the chemicals in this group is not subject to any specific national environmental regulations.

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

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

During the Categorization of the Canadian Domestic Substances List (DSL), ammonium PFHpA was found to be Persistent (P), Bioaccumulative (B) and Inherently Toxic to the Environment (IT_E) (Environment Canada, 2013b). A draft screening assessment published in February 2015 found that the current use patterns and quantities in commerce of the chemical were unlikely to result in concern for organisms or the broader integrity of the environment (Environment Canada, 2015).

The remaining chemical in this group is not listed on the DSL (Environment Canada, 2013a).

European Union

The two chemicals in this group have been pre-registered, but have not yet undergone the full registration process, under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation (ECHA, 2014a; 2015). Under the phase-in arrangements of the REACH legislation, full registration was required for chemicals used at volumes greater than 100 tonnes per annum in 2013 (ECHA, 2014b).

United States of America

The chemicals in this group do not belong to any of the chemical classes covered by an Existing Chemical Action Plan and have not been selected for action plan development (US EPA, 2013).

Environmental Exposure

Direct release of the chemicals in this group to the environment as a result of their current industrial uses is considered unlikely, as these chemicals are not expected to have significant use in Australia.

The acid in this group is considered more likely to be released to the environment from the use, disposal and degradation of other perfluorinated and polyfluorinated chemicals. However, this exposure route is beyond the scope of this assessment. Indirect releases of the chemicals in this group as a result of environment degradation of other industrial per- and poly-fluorinated chemicals listed on the Inventory will be considered separately.

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 conjugate base anion of PFHpA is the dominant form of these substances in the aquatic compartment.

The acid in this group is a strong acid and it can be assumed that dissolution of the acid in water will involve dissociation into the conjugate base anion. This will be the predominant species in water under typical environmental conditions. As a salt of a strong acid, the ammonium salt in this group will dissociate into its constituent ions in water. The partitioning (and speciation) behaviour of these chemicals in the aquatic compartment may be further influenced by the surface activity of the conjugate base anion (Vierke, et al., 2013).

The conjugate base anion of the acid in this group is not expected to volatilise into the air compartment from water and is generally likely to remain in the water compartment under typical environment conditions (Vierke, et al., 2013). However, the acid is a volatile substance and volatilisation of the acid to the air compartment is possible.

Degradation

PFHpA is highly resistant to degradation.

Multiple studies conducted on a range of perfluorinated substances have found no evidence of potential for biodegradation, hydrolysis or aqueous photolysis under environmental conditions (NICNAS, 2015c; 2015f). Both the C₆ and C₈ homologues (PFHxA and PFOA) have been found to not be biodegradable in studies using methods similar to the relevant OECD Test Guidelines (NICNAS, 2015a; 2015f; OECD, 2008).

The estimated atmospheric lifetime for the acid in this group based on indirect photo-oxidation by hydroxyl radicals is 130 days (OECD, 2008).

Bioaccumulation

The biomagnification potential of PFHpA in marine and terrestrial mammals is uncertain.

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). Martin et al. (2003) found no evidence of bioaccumulation in tissues (including blood, liver and kidney) of rainbow trout (*Onchorhynchus mykiss*) as a result of dietary exposure to PFHpA.

Similar results were obtained when the same species of fish was exposed to a mixture of perfluorinated carboxylic acids (Martin J.W., et al., 2003).

However, a field study considering multiple species of fish detected PFHpA in six of the ten species tested (Fang, et al., 2014). The concentrations detected indicated low bioaccumulation potential in aquatic organisms, although it should be noted that muscle tissue is reported to contain some of the lowest perfluorinated chemical concentrations in fish (Ng and Hungerbühler, 2014). Nevertheless, this study found the bioaccumulation of PFHpA exceeded that of PFOA in these species. Conversely, PFHxA was only detected in two fish species (Fang, et al., 2014).

The key bioaccumulation concern identified for PFOA is its significant potential to biomagnify in marine and terrestrial mammals (Environment Canada, 2010; NICNAS, 2015f). A study of the biomagnification of perfluorinated acids in a Canadian Arctic marine food web showed that PFCAs with eight to fourteen carbon atoms were highly bioaccumulative in the marine mammalian food web. The same study concluded that PFHpA did not biomagnify in marine mammals, although this acid was measured at similar concentrations (on a protein-corrected basis) in biota across the web. There was no biomagnification of the perfluorinated acids (including PFHpA and PFOA) in the aquatic organisms of the food web (Kelly, et al., 2009).

