



Australian Government  

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Department of Health and Ageing  
NICNAS

Current status of PERFLUOROOCTANE SULFONATE (PFOS) AND  
PERFLUOROALKYL SULFONATE (PFAS) in Australia

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# 1 Introduction

## 1.1 Background

Perfluorinated substances are characterised by a fully fluorinated carbon chain with all hydrogens in the chain being replaced by fluorine atoms. The bond between carbon and fluorine is very strong making these substances persistent in the environment.

Perfluoroalkyl sulfonate (PFAS) is a generic term used to describe any fully fluorinated carbon chain length sulfonate, and includes higher and lower homologues. PFAS-related substances may be simple salts or large polymers that contain the PFAS as only a portion of the entire polymer (OECD, 2006, 2007).

Perfluorooctane sulfonate (PFOS) is a fully fluorinated eight carbon length organic sulfonate. PFOS based substances can be simple salts of PFOS, e.g. potassium, lithium, ammonium, diethanolamine or more complex polymer compounds that contain PFOS as a portion of a polymer molecule. The majority of PFOS-related substances are high molecular weight polymers in which PFOS represents a fraction of the total polymer weight (EC, 2006; OPSAR, 2005). PFOS belongs to the PFAS group of chemicals.

Used since the 1950s, PFOS and PFAS have unique surfactant properties and many speciality applications in consumer and industrial areas. These applications include heat, chemical and abrasion resistance, and as dispersion and wetting agents and for surface treatment.

### 1.1.1 Health and environmental impacts of PFAS

PFAS substances are of interest because some members of this group, such as PFOS are hazardous to human health and the environment. There is evidence that PFOS causes chronic and reproductive toxicity in humans and aquatic organisms (OECD, 2002) and structure activity relationship analysis indicate that these results are applicable to other PFAS as well. PFOS is also persistent, bio-accumulates and does not biodegrade easily in the environment (Brooke, 2004). Australia, in line with other countries and international bodies, considers that the use of certain PFAS should be phased out. This call for information on the import and use of PFAS and PFOS is a step in this direction.

### 1.1.2 Previous projects and activities

Data had been collected over the last few years on the manufacture and import of PFAS group of substances including PFOS. Summaries of this data are available to the public through the NICNAS website as Alerts ([http://www.nicnas.gov.au/Publications/NICNAS\\_Alerts.asp](http://www.nicnas.gov.au/Publications/NICNAS_Alerts.asp)).

Data from the 2002 survey (NICNAS Alert No.1) showed that PFOS, its salts and its precursors were not manufactured in Australia although products containing PFOS were made and used in Australia. PFOS was a component of the Scotchgard™ range of products phased out by its manufacturer 3M (3M website).

This phase out of 3M products resulted in a rapid decrease in PFOS use in products and by 2003 there were very few remaining uses in Australia – in class B fire fighting foams and in some specialised applications such as processing rubber and production of paints and coatings. At the same time the only reported use of PFAS was in an adhesive that was used to bond timber in the building and construction industry. However PFAS (including PFOS) products were expected to be held as stocks.

A call for information by NICNAS in 2006 showed no import of PFOS in Australia in 2004 and 2005. However PFOS products were used such as leather treatment products. Large stocks of fire fighting foam (180,000 L) containing PFOS were also reported. Nearly 1700 kgs of PFAS was imported in 2005. Approximately half of this was used to formulate products such as industrial coatings, rubber mouldings and acid mist suppressants. A small amount of PFAS was also used for formulating floor sealers and in fire fighting foams.

Efforts to reduce the importation and use of PFOS, its salts and precursors had largely been through recommendations made by NICNAS via publication of *Alerts* and subsequent voluntary action by Industry. The *Alerts* recommended that these substances be restricted to only essential uses for which no suitable and less hazardous alternatives were available. Existing PFOS based fire fighting foams were recommended to be used only in emergencies and not for training purposes to limit environmental release.

Despite the voluntary phase-out of many PFOS based applications, imports for essential uses continued and the potential exists for PFOS and PFOS-containing products to be imported into Australia.

### **1.1.3 Objectives of project**

The objective of this project was to collect import and use data on PFOS and PFAS and related substances for the years 2006 and 2007. This included quantities imported or manufactured in Australia and uses of these products/mixtures. Data were also collected on essential uses of these substances and efforts towards finding safer alternatives. A secondary aim of this project was to compare the current findings with the results of the previous survey to observe patterns of change in import and use of perfluorinated substances in Australia. The information collected will assist NICNAS in developing a national risk management strategy and appropriate regulatory activity.

