Additional information relating to the draft risk management evaluation on long-chain perfluorocarboxylic acids, their salts and related compounds

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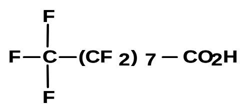
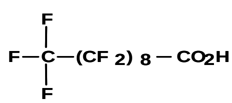
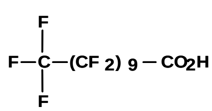
1. Introduction

1.1 Chemical Identity

1. The chemical identity of long-chain perfluorocarboxylic acids (PFCAs; C_9 to C_{21}), and the available experimental and calculated physical and chemical data for this group are given in Tables 1 and 2 below.

Table 1. Chemical identity of long-chain PFCAs

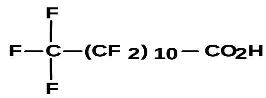
C_9 PFCA	
CAS number:	375-95-1
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluorononanoic acid
Chemical Abstracts Index name:	Nonanoic acid, heptadecafluoro-
Molecular formula:	$C_9HF_{17}O_2$
Structural formula:	
Synonyms:	PFNA; C 1800; Heptadecafluorononanoic acid; Perfluorononanoic acid; Perfluoropelargonic acid
C_{10} PFCA	
CAS number:	335-76-2
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluorodecanoic acid
Chemical Abstracts Index name:	Decanoic acid, nonadecafluoro-
Molecular formula:	$C_{10}HF_{19}O_2$
Structural formula:	
Synonyms:	PFDA; Nonadecafluoro-n-decanoic acid; Nonadecafluorodecanoic acid; Perfluoro-n-decanoic acid; Perfluorocapric acid; Perfluorodecanoic acid
C_{11} PFCA	
CAS number:	2058-94-8
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-henicosafluoroundecanoic acid
Chemical Abstracts Index name:	Undecanoic acid, heneicosafluoro-
Molecular formula:	$C_{11}HF_{21}O_2$
Structural formula:	
Synonyms:	PFUnDA; Heneicosafluoroundecanoic acid; Perfluoroundecanoic acid; Perfluoroundecylic acid; PFUnA
C_{12} PFCA	
CAS number:	307-55-1

IUPAC name: 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-tricosafluorododecanoic acid

Chemical Abstracts Index name: Dodecanoic acid, tricosafluoro-

Molecular formula: $C_{12}HF_{23}O_2$

Structural formula:



Synonyms: PFDoDA; Perfluorododecanoic acid; Perfluorolauric acid; PFDoA

C_{13} PFCA

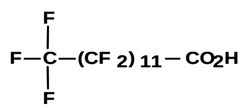
CAS number: 72629-94-8

IUPAC name: 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,13-pentacosafluorotridecanoic acid

Chemical Abstracts Index name: Tridecanoic acid, pentacosafluoro-

Molecular formula: $C_{13}HF_{25}O_2$

Structural formula:



Synonyms: PFTrDA; Perfluorotridecanoic acid; PFTrA

C_{14} PFCA

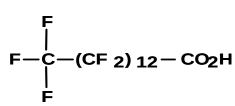
CAS number: 376-06-7

IUPAC name: 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-heptacosafluorotetradecanoic acid

Chemical Abstracts Index name: Tetradecanoic acid, heptacosafluoro-

Molecular formula: $C_{14}HF_{27}O_2$

Structural formula:



Synonyms: PFTDA; Perfluoromyristic acid; Perfluorotetradecanoic acid; PFTeA

C_{15} PFCA

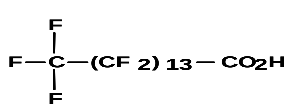
CAS number: 141074-63-7

IUPAC name: 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,15-nonacosafluoropentadecanoic acid

Chemical Abstracts Index name: Pentadecanoic acid, nonacosafluoro-

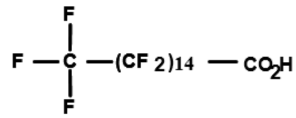
Molecular formula: $C_{15}HF_{29}O_2$

Structural formula:

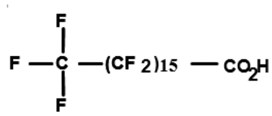


Synonyms: PFPeDA; Perfluoropentadecanoic acid

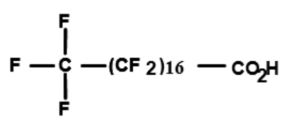
C_{16} PFCA

CAS number:	67905-19-5
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,16-hentriacontafluorohexadecanoic acid
Chemical Abstracts Index name:	Hexadecanoic acid, hentriacontafluoro-
Molecular formula:	$C_{16}HF_{31}O_2$
Structural formula:	
Synonyms:	PFHxDA; Perfluoropalmitic acid; Perfluorohexadecanoic acid; Hexadecanoic acid

C_{17} PFCA

CAS number:	57475-95-3
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,17,17,17-tritriacontafluoroheptadecanoic acid
Chemical Abstracts Index name:	Perfluoroheptadecanoic acid
Molecular formula:	$C_{17}HF_{33}O_2$
Structural formula:	
Synonyms:	PFHpDA

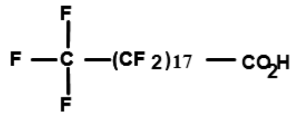
C_{18} PFCA

CAS number:	16517-11-6
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,17,17,18,18,18-pentatriacontafluorooctadecanoic acid
Chemical Abstracts Index name:	Octadecanoic acid, pentatriacontafluoro-
Molecular formula:	$C_{18}HF_{35}O_2$
Structural formula:	
Synonyms:	PFODA; Perfluorostearic acid; Perfluorooctadecanoic acid; Octadecanoic acid

C_{19} PFCA

CAS number:	133921-38-7
IUPAC name:	2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,17,17,18,18,19,19,19-heptatriacontafluorononadecanoic acid
Chemical Abstracts Index name:	Perfluorononadecanoic acid
Molecular formula:	$C_{19}HF_{37}O_2$

Structural formula:



Synonyms: PFNDA

C_{20} PFCA

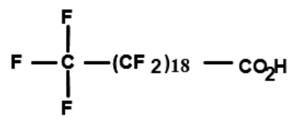
CAS number: 68310-12-3

IUPAC name: 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,17,17,18,18,19,19,20,20,20-nonatriacontafluoroicosanoic acid

Chemical Abstracts Index name: Perfluoroeicosanoic acid

Molecular formula: $C_{20}HF_{39}O_2$

Structural formula:



Synonyms: Eicosanoic acid, nonatriacontafluoro- (9CI); Nonatriacontafluoroeicosanoic acid

C_{21} PFCA

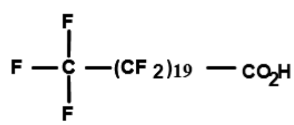
CAS number: –

IUPAC name: –

Chemical Abstracts Index name: Heneicosanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,17,17,18,18,19,19,20,20,21,21,21-hentetracontafluoro-

Molecular formula: $C_{21}HF_{41}O_2$

Structural formula:



Synonyms: Perfluoroheneicosanoic acid

Table 2: Overview of available physicochemical properties of long-chain PFCAs

Property	*Value*	*Type*	*Reference*
C_9 PFCA			
Molecular mass (g/mol)	464.08	–	–
Melting point (°C)	77	Experimental	Fontell and Lindman 1983
	71	Experimental	Blancou et al. 1976
	71–72	Experimental	Herbst et al. 1985
	65	Experimental	Beneficemalouet et al. 1991
	59.3–61.1	Experimental	Kunieda and Shinoda 1976
	69–71	Experimental	Ishikawa et al. 1983
Boiling point (°C)	203.4	Calculated	Kaiser et al. 2005
Vapour pressure (Pa) at 25°C	0.10 (log p_L*)	Experimental	Arp et al. 2006
	1.1–99.97 kPa	Calculated	Kaiser et al. 2005