In other biomonitoring studies, PFHpA was detected in polar bears in East Greenland, and seals and dolphins in the Atlantic Ocean (Fair, et al., 2010; Greaves, et al., 2012; Shaw, et al., 2009). In the dolphin study, the maximum PFOA concentration detected (27.3 nanograms per gram (ng/g)) only slightly exceeded that of PFHpA (22.7 ng/g) (Fair, et al., 2010), even though other studies targeting the same region have indicated that the oceanic concentration of PFOA is approximately twice that of PFHpA (Benskin, et al., 2012). However, it is noted that PFHpA may be present in biota as a metabolite of other substances as well as a result of environmental exposure.

PFHpA is further reported to have a comparatively long bioelimination half life in mammals, with estimates of the half life in humans ranging from 70 days to 1.5 years (Russell, et al., 2015; Zhang, et al., 2013). By comparison, the mean serum elimination half life of PFOA has been reported to be up to 3.8 years, while the mean half life of PFHxA is reported to be 32 days (NICNAS, 2015d; 2015e).

Perfluoroheptanoic acid is intermediate in chain length between PFHxA, which is not currently considered to pose a bioaccumulation hazard, and PFOA, which biomagnifies in the top predators of marine and terrestrial food webs. Based on the bioaccumulation data outlined above, it is currently not possible to determine which of these two immediate homologues best represents the likely bioaccumulation potential of PFHpA. It is therefore concluded that PFHpA may have some potential to biomagnify, although the magnitude of this bioaccumulation hazard is currently uncertain.

Transport

PFHpA is a globally distributed pollutant.

Numerous studies have identified PFHpA in various locations worldwide. The chemical has been measured in remote locations such as Antarctica and in the European Alps (Cai, et al., 2012; Kirchgeorg, et al., 2013). The global distribution of perfluorinated carboxylic acids as environmental contaminants 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 acids, transport of anions in surface water or ocean currents, and/or transport of volatile precursors (e.g. fluorotelomer alcohols) (Ellis, et al., 2004; OECD, 2013a).

Predicted Environmental Concentration (PEC)

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

Nevertheless, the chemicals in this group may be present in the environment due to past industrial use of other perfluorochemicals contaminated with these substances, use in articles, or from the use of per- and poly-fluorinated chemicals which degrade to these substances in the environment. In Australia, PFHpA was recently detected in 100% of samples taken from the Parramatta River (main tributary of Sydney Harbour), with a mean concentration of 1.8 nanograms per litre (ng/L) (Thompson, et al., 2011). Sampling of the Brisbane River catchment following a major flooding event in 2011 also found PFHpA present in water at Jindalee, Oxley Creek, West End, Bulimba and Moreton Bay. The chemical was detected in all samples

obtained at these sites (except Moreton Bay) in concentrations ranging between 0.06 and 3.7 ng/L (Gallen, et al., 2014). These surface water concentrations for PFHpA are comparable to the concentrations of PFHxA and PFOA measured in the same studies (NICNAS, 2015a; 2015f).

Environmental Effects

Effects on Aquatic Life

The potential long-term toxicity of these chemicals in aquatic organisms is uncertain.

Acute toxicity

The following measured median effective concentration (EC50) and median lethal concentration (LC50) values for model organisms across two trophic levels for perfluoroheptanoic acid were reported by Boudreau (2002) or Latala et al. (2009). Both chemicals in this group are expected to dissociate into the perfluoroheptanoate anion in water and therefore these data are used to characterise the toxicity of the acid and its ammonium salt:

Taxon	Endpoint	Method
Invertebrates	48 h LC50 > 10 000 mg/L	Experimental <i>Daphnia magna</i> (Water flea)
Algae	72 h EC50 = 1896 mg/L	Experimental <i>Chlorella vulgaris</i> (Green algae) Modified ISO guideline Reduced growth observed

Chronic toxicity

The findings available for other perfluorinated acids indicate that the primary toxicity concern for these substances is chronic, intergenerational toxicity. Fish toxicity data available for PFOA show potential for increased mortality in offspring when the parent and F₁ generation are exposed to concentrations as low as 0.1 mg/L (NICNAS, 2015f). However, other studies also indicate that the toxicity of perfluoroalkyl carboxylic acids decreases with chain length (eg. Barmentlo, et al., 2015). The currently available long-term exposure studies suggest that short-chain homologues of PFHpA do not have high chronic toxicity (NICNAS, 2015a).

No studies on the long-term aquatic toxicity of PFHpA were identified for this assessment. Although toxicity is expected to decrease with perfluorinated chain length, there are insufficient data available to reliably interpolate the chronic toxicity of PFHpA from the chronic effects of short and long-chain perfluorocarboxylic acid homologues. Therefore, the chronic aquatic toxicity of this intermediate chain-length acid is currently uncertain.