## **1.2 Data collection strategy**

### **1.2.1 Call for information**

Call for data on PFOS and PFAS substances was published in the *Chemical Gazette* of April 2008 in the form of a questionnaire. Information was sought under Section 48 of the *Industrial Chemicals (Notification and Assessment) Act 1989* on the following substances:

- Perfluorooctane sulfonate (PFOS) CAS No. 1763-23-1
- PFOS related and/or PFOS based substances
- Other chemicals in the perfluoroalkyl sulfonate (PFAS) group
- PFAS related substances

The information sought was:

- Chemical name and CAS number;
- Quantities imported and/or manufactured in Australia in the calendar years 2006 and 2007;
- Amount of chemical held in stock;
- Uses of the chemical; and
- Substitutes or alternative compounds used.

The information required on products/mixtures containing the above chemicals included:

- Product/mixture name;
- Chemical name and CAS number of the contained chemical;
- Concentration of chemical in the product/mixture;

- Quantities of the product/mixture imported and/or manufactured in Australia in the calendar years 2006 and 2007;
- Amount of product/mixture held in stock;
- Uses of the product/mixture containing the chemical; and
- Product/mixture containing alternatives to PFAS compounds.

The notice was directed to all persons who had manufactured or imported one or more of the chemicals or products in the calendar years 2006 and 2007. Importers and manufacturers were required to provide the information. Users of these substances were strongly encouraged to provide information on uses and availability of substitutes or alternatives of these substances.

### **1.2.2 Industry database**

In addition to the publication in the *Chemical Gazette*, a database of relevant companies and organisations known or expected to deal in these substances was compiled. Considerable assistance was received from the relevant industry associations in compiling this database and in the dissemination of the survey questionnaire to importers and users of these chemicals.

Other information sources used in compiling this database included previous survey lists, company data held by NICNAS and the ANZ Directory of Chemical Manufacturers. The focus was on industries involved in surface coatings, electrical, electronic, textile processing, textile auxiliaries, paper and pulp manufacturing, mining, metal extraction, metal plating & finishing, surfactant users, leather tanning, carpet manufacturing, aviation, photographic paper and film processing. The database included a wide range of companies from the small importer/user to the major hazard facilities.

Questionnaires were sent out in April and May 2008 to the companies on this database and to selected associations to forward to their members.

## 2 Data summary and quality

### 2.1 Response

Two hundred and seven questionnaires were sent to relevant companies and organisations following the publication of the notice in the *Chemical Gazette*. Approximately 65% of the organisations contacted responded to the call for information.

The majority of the respondents indicated that they were not importers or users of PFOS/PFAS related substances. Responses providing information on PFOS and PFAS import or use were received from 27 organisations, which included general industry, major hazard facilities and fire fighting organisations.

Most of the respondents were able to provide all the data requested in the questionnaire. However some provided only partial information due to substance identity and/or concentration of some components being confidential business information (CBI).

In some responses, importation could not be easily distinguished from local sourcing and in such cases, data reflected supply of PFAS or PFOS substances, rather than importation. Therefore, the total volumes reported could exceed the actual amount imported if the product was reported for both importation and resale. This was however, not a frequent occurrence.

Where information was not provided on the percentage of PFOS salt in the product / mixture, it was gathered from published literature, MSDS or the overseas manufacturer. If however, this information was not available from any source, then the conservative percentages for PFAS of ~5% for fire fighting foams and 100% for all others were used.

Table 1. *Response summary*

Mail out list name	Number contacted	Responses	Respondents with information on PFOS / PFAS
General Industry	147	64%	9 %
Major Hazard Facilities	52	63%	6 %
Fire Fighting Organisations	8	88%	63%
<i>Sub-totals</i>	<i>207</i>	<i>65%</i>	<i>10.0%</i>
Responded to Gazette Notice	13	n/a	46.0%
Total	220	n/a	12.0%