Property	*Value*	*Type*	*Reference*
	(at 99.6–203°C)		
Water solubility	< 0.2 percent weight at 60°C	Experimental	Fontell and Lindman 1983[1]
	1.3 g/L (critical micelle concentration)	Experimental	Kunieda and Shinoda 1976[1]
pK_a (dimensionless)	< 0.8	Calculated	Goss 2008
Log K_{ow}	5.9	Estimated	Wang et al. 2011
log K_{oc} (dimensionless)	2.3–2.48	Experimental	Higgins and Luthy 2006
C_{10} PFCA			
Molecular mass (g/mol)	514.08	–	–
Melting point (°C)	87.4–88.2	Experimental	Bernett and Zisman 1959
	87.4–88.2	Experimental	Bernett and Zisman 1959
	83.5–85.5	Experimental	Mukerjee and Handa 1981
	76.5	Experimental	Ikawa et al. 1988
	87.4-88.2	Experimental	Hare et al. 1954
Boiling point (°C)	218	Experimental	Kauck and Diesslin 1951
	219.4	Calculated	Kaiser et al. 2005
	203.4	Calculated	Kaiser et al. 2005
	218	Experimental	Sigma Aldrich 2004
Vapour pressure (Pa) at 25°C	-0.64 (log p_L*)	Experimental	Arp et al. 2006
	3.1–99.97 kPa (at 129.6–218.9°C)	Calculated	Kaiser et al. 2005
Water solubility (g/L)	5.14	Experimental	Kauck and Diesslin 1951
	0.40 (critical micelle concentration)	Experimental	Bernett and Zisman 1959[1]
	0.46 (critical micelle concentration at 30°C)	Experimental	Klevens and Raison 1954[1]
pKa (dimensionless)	2.58	Calculated	Moroi et al. 2001
Log K_{ow}	6.5	Estimated	Wang et al. 2011
log K_{oc} (dimesionless)	2.65–2.87	Experimental	Higgins and Luthy 2006
C_{11} PFCA			
Molecular mass (g/mol)	564.1	–	–
Melting point (°C)	112-114	Experimental	Huang et al. 1987
	97.9-100.3	Experimental	Kunieda and Shinoda 1976
Boiling point (°C)	238.4 at 101.325 kPa	Calculated	Kaiser et al. 2005
Vapour pressure (Pa) at 25°C	-0.98 (log p_L*)	Experimental	Arp et al. 2006
	0.6–99.97 kPa (at 112–237.7°C)	Calculated	Kaiser et al. 2005
Water solubility (g/L) at 25°C	1.2E-4; pH 1	Calculated	ECHA 2018b
	9.0E-4; pH 2	Calculated	ECHA 2018b
	8.5E-3; pH 3	Calculated	ECHA 2018b
	0.056; pH 4	Calculated	ECHA 2018b
	0.14; pH 5	Calculated	ECHA 2018b

Property	*Value*	*Type*	*Reference*
	0.16; pH 6-10	Calculated	ECHA 2018b
pKa (dimensionless)	0.52 ± 0.10	Calculated	ECHA 2018b
Log K_{ow}	7.2	Estimated	Wang et al. 2011
log K_{oc} (dimesionless)	3.19–3.41	Experimental	Higgins and Luthy 2006
C_{12} PFCA			
Molecular mass (g/mol)	614.1	–	–
Melting point (°C)	112.6–114.7	Experimental	Bernett and Zisman 1959
	112.6-114.7	Experimental	Hare et al. 1954
	112-114	Experimental	Huang et al. 1987
Vapour pressure	0.9–99.96 kPa (at 127.6–247.7°C)	Calculated	Kaiser et al. 2005
Water solubility (g/L) at 25°C	4.81E-6 mg/	Estimated	ECHA 2018b
	2.9E-5; pH 1	Calculated	ECHA 2018b
	2.2E-4; pH 2	Calculated	ECHA 2018b
	2.0E-3; pH 3	Calculated	ECHA 2018b
	0.014; pH 4	Calculated	ECHA 2018b
	0.034; pH 5	Calculated	ECHA 2018b
	0.039; pH 6	Calculated	ECHA 2018b
	0.040; pH 7	Calculated	ECHA 2018b
	0.041; pH 8-10	Calculated	ECHA 2018b
		Calculated	ECHA 2018b
pKa (dimensionless)	0.52 ± 0.10	Calculated	ECHA 2018b
Log K_{ow}	7.8	Estimated	Wang et al. 2011
C_{13} PFCA			
Molecular mass (g/mol)	664.0989	–	–
Melting point (°C)	117.5–122	Experimental	Kunieda and Shinoda 1976
Boiling point (°C)	260.7±35.0 °C (at 101.32 kPa)	Calculated	ECHA 2018b
Vapour pressure (Pa) at 25°C	0.479	Calculated	ECHA 2018b
Water solubility (g/L) at 25°C	7.3E-6; pH 1	Calculated	ECHA 2018b
	5.5E-5; pH 2	Calculated	ECHA 2018b
	5.1E-4; pH 3	Calculated	ECHA 2018b
	3.5E-3; pH 4	Calculated	ECHA 2018b
	8.6E-3; pH 5	Calculated	ECHA 2018b
	0.0100; pH 6-10	Calculated	ECHA 2018b
		Calculated	ECHA 2018b
pKa (dimensionless)	0.52 ± 0.10	Calculated	ECHA 2018b
Log K_{ow}	8.25	Estimated	Wang et al. 2011
C_{14} PFCA			
Molecular mass (g/mol)	714.12	–	–
Melting point (°C)	130.4	Experimental	Lehmler et al. 2001
	130	Experimental	Kunieda and Shinoda 1976
Vapour pressure (Pa) at 25°C	0.183	Calculated	ECHA 2018b

Property	*Value*	*Type*	*Reference*
Water solubility (g/L) at 25°C	1.9E-6; pH 1 1.4E-5; pH 2 1.3E-4; pH 3 9.3E-4; pH 4 2.2E-3; pH 5 2.6E-3; pH 6-10	Calculated Calculated Calculated Calculated Calculated Calculated Calculated	ECHA 2018b ECHA 2018b ECHA 2018b ECHA 2018b ECHA 2018b ECHA 2018b ECHA 2018b
pKa (dimensionless)	0.52 ± 0.10	Estimated	Wang et al. 2011
Log K_{ow}	8.9	Estimated	Wang et al. 2011
C_{15} PFCA			
Molecular mass (g/mol)	764.1	–	–
Boiling point (°C)	285.4166	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	1.89E-02	Estimated	COSMOtherm[2]
Water solubility at 25°C	2.05E-04	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	10.38993	Estimated	COSMOtherm[2]
C_{16} PFCA			
Molecular mass (g/mol)	814.133	–	–
Boiling point (°C)	299.3138	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	6.96E-03	Estimated	COSMOtherm[2]
Water solubility at 25°C	2.89E-05	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	11.0202	Estimated	COSMOtherm[2]
C_{17} PFCA			
Molecular mass (g/mol)	864.141	–	–
Boiling point (°C)	312.6848	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	1.78E-03	Estimated	COSMOtherm[2]
Water solubility at 25°C	4.59E-06	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	11.77832	Estimated	COSMOtherm[2]
C_{18} PFCA			
Molecular mass (g/mol)	914.149	–	–
Boiling point (°C)	322.4937	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	6.67E-04	Estimated	COSMOtherm[2]
Water solubility at 25°C	5.46E-07	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	12.4038	Estimated	COSMOtherm[2]
C_{19} PFCA			
Molecular mass (g/mol)	964.157	–	–
Boiling point (°C)	339.5117	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	1.56E-04	Estimated	COSMOtherm[2]
Water solubility at 25°C	5.19E-08	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	12.97115	Estimated	COSMOtherm[2]
C_{20} PFCA			
Molecular mass (g/mol)	1.01E+03	–	–
Boiling point (°C)	352.8301	Estimated	COSMOtherm[2]

Property	*Value*	*Type*	*Reference*
Vapour pressure (Pa) at 25°C	9.37E-05	Estimated	COSMOtherm[2]
Water solubility at 25°C	1.03E-08	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	13.6765	Estimated	COSMOtherm[2]
C_{21} PFCA			
Molecular mass (g/mol)	1.06E+03	–	–
Boiling point (°C)	361.3309	Estimated	COSMOtherm[2]
Vapour pressure (Pa) at 25°C	2.62E-05	Estimated	COSMOtherm[2]
Water solubility at 25°C	2.12E-09	Estimated	COSMOtherm[2]
Log $K_{ow\ (wet\ octanol)}$	14.07693	Estimated	COSMOtherm[2]

[1] Solubility values refer to an aqueous phase containing a mixture of protonated acid and perfluorocarboxylate anion, at an "autogenous" pH. If the pH is reduced by addition of, for example, a mineral acid, the proportion of protonated acid will increase, and the overall solubility will decrease.
[2] Personal communication, emails from Glüge to Environment and Climate Change Canada, dated 30 May 2022 and 14 June 2022; unreferenced.
Abbreviations: K_{oc}, organic carbon partition coefficient; K_{ow}, octanol water partition coefficient; pK_a, acid dissociation constant, p_L*: saturated subcooled liquid vapor pressure.

Potential overlap between the listing of PFOA, its salts and related compounds and potential listing of long-chain PFCAs, their salts and related compounds

2. An indicative list of Chemical Abstracts Service (CAS) numbers for long-chain PFCAs, their salts and related compounds is provided in UNEP/POPS/POPRC.19/INF/y. Some of the substances identified on this list have also been identified as compounds related to perfluorooctanoic acid (PFOA; C_8 PFCA) in the indicative list of substances covered by the listing of PFOA, its salts and PFOA-related compounds[1]. Examples of compounds that, based on their molecular formula, would fall under both the definition of PFOA-related compounds and the proposed definition of long-chain PFCA-related compounds are presented in Table 3.