Effects on Sediment-Dwelling Life

The chemicals in this group are not expected to have high toxicity to sediment-dwelling life.

No data were available for any of the chemicals in this group. However, the low sediment toxicity of the C₈ homologue, PFOA (NICNAS, 2015f), suggests the chemicals in this group will have low toxicity to sediment-dwelling life.

Effects on Terrestrial Life

The potential long-term toxicity of these chemicals in terrestrial organisms is uncertain.

The majority of toxicity testing of the chemicals in this group in regards to effects in terrestrial organisms has been conducted to evaluate toxicity in humans. However, insufficient data are available for critical endpoints to determine the toxicity of this chemical. Further information can be found in the IMAP Tier II Human Health Assessment for Perfluoroheptanoic Acid and its Direct Precursors (NICNAS, 2015g).

Predicted No-Effect Concentration (PNEC)

Use of the chemicals in this group will result in the environmental release of PFHpA, which is persistent and potentially bioaccumulative. 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 heptanoic acid, tridecafluoro- (PFHpA); and heptanoic acid, tridecafluoro-, ammonium salt (ammonium PFHpA) according to domestic environmental hazard thresholds is presented below (EPHC, 2009; NICNAS, 2013b):

Persistence

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

Bioaccumulation

Uncertain (Uncertain B). There is currently insufficient information to conclude whether the bioaccumulation potential of PFHpA is comparable to highly bioaccumulative long-chain homologues or to less bioaccumulative short-chain perfluorocarboxylic acids. The bioaccumulation potential of these chemicals is therefore categorised as Uncertain.

Toxicity

Uncertain (Uncertain T). The primary toxicity concern for the chemicals in this group is chronic toxicity. There is currently insufficient information to conclude whether the long-term aquatic toxicity of PFHpA is comparable to toxic long-chain homologues or to less toxic short-chain perfluorocarboxylic acids. The toxicity of these chemicals is therefore categorised as Uncertain.

Summary

Heptanoic acid, tridecafluoro- and heptanoic acid, tridecafluoro-, ammonium salt are categorised as:

- P
- Uncertain B
- Uncertain T

Risk Characterisation

Risk quotients (RQs) have not been calculated for these chemicals.

The chemicals in this group have been identified as persistent and potentially bioaccumulative. Chemicals which are persistent and bioaccumulative remain in the environment and accumulate in biota over an extended period of time, even if new emissions of the chemicals cease. These characteristics can result in very high internal concentrations in exposed organisms, which may cause long-term toxic effects that are not readily identified through standard testing protocols. Chemicals with these hazard characteristics are therefore considered to be of concern for the environment.

Key Findings

The chemicals in this group are not expected to have significant current industrial use in Australia. However, if released to the environment, the chemicals in this group are expected to release PFHpA. This chemical has become a globally distributed pollutant, and available data indicate some potential for biomagnification in marine and terrestrial mammals. The persistence and possible biomagnification of this chemical increases the potential for chronic toxicity. However, no chronic toxicity data are available for PFHpA. Nevertheless, it is noted that the C₈ homologue, PFOA, can cause chronic intergenerational toxicity in fish.

The chemicals in this group have been categorised as persistent (P) according to domestic environmental hazard criteria. The bioaccumulation potential and toxicity of the chemicals in this group are categorised as Uncertain.

In the absence of data which demonstrate a lower toxicity profile for PFHpA compared to PFOA, the chemicals in this group should be assumed to be of equivalent concern to PFOA in accordance with the action plan.

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 the requirement for 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.

The Action Plan

Insufficient data are available to demonstrate a lower toxicity profile for PFHpA compared to PFOA. It is therefore recommended that the action plan currently contained in Appendix G of the Handbook for Notifiers should continue to be applied to the assessment of chemicals which degrade to perfluoroheptanoic acid (NICNAS, 2015b).

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 heptanoic acid, tridecafluoro- and heptanoic acid, tridecafluoro-, ammonium salt 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 4 (H413)	May cause long lasting harmful effects to aquatic life

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. No chronic ecotoxicity data are available. The chemicals in this group were classified as Chronic Category 4 ("safety net" classification), as the available evidence indicates they are highly persistent and there are significant concerns that they may be bioaccumulative in aquatic ecosystems (UNECE, 2007).

Should additional data become available to suggest an alternate hazard classification is warranted for any of the chemicals in this group, these classifications may be revised as appropriate.

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