### 2.2 Quantity and range of applications

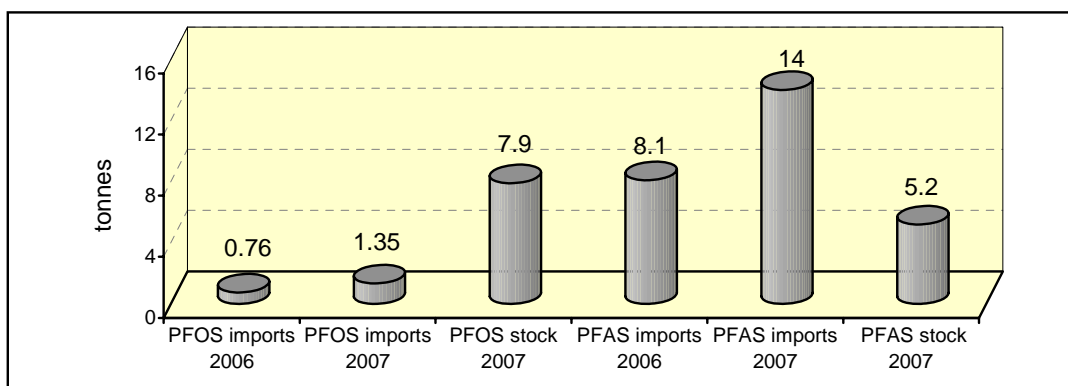
Information provided by respondents showed that overall, the largest quantities of PFOS imports were occurring for the metal plating industry, followed by small quantities of imports for aviation, photography and photolithography (Table 2). Although no PFAS was imported by the fire fighting industry, it continued to hold large stocks of fire fighting foam containing PFOS.

Large imports of PFAS were occurring for the metal plating industry followed by industrial coatings and surface treatments. Small quantities of PFAS were imported for use in printing, curatives and fire fighting foams.

Table 2. *Imports of PFOS and PFAS by application*

Application	PFOS (kg)			PFAS (kg)		
	2006	2007	Stock 2007	2006	2007	Stock 2007
Aviation	10.00	15.00	nil	--	--	--
Photolithography	0.00	1.50	nil	--	--	--
Photography	2.75	2.3	nil	--	--	--
Metal plating	747.50	1335.00	225.00	6947.24	13534.61	2036.26
Fire Fighting	--	--	7724.00	--	80.00	3135.00
Surface treatments	--	--	--	417.67	--	--
Curatives	--	--	--	2.99	4.48	--
Printing	--	--	--	5.82	6.12	0.33
Industrial coatings	--	--	--	733.4	380	--
Total	760	1354	7949	8107	14005	5172

Figure 1. *Import and current stocks of PFOS and PFAS*



## 2.3 Identifying essential uses in Australia

### 2.3.1 Background

PFOS chemicals are persistent, bioaccumulative and toxic to human health and the environment. For this reason, many uses of PFOS have been phased out or replaced by shorter carbon chain fluorinated sulfonates, alternatives such as fluorinated telomers or in some cases non-fluorinated substances. However for some applications of PFOS, less toxic suitable replacements are either not available or not possible due to reasons such as economic viability for the industry. These have been termed *essential uses*.

### 2.3.2 Australian data

Five industries imported and/or used PFOS and related products and mixtures (Table 3). The respondents considered use of PFOS in four out of the five industrial applications as essential uses. Use of fire-fighting foam containing PFOS was not considered essential, however it was reported that the stocks of fire fighting foam would be used till all stocks were depleted or a safer way of disposing these foams was available. PFAS and related compounds were used in

industries such as metal plating and industrial coatings. None of the uses of PFAS had been considered as an essential use.

*Table 3. Range of current uses of PFOS and PFAS*

No.	Use	PFOS	Essential use	PFAS
1	Aviation	√	√	
2	Photolithography	√	√	
3	Photography	√	√	
4	Metal plating	√	√	√
5	Fire fighting	√		√
6	Surface treatments (carpet, etc.)			√
7	Curative			√
8	Printing			√
9	Industrial coatings			√

### 3 Industry and applications

#### 3.1 Aviation

##### 3.1.1 Overview

PFOS based substances are used as anti-erosion additives in fire-resistant aviation hydraulic fluids to protect metal parts (KEMI, 2004). Use of PFOS containing fire resistant performance additives in aviation hydraulic fluids is currently identified as an essential use as replacements providing similar quality of performance are not available on the market. According to published studies, changing hydraulic fluid formulations requires extensive testing and approval and may take ten years from concept to commercial manufacture (RPA, 2004). The total global market for PFOS substances in aircraft hydraulic fluids is believed to be around 2.3 tonnes per annum (OPSAR, 2006). Use of PFOS related substances in aviation hydraulic systems gives rise to emissions and any national strategy would need to consider the feasibility of phasing out this use (KEMI, 2004).