Table 3. Examples of compounds that meet the definition of PFOA-related compounds and the proposed definition of long-chain PFCA-related compounds (EU Annex F information 2022)

Acronym	CAS number
Fluorotelomer acrylates and methacrylates (FTACs and FTMACs)	
14:2 FTMAC	4980-53-4
12:2 FTMAC	6014-75-1
10:2 FTMAC	2144-54-9
8:2 FTMAC	1996-88-9
Fluorotelomer saturated and non-saturated acids (FTCAs and FTUCAs)	
10:2 FTUCA	70887-94-4
9:2 FTCA	191852-87-6
8:2 FTUCA	70887-84-2
Fluorotelomer alcohols (FTOHs)	
14:2 FTOH	60699-51-6
13:2 FTOH	176676-70-3
12:2 FTOH	39239-77-5
11:2 FTOH	1545-59-1
10:2 FTOH	865-86-1
9:2 FTOH	87017-97-8
8:2 FTOH	678-39-7
Fluorotelomer iodides (FTIs)	
8:2 FTI	2043-53-0
10:2 FTI	2043-54-1

[1] UNEP/POPS/POPRC.17/INF/14/Rev.1

12:2 FTI	30046-31-2
14:2 FTI	65510-55-6
9:2 FTI	65510-56-7

Composition of fluorinated starting materials

3. Based on the available commercial information, starting materials that may be used for the production of compounds related to long-chain PFCAs consist of fluorotelomer alchohol (FTOH) mixtures of fluorinated chain lengths ranging from 4 to 20 carbons (see Table 4).

Table 4. Description of starting material used for the production of compounds related to long-chain PFCAs

<table>
<tr><th>Use</th><th>Description of the starting material</th><th>Reference</th></tr>
<tr><td>Fluorinated lubricant additives</td><td>"[…] suitable fluorinated alcohols […] may be selected from the following species:
• $F(CF_2)_xCH_2OH$, wherein x is from 1 to about 20 […];
• $H(CF_2)_xCH_2OH$, wherein x is from 1 to about 20 […];
• $F(CF_2CF_2)_xCH_2CH_2OH$, wherein x is from 1 to about 10 […];
• $F(CF_2CF_2)_x(CH_2CH_2O)_yOH$, a telomer ethoxylate alcohol wherein x is from 1 to about 10 and y is from 1 to about 20 […]"</td><td>Beatty 2003</td></tr>
<tr><td>Fluorochemical oil and water repellents</td><td>Compositions of fluoroalcohols of formula $F(CF_2CF_2)_nCH_2CH_2OH$:
<table>
<tr><th></th><th colspan="2">Composition by weight %</th></tr>
<tr><th>n</th><th>(i)</th><th>(ii)</th></tr>
<tr><td>2</td><td>0-3</td><td></td></tr>
<tr><td>3</td><td>27-37</td><td>0-3</td></tr>
<tr><td>4</td><td>28-32</td><td>45-52</td></tr>
<tr><td>5</td><td>14-20</td><td>26-32</td></tr>
<tr><td>6</td><td>8-13</td><td>10-14</td></tr>
<tr><td>7</td><td>3-6</td><td>2-5</td></tr>
<tr><td>8</td><td>0-2</td><td>0-2</td></tr>
<tr><td>9</td><td>0-1</td><td>0-1</td></tr>
<tr><td>10</td><td>0-1</td><td>0-1</td></tr>
</table></td><td>Sherman et al. 2001</td></tr>
</table>

Unintentional production of long-chain PFCAs

4. Long-chain PFCAs and related compounds may be unintentionally produced during the manufacturing of other per- and polyfluoroalkyl substances (PFASs), including those containing a carbon chain of less than nine carbon atoms.

5. The manufacture of ammonium perfluorononanoate (APFN) leads to a technical mixture of PFCAs. Armitage et al. (2009) described the homologue profile for commercial APFN to consist primarily of C_9 PFCA (73.6%), C_{11} PFCA (20.0%) and C_{13} PFCA (5.0%).

6. Perfluoroalkyl substances are, in general, manufactured via electrochemical fluorination or telomerisation (Buck et al. 2011). Both odd- and even-numbered PFCAs may be prepared from either process. The raw material to manufacture perfluorinated chemicals via the telomerisation process is trifluoroethylene gas and iodine. The telomerisation process results in fluorotelomer iodide (FTI) fractions. The telomer iodide fractions are separated by distillation into a C_8/long-chain side fraction (approx. 20%) and a C_6 iodide fraction (approx. 80%). The C_6 iodide fraction is further processed to C_6 ethyl iodide, C_6 FTOH and the C_6 monomers (e.g. fluorotelomer acrylate or methacrylate esters). These C_6 monomers are the basis for polymerisation reactions to manufacture mixtures containing C_6-based polymers, which are then further used and processed by downstream users. These fractions still contain impurities of longer chain PFCAs, thus C_9–C_{14} PFCAs occur as impurities in C_6-based chemistries (EU Annex F information 2022). According to Prevedourous et al. (2006), during every step of the production, residues from the previous step remain.

7. During the manufacturing of the perfluorohexanoic acid- (C_6 PFCA) based substances, the fraction containing mainly long-chain PFCAs (referred to as the C_8-fraction) can include up to 30% C_9–C_{14} PFCAs and related compounds (ECHA 2018b). The other fraction (the C_6-fraction) has a reduced concentration of C_9–C_{14} PFCAs (up to 25 parts per billion (ppb)) and their related compounds (in the low parts per million (ppm) range) (ECHA 2018b). These fractions can

be reworked or further processed to reduce the concentration of C_9–C_{14} PFCAs in mixtures and articles placed on the market (ECHA 2018b). C_9–C_{14} PFCAs can also be impurities produced during the manufacturing of perfluorooctanoic acid (PFOA) (i.e., up to 0.21% C_9–C_{14} PFCAs) and PFOA-related compounds (i.e., 20 to 45% C_9–C_{14} related compounds to long-chain PFCAs) (ECHA 2018b).

8. Although no information is available, it seems possible that C_9–C_{14} PFCAs, their salts and related substances may also occur as unintended byproducts during the manufacturing of C_4-chemistries (EU Annex F information 2022).

9. According to information provided in a call for evidence conducted by ECHA in 2020, it seems that all fluoropolymers (both fluoroplastics and fluoroelastomers) may contain C_9–C_{14} PFCAs as trace impurities at different levels, but the highest levels may be found in fluoropolymers containing perfluoroalkoxy-groups. C_9–C_{14} PFCAs are generated unintentionally as impurities in the polymerisation of fluoropolymers containing perfluoroalkoxy-groups in a side reaction that is not fully understood. The total group of fluoropolymers and fluoroelastomers is very large, potentially representing a use in the EU of 50,000–60,000 tonnes/year. The concentration of C_9–C_{14} PFCAs is largely unknown. However, one company reports concentrations up to 1500 ppb C_9–C_{14} PFCAs in some types of fluoropolymers, and that "a maximum of 104 kg C_9–C_{14} PFCAs may be placed on the market as trace impurities in fluoropolymers and fluoroelastomers per year" (EU Annex F information 2022).

10. Long-chain PFCAs may also be present as unintentional impurities in polytetrafluoroethylene (PTFE) micro powders (ECHA 2018b, 2020). PTFE micro powders are finely divided low molar mass (104−106 g/mol) PTFE fragments with small particle sizes (1−20 μm). The majority of PTFE micro powders (about 85% of those currently produced on a global scale) are manufactured by the degradation of PTFE resin via controlled irradiation or thermal degradation to produce lower molecular weight PTFE. It is then ground to varying particle size ranges to suit specific applications. The manufacturing processes generates PFOA and C_9–C_{14} PFCAs as unintended impurities. A post-treatment process is required to reduce the concentration of such impurities to concentration levels below 25 ppb (EU Annex F information 2022).

1.5 National or regional control actions taken

11. As described in the draft risk management evaluation (UNEP/POPS/POPRC.19/x), control actions to prohibit or restrict certain long-chain PFCAs, their salts and related compounds were recently proposed or taken in Canada and the European Union (EU). These regulatory actions, including (proposed) exemptions/derogations, are summarized in Table 5 below.

12. In the EU regulatory action, the derogations which apply to the use of PFOA, its salts and PFOA-related compounds in the Regulation (EU) 2019/1021 on Persistent Organic Pollutants (EU POP Regulation) also apply to the use C_9–C_{14} PFCAs, their salts and related substances under the same conditions because of the manufacturing process of fluorochemicals in which both group of substances are present as impurities. The manufacturing and placing on the market of C_9–C_{14} PFCAs, their salts and related compounds as substances on their own is prohibited, and these derogations are only intended to allow manufacturing and use of C_8/C_6-based or lower chain length perfluorochemicals where these substances may be present as impurities (EU Annex F information 2022). The following derogations and/or concentration limits were also granted based on information provided by stakeholders:

(a) Derogations were granted to allow speciality semiconductors that contain low levels of C_9–C_{14} PFCAs to be made available until 31 December 2023 to avoid supply chain disruption and, until 2030, for semiconductors used in spare or replacement parts for finished electronic equipment placed on the market before the end of 2023.

(b) Until 2028, a 7-year derogation was granted for the production of the internal can coating of pressurised metered-dose inhalers.

(c) In transported isolated intermediates C_9–C_{14} PFCAs, their salts and related substances are present when using C_6-based chemistry. Thus, to allow the manufacturing and processing of C_6-based chemistries, stakeholders asked either for a derogation for transported isolated intermediates or to set a higher threshold. A derogation was included for transported isolated intermediates provided that the use takes place under strictly controlled conditions as defined in Article 18(4) (a) to (f) of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation.

(d) Higher concentration limits were included in the restriction to allow the production of fluoropolymers and fluoroelastomers, as well as the production of PTFE micro powders and the use in mixtures and articles for industrial and professional applications containing higher concentrations of long-chain PFCAs (EU Annex F information 2022).

13. In its Annex F submission (2022), the EU indicated that because, as per note (i) of Annexes A and B to the Stockholm Convention, quantities of a chemical occurring as unintentional trace contaminants in products and articles are not to be considered to be listed in these Annexes and there is no current intentional manufacturing and use of long-chain PFCAs, their salts and related substances in the EU, it does not foresee at this time the need for any specific exemptions under the Convention to allow the manufacturing of these substances in the EU. Similarly, as it is understood that long-chain PFCAs, their salts and related substances are likely to be unintentionally present in pressurised metered-dose inhalers, the EU does not foresee a need for a specific exemption for this use. However, a specific exemption would be needed by the EU to allow the use and placing on the market (including import into the EU) of long-chain PFCAs in semiconductors for their use in spare or replacement parts for finished electronic equipment.

14. As described in UNEP/POPS/POPRC.19/x, national or regional control actions were also taken or are being considered in Switzerland, Norway, the USA and Australia. In addition, in the EU, 20 PFASs, including C_9–C_{13} PFCAs, are listed in the EU Drinking water Directive (2020/2184/EU), for which there is a limit value of 0.10 µg/L for the sum of PFAS. In addition, a limit of 0.50 µg/L has been adopted for the sum of all PFAS in drinking water. The establishment of maximum residue limits in water and fish is also being considered within the EU (COM(2022) 540 final, 2022/0344 (COD)) (Sweden Annex F information 2022)

Table 5. Overview of control actions taken or proposed, their chemical scope and exemptions for long-chain PFCAs, their salts and related compounds in Canada and the EU

	Canada (Canada 2022)	**EU European Commission 2021**
Chemical scope	Perfluorocarboxylic acids that have the molecular formula $C_nF2_{n+1}CO_2H$ in which $8 \leq n \leq 20$ (C_9–C_{21} PFCAs) and their salts, and compounds that consist of a perfluorinated alkyl group that has the molecular formula C_nF_{2n+1} in which $8 \leq n \leq 20$ and that is directly bonded to any chemical moiety other than a fluorine, chlorine or bromine atom.	Linear and branched perfluorocarboxylic acids of the formula C_nF_{2n+1}-C(= O)OH where n = 8, 9, 10, 11, 12 or 13 (C_9–C_{14} PFCAs), including their salts, and any combinations thereof; Any C_9–C_{14} PFCA-related substance having a perfluoro group with the formula C_nF_{2n+1}- directly attached to another carbon atom, where n = 8, 9, 10, 11, 12 or 13, including their salts and any combinations thereof; Any C_9–C_{14} PFCA-related substance having a perfluoro group with the formula C_nF_{2n+1}- that it is not directly attached to another carbon atom, where n = 9, 10, 11, 12, 13 or 14 as one of the structural elements, including their salts and any combinations thereof. The following substances are excluded from this designation: - C_nF_{2n+1}-X, where X = F, Cl, or Br where n = 9, 10, 11, 12, 13 or 14, including any combinations thereof, - C_nF_{2n+1}-C(= O)OX' where n> 13 and X'=any group, including salts.
Control action taken or proposed	Since 2016, the manufacture, use, sale, offer for sale and import of long-chain PFCAs, their salts and their precursors, and products containing them, have been prohibited in Canada, with a limited number of exemptions. The proposed *Prohibition of Certain Toxic Substances Regulations, 2022* proposed to remove most of these exemptions. Comments received in response to the proposed Regulations are being taken into consideration in the development of the final Regulations. Therefore, exclusions and exemptions presented here are subject to change. The publication of the final Regulations is expected in late 2023.	Prohibition of manufacture or placing on the market as substances on their own (coming into force on 25 February 2023). Prohibition of use, or placing on the market, in: (a) another substance, as a constituent; (b) a mixture; (c) an article. The prohibition of use, or placing on the market, will come into force on 4 July 2023 for: (i) textiles for oil- and water-repellency for the protection of workers from dangerous liquids that comprise risks to their health and safety; (ii) the manufacture of polytetrafluoroethylene (PTFE) and polyvinylidene fluoride (PVDF) for the production of: - high performance, corrosion resistant gas filter membranes, water filter membranes and membranes for medical textiles; - industrial waste heat exchanger equipment;

		- industrial sealants capable of preventing leakage of volatile organic compounds and $PM_{2.5}$ particulates. The prohibition of use, or placing on the market, will come into force on 23 December 2023 for: (i) semiconductors on their own; (ii) semiconductors incorporated in semi-finished and finished electronic equipment.
Exclusions (concentration limits)	The proposed Regulations proposed to define incidental presence of these substances in a product, including aqueous film-forming foams (AFFF), at a total concentration of ≤1 ppm of long-chain PFCAs, their salts and related compounds.	- In another substance, the mixture or the article: - <25 ppb for the sum of C_9–C_{14} PFCAs and their salts; or - <260 ppb for the sum of C_9–C_{14} PFCA-related substances. - Use as a transported isolated intermediate for the manufacturing of fluorochemicals with a perfluoro carbon chain length ≤6 atoms: - 10 ppm for the sum of C_9–C_{14} PFCAs, and their salts and related substances - In fluoroplastics and fluoroelastomers that contain perfluoroalkoxy groups: - <2000 ppb for the sum of C_9–C_{14} PFCAs (until 25 August 2024) - <100 ppb for the sum of C_9–C_{14} PFCAs (after 25 August 2024) - In PTFE micro powders produced by ionising or by thermal degradation, mixtures and articles for industrial and professional uses containing PTFE powders: - <1000 ppb for the sum of C_9–C_{14} PFCAs
Exemptions for semiconductor industry	- Use, sale and import of (and use and sale of manufactured items containing) micro-electromechanical system-based semiconductors, containing perfluorodecanoic acid (C_{10} PFCA) in a concentration that is ≤0.1% (w/w), designed for: - Non-vehicle and vehicle manufactured items (until 31 December 2025); - Replacement parts for non-vehicle manufactured items (until 31 December 2030); and - Replacement parts for vehicle manufactured items (until 31 December 2040).	- Photolithography or etch processes in semiconductor manufacturing (until 4 July 2025) - Semiconductors used in spare or replacement parts for finished electronic equipment placed on the market before 31 December 2023 (until 31 December 2030)
Exemptions for photo-imaging		- Photographic coatings applied to films (until 4 July 2025)
Exemptions for medical uses		- Invasive and implantable medical devices (until 4 July 2025) - Can coating for pressurised metered-dose inhalers (until 25 August 2028)

Exemptions for fire-fighting	- Until 31 December 2025, use of AFFF containing long-chain PFCAs to: - Test fire-fighting systems, provided all releases are contained and disposed of in an environmentally sound manner; and - Suppress liquid fuel vapour and liquid fuel fires in emergency situations.	- Until 4 July 2025, fire-fighting foam for liquid fuel vapour suppression and liquid fuel fire (Class B fires) already installed in systems, including both mobile and fixed systems, subject to the following conditions: - fire-fighting foam shall not be used for training, and shall not be used for testing unless all releases are contained; - from 1 January 2023, uses of fire-fighting foam shall only be allowed to sites where all releases can be contained; - fire-fighting foam stockpiles shall be managed in accordance with Article 5 of Regulation (EU) 2019/1021.