##### 3.1.2 Australian data

Import of PFOS products occurred in 2006 and 2007 and was expected to continue in the future. Use of PFOS in aviation hydraulic fluids was indicated as an essential use. Importers indicated that in addition to PFOS products, other PFAS products would also be imported in the future for aviation hydraulic fluids.

In the 2006 survey PFOS import/use in aviation hydraulic fluids was not reported.

Table 4. *Aviation hydraulic fluid import and stock (PFOS)*

Aviation hydraulic fluid	Volume of product/mixture (10 <sup>3</sup> L)			% PFOS	Amount of PFOS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	<40.00	<50.00	0.00		0.025	<10.00	<15.00

#### 3.2 Photolithography

##### 3.2.1 Overview

PFOS based substances are widely used in photolithography due to their ability to withstand strong acidic conditions. Inclusion of PFOS and related substances in the manufacture of semiconductors and printed plates for electronic devices such as digital cameras, cell phones and music systems is not a major quantitative use but has been considered as an essential use as a substitute is currently not available. It is anticipated that commercial alternatives may be available in the near future. Emissions from the processes are considered to be low as overseas data indicated that most of the use occurs within enclosed systems (OPSAR, 2005; RPA, 2004).

##### 3.2.2 Australian data

Approximately 1.5L of PFOS was imported in 2007 for photolithography use. No imports were reported for 2006 and stocks were not held. Information about the percentage of PFOS was not available, therefore conservatively it was assumed at 100%.

In the 2006 survey, imports of PFOS for photolithographic purposes were not reported.

Table 5. *Photolithography aids import and stock (PFOS)*

Photolithography aids	Product volume (L)			% PFOS	Amount of PFOS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	0	1.50	0	100%*	0	1.50	0

\* Default conservative value

### 3.3 Photography

#### 3.3.1 Overview

The surface-active properties of PFOS substances allow very small quantities of PFOS materials to be used in the coatings on photographic paper. This is a very useful property as use of larger quantities of material in coatings can diminish the quality of images (Kemi & EPA, 2004). The use of PFOS based substances in this industry is expected to decline in the future with the increasing use of digital technology. However published reports show that the use of these products may not cease until suitable replacements have been found as they have applications in many essential areas such as defence and healthcare (Danish EPA, 2005).

#### 3.3.2 Australian data

Less than 3 kg of PFOS was imported each year in 2006 and 2007 for photographic purposes. No PFOS stocks were held for this use. Data provided showed that PFOS based substances were useful in the storage and transport of films and photographic paper and functioned as surfactants, antistatic agents, friction control agents and dirt repellents.

In the 2006 survey, import or use of PFOS/PFAS for photography was not reported for the years 2004 and 2005. There were no PFOS stocks held for this use.

Table 6. *Photography surfactants import and stock (PFOS)*

Photography surfactants	Amount of product (kg)			% PFOS	Amount of PFOS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	4.1	3.4	0.00	67	2.75	2.27	0.00
0.7	0.6	0.00	5	0.035	0.035	0.00	
Total	4.8	4.0	0.00		2.79	2.31	0.00

### 3.4 Metal Plating

#### 3.4.1 Overview

PFOS related substances are used in chromium plating, anodising and acid pickling. Currently this is a critical use and there are no replacements. Due to the high level of toxicity of hexavalent chromium and its use in chrome plating an effective fume suppressant is required. PFOS related substances and selected PFAS related substances are used as mist suppressants

in both hard and decorative chromium plating. The hazards of use of PFOS reside in the release of PFOS emissions from the systems and also disposal of spent PFOS substances. Hexavalent chromium is a known carcinogen and future research and technology are focussing on the possibility of using trivalent chromium (Cr3) in place of hexavalent chromium (Cr6). This may reduce the need for PFOS substances for acid mist suppression. However substitution of Cr6 with Cr3 is currently not considered a suitable option, as the latter is not considered useful for production of high quality hard chromium plating (RPA, 2004).

### 3.4.2 Australian data

Large quantities of PFAS and PFOS were imported for use in the metal plating industry. Also included were imports of technical grade PFOS, 135 kg and 560 kg in 2006 and 2007 respectively, to be formulated as required.

Data from the 2006 survey showed that in 2004 and 2005, approximately 1240 kg and 1060 kg respectively of PFAS in products /mixtures was imported for mist suppression in the metal plating industry. Import of PFOS for metal plating was not reported in 2006.