2. Summary of the information relevant to the risk management evaluation

Production and Uses

15. Worldwide total manufacturing volumes of the ammonium salt of C_9 PFCA (ammonium perfluorononanoate or APFN) for the production of primarily polyvinylidene fluoride (PVDF) for the years 1975 to 2004 was estimated to be in the range of 800 to 2300 tonnes (with production estimated to be in the range of 15 to 100 tonnes/year) (Prevedourous et al. 2006). For the year 2004, APFN volumes were estimated to range between 15 and 75 tonnes (PERFORCE 2004; Posner et al. 2009). Wang et al. (2014) estimated the APFN usage in Japan, Western Europe and the United States of America (USA) to range between 8 and 107 tonnes per year for the years 1975 to 2015. For the period of 2016–2030, the authors' assumption was that the use of APFN in PVDF production, and associated production of APFN in those countries, would cease as the major manufacturing companies committed to the United States Environmental Protection Agency (US EPA) Stewardship program.

16. In response to a survey conducted by the OECD for the year 2009 (OECD 2011), four companies in two countries reported manufacture of long-chain PFCAs, their salts and related compounds, with perfluorinated chain lengths of 9 to 18 carbons. Twenty-three long-chain PFCAs (C_9–C_{12}), their salts and related compounds, including 10:2–18:2 fluorotelomers, were reportedly contained in products or mixtures, whether as part of the formulation or as residue (impurity). The total volume of these substances in products was approximately 16 tonnes. The majority of the substances were reported to have uses as raw materials (for surface treatment agents, water/oil repellents and soil repellents), fluoropolymer polymerisation aids or manufacturing intermediates (OECD 2011). Although no specific information regarding the intentional manufacture of substances with perfluorinated chain lengths greater than 18 carbons has been found, it is expected that these chain lengths would be present as components or impurities within the C_9–C_{18} materials.

17. Worldwide production of fluorotelomers was estimated at approximately 9,100 tonnes (reported as 20 million pounds) in 2006 and, at that time, the USA was considered to account for more than 50 percent of the production (US EPA 2009). Textiles and apparel were considered to account for approximately 50 percent of the volume, with carpet and carpet care products accounting for the next largest share in consumer product uses. Coatings, including those for paper products, were identified as the third largest category of consumer product uses (US EPA 2009). For the years 2012 to 2015, annual national aggregate production volumes of < 454 tonnes were reported in the USA for each of the following FTOHs: 8:2, 10:2, 12:2 and 14:2 (CDR 2020).

18. Wang et al. (2014) estimated the global annual production of fluorotelomer-based products to range between 2,500 and 20,000 tonnes for the years 1961 to 2004, and production was estimated or projected at 45,000 tonnes per year for the period 2005 to 2030. The authors also reported that, since 2002, there has been a geographical shift of industrial sources of PFCAs as a result of the relocation of PFCA, fluoropolymer and other PFAS product production from the USA, Western Europe and Japan to emerging Asian economies, especially China.

19. Information collected for the years 2004 and 2005 indicate that eight products containing compounds related to long-chain PFCAs (i.e., used for automotive painting, glass treatment and ink cartridges, or as water/oil repellents for textiles, carpets and masonry/cement surfaces) were imported into Australia during that period, for a total volume of up to 33 tonnes (reported as 33,300 kg) per annum (NICNAS 2019b). Two compounds related to PFCAs were also imported into Australia in 2005: a perfluorinated furan compound used as an analytical reagent (0.00025 tonnes) and a polymer containing a perfluoroalkylethyl ester moiety used to formulate coatings for wood boards of internal wall cladding (0.15 tonnes).

20. Based on two industry surveys conducted under the authority of the Canadian Environmental Protection Act, 1999 (CEPA) for the years 1997–2000, and 2004, long-chain PFCAs were not reported to be manufactured or imported into Canada. However, in both surveys, between 1 and 100 tonnes of a number of compounds related to the long-chain PFCAs were reported to be imported into Canada (Environment Canada 2001, 2005). In addition, substances imported within manufactured items, incidentally or not, were not accounted for as they were not reported through these surveys. Lastly, an average of 0.003 tonnes per year of long-chain PFCAs, their salts and/or related compounds were used for analysis, in scientific research or as a laboratory analytical standard, over the period of 2017 to 2021 (Canada Annex F information 2022). While long-chain PFCAs, their salts and related compounds were never manufactured in Canada, they were historically imported and may continue to be imported in aqueous film-forming foams (AFFF) used in fire-fighting applications, and in manufactured items such as nano coatings; textiles (e.g. carpets, clothing, outdoor equipment, protective clothing), membranes for use in medical textiles, filtration in water treatment, production processes and effluent treatment; paper and packaging; and electrical and electronic equipment (EEE) (including semiconductors and spare parts for the transportation sector) (Canada 2018).

21. In the EU, no intentional manufacturing or use (including import and export) of C_9–C_{14} PFCAs, their salts or

related compounds above 1 tonne/annum was identified as of June 2017, and long-chain (C_9–C_{14}) PFCAs, their salts or related compounds were reported as being mainly manufactured unintentionally during the manufacturing of PFCAs containing a carbon chain length of less than nine carbon atoms (ECHA 2018b). Data from the Swedish Product Register showed declining trends on the use of substances related to C_9–C_{14} PFCAs in textiles, paper and paints between 2007 and 2015. It was assumed that a similar substitution process had taken place in the rest of the EU (ECHA 2017). However, one company reported the use of C_{10} PFCA (in the low kg range) in a small number of semiconductors which are imported into the EU (ECHA 2018a, c). One producer of pressurised metered-dose inhalers also indicated that the can coating process typically involves applying an aqueous dispersion of polymer and emulsifier, which can contain low levels of C_9–C_{14} PFCAs. Based on the information provided by the company, the long-chain PFCAs present in the fluoropolymers are likely to be impurities rather than the result of an intentional use (EU Annex F information 2022). In addition, under REACH, one company has registered multi-constituent substances, including C_9–C_{14} PFCAs. During the stakeholder consultation conducted in the course of the REACH restriction process, the registrant explained that the C_9–C_{14} PFCAs, their salts and related substances have never been manufactured intentionally, but occurred as unintended chemical by-product during the manufacturing of the C_8-chemistry. The registrant manufactured and used three of the registered substances until December 2015. In June 2017, the registrant deactivated these registrations because the registrant moved from manufacturing PFOA and related substances (so-called C_8-chemistry) to short-chain alternatives consisting of six perfluorinated carbon atoms, C_6-chemistry (EU Annex F information 2022).

22. In their response to the request for Annex E and/or Annex F information (2022), Belarus, Monaco, New Zealand, Norway, Oman, the Republic of Korea, Saudi Arabia and the United Kingdom of Great Britain and Northern Ireland (UK) have indicated that long-chain PFCAs, their salts and related compounds are not (intentionally) manufactured in their countries. In addition, New Zealand has stated that none of the long-chain PFCAs or their salts appear in the New Zealand Inventory of Chemicals, but that a number of compounds related to long-chain PFCAs are present on the inventory, indicating they have been used as components in products approved for import into New Zealand.

23. In the UK, 20 downstream users were identified in the UK REACH Downstream User Import Notifications (DUINs), although several of these trade under multiple legal entities. The DUINs data covers the period from 31 December 2018 to 31 December 2020. Long-chain PFCAs, their salts and related compounds appear to have been used in several sectors in the UK, including in coating products, adhesives and sealants, wetting agents, paints, automobiles, and fire-fighting foams. It was not possible to verify whether uses were intentional or unintentional. DUINS were registered for 25 different substances with a unique CAS number, including six long-chain PFCAs, four salts and 15 related compounds. Tonnage data were reported for a limited number of DUINs. Where reported, in 90% of cases, notifications were made for imports of <1 tonne/year. The remaining notifications were for imports of >1 tonne/year, most of which were between 1-10 tonnes (UK Annex F information 2022).

24. In Norway (Annex F information 2022), some compounds related to long-chain PFCAs are registered for use in fire extinguishing agents, textile impregnants, water-based paints and varnishes, and wax and other floor polish. The registered CAS numbers and use volumes per year (in range) for the period 2018–2020 are provided in Table 6.

Table 6. Compounds related to long-chain PFCAs registered for use in Norway (Annex F information 2022)

Use	CAS number	Use volumes per year (in range) for 2018-2020 (kg)
Fire extinguishing agents	70969-47-0	1–400
	68187-47-3	5–150
Textile impregnants	86508-42-1	50–100
	65605-70-1	100–1000
	203743-03-7	40–100
Water-based paints and varnishes	65545-80-4	1–50
	65530-70-3	1–10
	65530-72-5	1–20
	65530-71-4	1–10
	68391-08-2	<1
Wax and other floor polish	68412-69-1	<5
	68412-68-0	<5

25. In its Annex F submission (2022), Japan indicated that the following uses of related compounds to long-chain PFCAs were newly identified as a result of a survey to domestic companies:

(a) Semiconductor manufacturing equipment and its components, and materials required for those operations;

(b) Inactive/inert fluorine liquid for quality evaluation testing of electric components and EEE (i.e. fluorine-based inert liquids containing long-chain PFCAs are widely used as test chamber media in hermeticity tests, as they do not corrode or alter electronic components and do not require cleaning after testing);

(c) Heat media in a closed system;

(d) Heat media requiring both optical properties and heat-transfer performance for medical devices;

(e) Refractive index solution for analytical instruments by fluorescence detection; and

(f) Inks for marking capacitors and cables.

26. In its Annex F submission (2023), the Canadian Vehicle Manufacturers' Association (CVMA) indicated that the use of long-chain PFCAs, their salts and related compounds has recently been identified in the automotive industry in vehicles in production, as well as in service and replacement parts for vehicles in production and those that have ceased mass production. More specifically, long-chain PFCAs, their salts and related compounds (see Table 8 for the specific CAS numbers identified) have been identified to be used in vehicle coatings, cables, electronics, engines and underhood applications, modules, hydraulic system components and relay assemblies.

27. Based on the information described in the risk profile (UNEP/POPS/POPRC.18/6/Add.1), Annex F submissions and additional publications found in the literature, long-chain PFCAs, their salts and related compounds (or products containing them) are used, or may have been used[2], in many applications as summarized in Table 7. In addition, available information (including CAS numbers) related to specific long-chain PFCAs, salts and/or related compounds, or products containing them, reported to be used (or to may have been used) in various applications is provided in Table 8.

Table 7. Known or potential uses of long-chain PFCAs, their salts and related compounds or products containing them

Category	Reported applications	Reported detections or patents
Industrial uses	Surfactant applications (Prevedouros et al. 2006; OECD 2015; Environment Canada 2012); fluoropolymer polymerisation aids (Prevedouros et al. 2006; OECD 2011; Environment Canada 2012; Kannan et al. 2011); manufacturing intermediates (OECD 2011); analytical reagents (NICNAS 2019b); lubricants used in the manufacture of fluoropolymers (Japan Annex F information)	Mould release agents (Glüge et al. 2020);
Electronic articles and medical and laboratory devices	Semiconductors (EU and Canada Annex F information 2022); cooling applications for the manufacture of high-heat and high-voltage parts for semiconductor manufacturing equipment (Japan Annex F information 2022); functional fluids in closed systems for computer and electronic product manufacturing (Glüge et al. 2020); inactive/inert fluorine liquid for reliability testing for the manufacture of electric components, and EEE (Japan Annex F information 2022); heat media requiring both optical properties and heat-transfer performance in components of *in vitro* medical devices (Japan Annex F information 2022); refractive media inanalytical instruments for detecting fluororescence (Japan Annex F information 2022)	UV-hardened dental restorative materials; manufacturing of contact lenses (Swedish Chemicals Agency 2015; ECHA 2018b)
Photo-imaging	Photographic materials (I&P Europe Annex F information 2022; Glüge et al. 2020)	
Inks	Printing inks (NICNAS 2019b; ECHA 2018b);	

[2] For example, based on available patent information and reported detections in articles and products.

	inks for marking capacitors and cables (Japan Annex F information 2022)	
Building and construction materials	Glass treatments (NICNAS 2019b); products used for masonry/cement surfaces (NICNAS 2019b); coatings for wood boards of internal wall cladding (NICNAS 2019b); raw materials for surface treatment agents, water/oil repellents and soil repellents (OECD 2011)	Coatings and foil for facades or glass-substituents, and window films (Janousek et al. 2019; Bečanová et al. 2016; Gewurtz et al. 2009); stone/tile/wood sealants, thread seal tapes and pastes (Guo et al. 2009; Liu et al. 2014; Arcadis 2021); surfactants used in caulks, coatings and adhesives (Dinglasan-Panlilio and Mabury 2006)
Food packaging	Paper and paperboard food packaging (OECD 2020)	Food-contact material (e.g. Schaider et al. 2017; Granby and Tesdal Håland 2018; Schultes et al. 2019; Yuan et al. 2016; Kotthoff et al. 2015; Blom and Hanssen 2015); plastic pet food packages (Chinthakindi et al. 2021); cookware (Guo et al. 2009; Sinclair et al. 2007; Herzke et al. 2012; Blom and Hanssen 2015)
Paints and varnishes	Automotive paints (NICNAS 2019b); automotive waxes and polishes (Glüge et al. 2020); paints, lacquers and varnishes (Nordic Council of Ministers 2015); water-based paints and varnishes (Norway Annex F information); waxes and other floor polishes (Norway Annex F information)	Surfactants used in paints and floor waxing (Dinglasan-Panlilio and Mabury 2006);floor waxes (Guo et al. 2009; Liu et al. 2014); paint sealants (Arcadis 2021);
Fire-fighting	Fire-fighting foams (Nordic Council of Ministers 2015; ECHA 2022); fire extinguishing agents (Norway Annex F information 2022)	
Textiles and apparel	Carpets (NICNAS 2019b); textile water/oil repellents (NICNAS 2019b); fabric and carpet protectors (Banks 1994; Nordic Council of Ministers 2015; Favreau et al. 2017); textile impregnants (Norway Annex F information 2022)	Apparel (e.g. outerwear and baby/children's bibs) (e.g. Gremmel et al. 2016; Commission for Environmental Cooperation 2017; Borg and Ivarsson 2017; Liu et al. 2014); medical garments (Guo et al. 2009; Liu et al. 2014); firefighter turnout gear (Peaslee et al. 2020); home textiles (e.g., curtains, bed covers/linens, quilts, carpets, table cloths) (e.g. Commission for Environmental Cooperation 2017; Vestergren et al. 2015; Herzke et al. 2009, 2012); outdoor textiles (Arcadis 2021); other types of fabric/textiles (i.e., awnings, seat covers for public transportation, maritime applications) (Janousek et al. 2019); fabric, foam and laminated composites of foam/fabric in children's car seats (Wu et al. 2021)
Personal care products	Cosmetics and sun creams (ECHA 2018b; Fujii et al. 2013)	Cosmetics (e.g. Keegan et al. 2022), dental floss and/or body lotions (e.g. Blom and Hanssen 2015; Whitehead et al. 2021; Swedish Chemicals Agency 2021; Schultes et al. 2018; Arcadis 2021)
Cleaning and washing agents	Cleaning products (NICNAS 2019a)	Carpet care liquids and foams, and dish cleaning or rinsing agents (Kotthoff et al. 2015; Dinglasan-Panlilio and Mabury 2006; Blom and Hanssen 2015); anti-fog sprays and cloths (Herkert et al. 2022)
Ski waxes		Ski waxes (Kotthoff et al. 2015; Plassmann and Berger 2013; Blom and Hanssen 2015; Fang et

		al. 2020)
Automotive products	Products for motor vehicle repair (Nordic Council of Ministers 2015, as summarized in NICNAS 2019b); vehicle coatings, cables, electronics, engines and underhood applications, modules, hydraulic system components and relay assemblies (CVMA Annex F information 2023)	Automotive lubricants (i.e., engine oils, hydraulic fluids and greases) (Zhu and Kannan 2020; Arcadis 2021)

Table 8. Long-chain PFCAs, their salts and related compounds, or products containing them, reported to be used, or to may have been used, in various applications

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
Industrial uses			
Fluoropolymerisation aid	Nonanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluoro- (C_9 PFCA)	375-95-1	OECD 2011
Fluoropolymerisation aid	Nonanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluoro-, ammonium salt (1:1) (APFN)	4149-60-4	Prevedourous et al. 2006
Fluoropolymerisation aid	Fatty acids, C7-13, perfluoro, ammonium salts	72968-38-8	OECD 2011
Production of PVDF	Nonanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluoro-, ammonium salt (1:1) (APFN)	4149-60-4	OECD 2011
Manufacturing intermediate/raw material	1-Decanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluoro-	678-39-7	OECD 2011
Manufacturing intermediate/raw material	Decane, 1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-heneicosafluoro-10-iodo-	423-62-1	OECD 2011
Manufacturing intermediate/raw material	Dodecane,1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12-pentacosafluoro-12-iodo-	307-60-8	OECD 2011
Manufacturing intermediate/raw material	1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14-Nonacosafluoro-14-iodotetradecane	307-63-1	OECD 2011
Manufacturing intermediate	1-Dodecanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-heneicosafluoro- (10:2 FTOH)	865-86-1	OECD 2011
Manufacturing intermediate	1-Tetradecanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafluoro- (12:2 FTOH)	39239-77-5	OECD 2011
Manufacturing intermediate	1-Hexadecanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,16-nonacosafluoro-	60699-51-6	OECD 2011

[3] American Chemical Society, 2022. CAS SciFinder^n. Available from: https://scifinder-n.cas.org/ (Accessed: 4 February 2022).