Table 7. *Mist suppressants import and stock (PFOS)*

Mist suppressants	Product/technical			% PFOS	Amount of PFOS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
Products / mixtures	1225 (L)	1550 (L)	150 (L)	~50	612	775	75
Technical grade	135 kg	560 kg	150 kg	100	135	560	150
Total					747	1335	225

Table 8. *Mist suppressants import and stock (PFAS)*

Mist suppressants	Product (L)			% PFAS	PFAS (kg)		
	2006	2007	Stock held		PFAS 2006	PFAS 2007	PFAS Stock held
	13108	25537	3842		53	6947	13535

## 3.5 Fire Fighting

### 3.5.1 Overview

Fires involving flammable liquids (Class B) can be difficult to extinguish with water as water can sink below the liquid and does not extinguish the fire. When water is combined with foam concentrate and air the resultant foam forms a low-density blanket over the fire to extinguish it (Kemi, 2004). Many new alternatives such as non-PFOS fluorosurfactants, silicone based surfactants, hydrocarbon based surfactants, and fluorine free foams are replacing the old foams for Class B fires. While the concentration of PFOS or PFAS substances is low in foam mixtures, the high volume of the product used in an emergency situation results in an increase in the total volume of PFOS/PFAS used. The various fire fighting foams designated for different fires are shown in Table 9 (OPSAR, 2005).

Table 9. *Fire fighting foams and uses (OPSAR, 2005)*

Foam type	Recommended use
FP (fluoroprotein foams)	used for hydrocarbon storage tank protection
AFFF (aqueous film forming foam)	used for aviation, marine fires and shallow spills
FFFP (film forming fluoroprotein foams)	used for aviation and shallow spills
AR-AFFF (alcohol resistant aqueous film forming foams)	used for all fires
AR-FFFP (alcohol resistant film forming fluoroprotein foam)	used for all fires

### 3.5.2 Australian data

PFOS in fire fighting foams was no longer imported but existed as old stocks. Data showed that in 2007 approximately 175,000L of fire fighting foams containing PFOS was in stock around the country.

In 2005, approximately 183,000L of fire fighting foam containing PFOS was held in stock around the country. The 2006 data did not report stocks of PFAS in fire fighting foams.

Table 10. *Fire fighting foams import and stock (PFOS)*

Fire fighting foams (PFOS)	Product volume (L)			% PFOS	Amount of PFOS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	0	0	175075		~5%	0	0

Table 11. *Fire fighting foams import and stock (PFAS)*

Fire fighting foams (PFAS)	Product volume (L)			% PFAS	PFAS amount (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	0	1600	59095		~5%	0	80

## 3.6 Surface treatments (carpet, leather, floor etc.)

### 3.6.1 Overview

Fluorinated products have been used extensively in the past to form coatings on floorings, carpets, textiles and leather that repel water and oil. This quality makes them very useful as dirt repellents and spot cleaners. The original PFOS based products have been phased out and are being substituted with fluorinated substances with shorter chains than C8 (Poulson et al., 2005, in Danish EPA, 2008). Other data suggest that suspension of production by 3M has led to a cessation in the use of PFOS in these applications (OPSAR, 2006, Kemi, 2004).

### 3.6.2 Australian data

The import of a carpet protector product containing PFOS or a PFAS related substance occurred in 2006. The product had been discontinued thereafter and no imports were reported in 2007. No stocks were reported in the most recent survey.

The 2006 data showed that mixtures containing 47 kg and 13 kg of PFOS were imported and formulated into products in 2004 and 2005, respectively, for treatment of leather products for

water resistance. This usage was discontinued. Approximately 1.1 kg in 2004 and 0.9 kg in 2005 of PFAS was reported as used in floor treatment products.

*Table 12. Carpet treatment products import and stock (PFAS)*

Carpet treatment	Product volume (L)			% PFAS	Amount of PFAS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	4585	0	0		2-11	417.67	0

### 3.7 Curatives

#### 3.7.1 Overview

Curatives as part of fluoroelastomer products are fabricated or moulded into products such as seals, gaskets, hoses, tubing and valve liners to provide improved compression and good metal adhesion. These can be used in the automotive industry, food processing, aerospace, chemical processing, oil and gas exploration, and industrial pollution control industries in applications requiring resistance to aggressive chemicals or heat (3M website).

#### 3.7.2 Australian data

No PFOS was reported to be imported for this use. Approximately 3kg and 5kg of PFAS were imported in 2006 and 2007 respectively, for use as curatives in fluoroelastomer and moulding products. No stocks were held.