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
	(14:2 FTOH)		
Manufacturing intermediate	Dodecane,1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-heneicosafluoro-12-iodo- (10:2 FTI)	2043-54-1	OECD 2011
Manufacturing intermediate	Tetradecane,1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12-pentacosafluoro-14-iodo- (12:2 FTI)	30046-31-2	OECD 2011
Manufacturing intermediate	Hexadecane,1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14-nonacosafluoro-16-iodo- (14:2 FTI)	65510-55-6	OECD 2011
Manufacturing intermediate	2-Propenoic acid, 2-methyl-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-heneicosafluorododecyl ester (10:2 FTMAC)	2144-54-9	OECD 2011
Manufacturing intermediate	2-Propenoic acid, 2-methyl-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafluorotetradecyl ester (12:2 FTMAC)	6014-75-1	OECD 2011
Manufacturing intermediate	2-Propenoic acid, 2-methyl-, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,16-nonacosafluorohexadecyl ester (14:2 FTMAC)	4980-53-4	OECD 2011
Manufacturing intermediate	2-Propenoic acid, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-heneicosafluorododecyl ester	17741-60-5	OECD 2011
Manufacturing intermediate	2-Propenoic acid, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-pentacosafluorotetradecyl ester	34395-24-9	OECD 2011
Mould release agent	1,2-Tridecanediol, 4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,13,13,13-eicosafluoro-12-(trifluoromethyl)-, 1-(dihydrogen phosphate)	63295-27-2	Glüge et al. 2020
Mould release agent	1,2-Pentadecanediol, 4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,15,15,15-tetracosafluoro-14-(trifluoromethyl)-, 1-	63295-28-3	Glüge et al. 2020

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
	(dihydrogen phosphate)		
Electronic articles			
Semiconductors	Decanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluoro-	335-76-2	Canada 2022
Functional fluids in computer and electronic product manufacturing	Perfluoro compounds, C5-18	86508-42-1	Glüge et al. 2020
Medical and laboratory devices			
Refractive index liquid for analytical instruments by fluorescence detection	Perfluoro compounds, C5-18	86508-42-1	Japan 2023[4]
Photo-imaging			
Photographic materials	Undecanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11-eicosafluoro-	1765-48-6	Glüge et al. 2020
Printing inks			
Printink inks	Alcohols, C8-14, γ-ω-perfluoro	68391-08-2	ECHA 2018b
Building and construction materials			
Wax and other floor polish	Phosphinic acid, bis(perfluoro-C6-12-alkyl) derivs.	68412-69-1	Norway Annex F information 2022
Wax and other floor polish	Phosphonic acid, perfluoro-C6-12-alkyl derivs.	68412-68-0	Norway Annex F information 2022
Building and construction products that have contact with lightweight concrete	Thiols, C8-20, γ-ω-perfluoro, telomers with acrylamide	70969-47-0	Swedish Chemical Agency 2015
Food packaging			
Oil/grease resistant sizing agent	2-Propen-1-ol, reaction products with 1,1,1,2,2-pentafluoro-2-iodoethane-tetrafluoroethylene telomer, dehydroiodinated, reaction products with epichlorohydrin and triethylenetetramine	464178-90-3	OECD 2020; California DTSC 2020
Coatings, paper/paperboard (i.e. used as an additive or polymerization processing aid)	Ethanol, 2,2′-iminobis-, compd. with α,α′-[phosphinicobis(oxy-2,1-ethanediyl)]bis[ω-	65530-64-5	RIVM 2019

[4] Information provided in response to requests from the drafters for additional information.

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
	fluoropoly(difluoromethylene)] (1:1) (diPAP)		
Paper/paperboard	Poly(difluoromethylene), α-fluoro-ω-[2-[(1-oxo-2-propen-1-yl)oxy]ethyl]-	65605-70-1	RIVM 2019
Paints and varnishes			
Water-based paints and varnishes; paints, lacquers and varnishes	Poly(oxy-1,2-ethanediyl), α-hydro-ω-hydroxy-, ether with α-fluoro-ω-(2-hydroxyethyl)poly(difluoromethylene) (1:1)	65545-80-4	Norway Annex F information 2022; Nordic Council of Ministers 2015
Water-based paints and varnishes	Poly(difluoromethylene), α,α′-[phosphinicobis(oxy-2,1-ethanediyl)]bis[ω-fluoro-, ammonium salt (1:1) (diPAP)	65530-70-3	Norway Annex F information 2022
Water-based paints and varnishes	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:2) (diPAP)	65530-72-5	Norway Annex F information 2022
Water-based paints and varnishes	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:1) (monoPAP)	65530-71-4	Norway Annex F information 2022
Water-based paints and varnishes	Alcohols, C8-14, γ-ω-perfluoro	68391-08-2	Norway Annex F information 2022
Paints, lacquers and varnishes	Ethanol, 2,2′-iminobis-, compd. with α,α′-[phosphinicobis(oxy-2,1-ethanediyl)]bis[ω-fluoropoly(difluoromethylene)] (1:1) (diPAP)	65530-64-5	Nordic Council of Ministers 2015
Paints, lacquers and varnishes	Ethanol, 2,2′-iminobis-, compd. with α-fluoro-ω-[2-(phosphonooxy)ethyl]poly(difluoromethylene) (1:1) (monoPAP)	65530-74-7	Nordic Council of Ministers 2015
Paints, lacquers and varnishes	Ethanol, 2,2′-iminobis-, compd. with α-fluoro-ω-[2-(phosphonooxy)ethyl]poly(difluoromethylene) (2:1) (monoPAP)	65530-63-4	Nordic Council of Ministers 2015
Wax and other floor polish	Phosphinic acid, bis(perfluoro-C6-12-alkyl) derivs.	68412-69-1	Norway Annex F information

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
			2022
Wax and other floor polish	Phosphonic acid, perfluoro-C6-12-alkyl derivs.	68412-68-0	Norway Annex F information 2022
Fire-fighthing			
Fire-fighthing foam	Nonanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluoro- (C_9 PFCA)	375-95-1	ECHA 2022
Fire-fighthing foam	Decanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluoro- (C_{10} PFCA)	335-76-2	ECHA 2022
Fire-fighthing foam	Undecanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-heneicosafluoro- (C_{11} PFCA)	2058-94-8	ECHA 2022
Fire-fighthing foam	Dodecanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-tricosafluoro- (C_{12} PFCA)	307-55-1	ECHA 2022
Fire-fighthing foam	Tridecanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,13-pentacosafluoro- (C_{13} PFCA)	72629-94-8	ECHA 2022
Fire-fighthing foam	Tetradecanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,13,13,14,14,14-heptacosafluoro- (C_{14} PFCA)	376-06-7	ECHA 2022
Fire-fighthing foam	1-Propanesulfonic acid, 2-methyl-, 2-[[1-oxo-3-[(γ-ω-perfluoro-C4-16-alkyl)thio]propyl]amino] derivs., sodium salts	68187-47-3	Nordic Council of Ministers 2015
Fire-fighthing foam	1-Propanaminium, 2-hydroxy-N,N,N-trimethyl-, 3-[(γ-ω-perfluoro-C6-20-alkyl)thio] derivs., chlorides	70983-60-7	Nordic Council of Ministers 2015
Fire extinguishing agents	Thiols, C8-20, γ-ω-perfluoro, telomers with acrylamide	70969-47-0	Norway Annex F information 2022
Fire extinguishing agents	1-Propanesulfonic acid, 2-methyl-, 2-[[1-oxo-3-	68187-	Norway Annex