Data from the 2006 survey showed that 5.9 kg and 4.1 kg of PFAS in products and mixtures was imported for use in rubber moulding in 2004 and 2005. Small amounts of imports of PFAS had occurred consistently over the last 4 years for curative applications.

*Table 13. Curatives import and stock (PFAS)*

Curatives	Product volume (L)			% PFAS	PFAS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	299.00	448.00	0		1%	2.99	4.48

### 3.8 Printing

#### 3.8.1 Overview

PFAS chemicals are used widely in small quantities in the printing industry to improve durability, reliability and colour retention. Thinners are used for thinning selected screen printing inks, printing clears and also for normal maintenance of inkjet printers. Toners are formulated to create durable multi-colour graphics and improve colour hue and saturation (3M website).

#### 3.8.2 Australian Data

Only small amounts of PFAS were used in printing inks for industrial application such as road signage, reflective sheeting, industrial printing and graphic coating applications.

Approximately 6kg of PFAS was imported each year in 2006 and 2007 for use in printing applications.

In 2006 import of PFAS for printing was not reported.

*Table 14. Printing inks import and stock (PFAS)*

Printing inks	Product volume (kg)			% PFAS	PFAS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	1496.00	1607.00	88.00		~0.55%	5.82	6.12

### 3.9 Industrial coatings

#### 3.9.1 Overview

PFAS products have been used as additives in non-emissive permanent industrial coatings. These PFAS products are used to impart soil, oil and water repellence to the surface and protect the surface from corrosion in electronic components such as computers and telecommunication equipment. These products can also be used as surface tension reducing agents (surfactants) in some consumer products.

#### 3.9.2 Australian data

Approximately 730kg and 380kg of PFAS in products and mixtures had been imported in 2006 and 2007. Stocks were not maintained as they were ordered as required.

In 2006, import of 375kg and 672kg of PFAS in 2004 and 2005 respectively were reported.

*Table 15. Industrial coatings import and stock (PFAS)*

Industrial Coatings	Product volume (kg)			% PFAS	PFAS (kg)		
	2006	2007	Stock held		2006	2007	Stock held
	768.00	398.00	0		~95.5%	733.40	380.00

## 4 Discussion and conclusions

The purpose of this project was to collect data on the import, manufacture or use of PFAS and PFOS in Australia. Data collected indicate that there was no manufacture of PFAS and PFOS in Australia. These substances were imported in formulations or imported as chemicals and for formulation into products in Australia.

Overall there was an increase in PFAS and PFOS imports in Australia compared to previous surveys. In 2007, over 14 tonnes of PFAS were imported into Australia with PFOS accounting for 1.3 tonnes (8.9%), whereas in 2006 approximately 8 tonnes of PFAS were imported into Australia with PFOS accounting for 0.76 tonnes (8.6%).

This was accompanied by substantial changes in the type of imports and use patterns compared to the previous years. There were significantly increased imports of PFAS and PFOS chemicals in the metal plating industry and of PFOS in the aviation industry. On the other hand, no imports of PFAS chemicals for surface treatments in 2007 occurred compared to half a tonne of imports in 2006. Imports for the other sectors of industry showed less significant variations.

Stocks of fire fighting foam containing PFOS continued to exist although there were no imports and existing stocks were reduced by a quarter since the last survey.

The survey data indicated that imports of PFAS including PFOS increased for industrial applications and declined or ceased for consumer applications and for fire fighting foams. In the latter case, respondents reported a move towards telomers and shorter chain length fluorinated sulphonates (mainly C<sub>4</sub> and C<sub>6</sub> chain lengths) or perfluorobutane sulphonates (PFBS).

Import of PFOS for applications such as aviation and metal plating and to a small extent for photography and photolithography are likely to continue as there are no viable replacements yet.

These findings are consistent with other international reports. The OECD survey in 2004 on the production and use of PFAS, PFOS, PFOA and related substances indicated that products containing PFOS were being manufactured and imported by many countries for use in the fire-fighting, metal plating, photographic, semiconductor and aviation industries.

As with all surveys, sources of uncertainties should be considered along with the findings. Potential underreporting could arise from importers or users not recognising PFAS/PFOS or related chemicals if these have not been disclosed by the manufacturer or on MSDS. On the other hand, possible overestimates could occur if a quantity of import was reported by the importer as well as reseller or user. These uncertainties however do not detract from the valuable findings of the survey.

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