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
	[(γ-ω-perfluoro-C4-16-alkyl)thio]propyl]amino] derivs., sodium salts	47-3	F information 2022
Textiles and apparel			
Textile impregnants	Perfluoro compounds, C5-18	86508-42-1	Norway Annex F information 2022
Textile impregnants	Poly(difluoromethylene), α-fluoro-ω-[2-[(1-oxo-2-propen-1-yl)oxy]ethyl]-	65605-70-1	Norway Annex F information 2022
Textile impregnants	2-Propenoic acid, 2-methyl-, hexadecyl ester, polymers with 2-hydroxyethyl methacrylate, γ-ω-perfluoro-C10-16-alkyl acrylate and stearyl methacrylate	203743-03-7	Norway Annex F information 2022
Personal care products			
Cosmetics (emulsifying)	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:2) (diPAP)	65530-72-5	ECHA 2018b
Cosmetics (emulsifying)	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:1) (monoPAP)	65530-71-4	ECHA 2018b
Cosmetics (emulsifying)	Poly(difluoromethylene), α,α′-[phosphinicobis(oxy-2,1-ethanediyl)]bis[ω-fluoro-, ammonium salt (1:1) (di PAP)	65530-70-3	ECHA 2018b
Cosmetics (cleansing, surfactant)	1-Propanaminium, 2-hydroxy-N,N,N-trimethyl-, 3-[(γ-ω-perfluoro-C6-20-alkyl)thio] derivs., chlorides	70983-60-7	ECHA 2018b
Cleaning and washing agents			
Cleaning products, polishing agents	Poly(difluoromethylene), α-[2-[(2-carboxyethyl)thio]ethyl]-ω-fluoro-, lithium salt (1:1)	65530-69-0	Nordic Council of Ministers 2015
Cleaning products, polishing agents	Poly(difluoromethylene), α-[2-[(2-carboxyethyl)thio]ethyl]-ω-fluoro-	65530-83-8	Nordic Council of Ministers 2015
Automotive products			
Products for motor vehicle repair	Poly(difluoromethylene), α-[2-[(2-carboxyethyl)thio]ethyl]-ω-fluoro-, lithium salt	65530-69-0	Nordic Council of Ministers

Reported use(s) of the substance or products containing it	CAS Name[3] (acronym)	CAS number	Reference(s)
	(1:1)		2015
Products for motor vehicle repair	Poly(difluoromethylene), α-[2-[(2-carboxyethyl)thio]ethyl]-ω-fluoro-	65530-83-8	Nordic Council of Ministers 2015
Automotive waxes and polish	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:1) (monoPAP)	65530-71-4	Glüge et al. 2020
Automotive waxes and polish	Poly(difluoromethylene), α-fluoro-ω-[2-(phosphonooxy)ethyl]-, ammonium salt (1:2) (diPAP)	65530-72-5	Glüge et al. 2020
Automotive waxes and polish	Poly(difluoromethylene), α,α′-[phosphinicobis(oxy-2,1-ethanediyl)]bis[ω-fluoro-, ammonium salt (1:1) (diPAP)	65530-70-3	Glüge et al. 2020
Coatings, cables, electronics, engines and underhood applications, modules, hydraulic system components and relay assemblies	Poly(difluoromethylene), α-fluoro-ω-[2-[(1-oxo-2-propen-1-yl)oxy]ethyl]-	65605-70-1	CVMA Annex F information 2023
	Perfluoro compounds, C5-18	86508-42-1	
	Poly(oxy-1,2-ethanediyl), α-hydro-ω-hydroxy-, ether with α-fluoro-ω-(2-hydroxyethyl)poly(difluoromethylene) (1:1)	65545-80-4	
	1-Decanol, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluoro- (8:2 FTOH)	678-39-7	
	Nonanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluoro- C_9 PFCA	375-95-1	
	Decanoic acid, 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluoro-, ammonium salt (1:1)	3108-42-7	

Releases

28. According to I&P Europe (Annex F information 2022), environmental releases of long-chain PFCAs and their related compounds from the manufacturing of conventional photographic materials are estimated to be extremely low, in part because the wastes generated by manufacturing facilities are incinerated (on- or off-site) or otherwise appropriately managed to minimise potential releases to the environment. There are, however, uncertainties on the capacity of incineration to irreversibly destroy PFASs, and environmental releases of these substances may not be extremely low in all incineration conditions (EU comments of the first draft RME). According to I&P Europe (Annex F information 2022), environmental releases of long-chain PFCAs and their related compounds from the use of photographic products are estimated to be very low due to the recycling operations in place to recover used and waste photographic materials from manufacturing and commercial users. These recycling operations are carried out, for example, to recover silver, film-based materials (e.g. polyethylene terephthalate, PET) and to protect intellectual property or sensitive operations. Consumer film and paper are, however, not usually returned to the manufacturer. It is unknown if such waste management practices and recycling operations are in place in the photo-imaging industry outside of Europe.

2.1 Identification of possible control measures

Control measures for releases from unintentional production

29. Manufacturers should aim to minimise, as far as technically and practically possible, the unintentional presence of long-chain PFCAs and their related compounds to the largest possible extent from commercial mixtures and materials. In its Annex F submission (2022), the EU provided information on the availability of technologies and the progress made in the EU towards minimising the unintentional production of long-chain PFCAs and their related compounds during the manufacturing of PTFE micro powders, the manufacturing of per- and polyfluorinated chemicals based on a C_6-based chemistries, and in the polymerisation of fluoropolymers containing perfluoroalkoxy-groups.

Minimising the unintentional presence of long-chain PFCAs in PTFE micro powders

30. Processes have been developed to reduce the concentration of PFOA in PTFE micro powders to below the 25 ppb threshold set out in the EU POP Regulation. These processes have been successfully implemented by most PTFE micro powder manufacturers. The remaining manufacturers indicated that they would be able to comply with this limit by 5 July 2022 (ECHA 2020).

31. Similar processes for the reduction of C_9–C_{14} PFCA impurities in PFTE micro powders are being, or have been, developed (ECHA 2020). These processes indicate the potential to reduce the concentration of C_9–C_{14} PFCAs from present levels of 1000 ppb to levels below 400 ppb (in some cases to <25 ppb). Several manufacturers indicated that they are in the process of implementing and validating these technical solutions. Taking into account the time required for the implementation of technical measures to reduce the level of PFOA impurities in PTFE micro powders, it is estimated that these processes may be fully operational by 2022 (ECHA 2020).

Minimising the unintentional presence of long-chain PFCAs in C_6 telomerisation products

32. Telomerisation is now the most commonly used process for manufacturing highly fluorinated substances, including short-chain fluoro substances. The first step involves the reaction of a perfluoroalkyl iodide with a tetrafluoroethylene iodide to form a mixture of perfluoroalkyl iodides with longer perfluorinated chains. This mixture is further distilled which leads to the production of a long-chain side fraction (called PFOI side fraction) and a C_6 main fraction. The long-chain side fraction is separated as an isolated intermediate and not used in the manufacture of C_6 substances (ECHA 2020). The PFOI side fraction consists mainly of long-chain substances with concentration levels as high as 40% of C_{10} to C_{14} compounds and represents approximately 20% of the total volume manufactured, the other 80% being the C_6 main fraction (ECHA 2020).

33. It is estimated that the manufacturing of C_6 chemistry generates 40 to 400 tonnes per year of long-chain perfluorinated compounds (including C_9–C_{14} PFCAs and PFOA) as by-products in the EU (ECHA 2020). The quantity of residual PFOI long-chain side fraction has been reduced in recent years and steps are being taken to reduce it even further. At present, the PFOI long-chain side fraction is exported for use in applications covered by exemptions under the EU POP Regulation/Stockholm Convention listing for PFOA. After expiry of these exemptions, the PFOI long-chain side fraction will be handled as waste and incinerated in an adequate facility (ECHA 2020).

34. The long-chain side fraction accounts for up to 20% of the production volume at present. However, it is expected that the implementation of alternative technologies in the manufacture of C_6 fluoro substances will lead to a reduction in the volume of long-chain perfluorinated compounds as by-products. According to the information available, these alternative technologies are already being implemented in the sector (ECHA 2020).

Minimising the unintentional presence of long-chain PFCAs in fluoropolymers that contain perfluoroalkoxy groups

35. Long-chain PFCAs are generated unintentionally in the polymerisation of fluoropolymers with perfluoroalkoxy-vinylethers. After polymerisation, long-chain PFCAs can be removed either by heat or by adsorption depending on the manufacturing process, although trace levels of long-chain PFCAs may remain as impurities (ECHA 2020).

36. According to the information provided in the call for evidence, best available technologies exist that can reduce long-chain PFCAs in fluoropolymers (fluoroplastics and fluoroelastomers) that contain perfluoroalkoxy groups to concentrations <100 ppb. Since these technologies have been implemented by at least one company, ECHA concluded that similar technologies are also technically feasible for those companies in the process of implementing additional risk management measures to reduce the level of C_9–C_{14} PFCAs in fluoropolymers (ECHA 2020).

2.3.1 Application-specific alternative substances

Textiles and apparel

37. The California Department of Toxic Substances Control (DTSC) (2022) and the Danish Environmental Protection Agency (EPA) (2015) identify a number of potential non-fluorinated alternatives to PFASs (and example products) in treatments for textiles and leather and during the manufacturing of textile and leather products, as summarized in Table 9.

Table 9. Potential alternatives to PFASs in textiles and apparel (California DTSC 2022; Danish EPA 2015)

In treatments for textiles and leather
Silicones[5] found in a variety of commercial products contain a rigid rough surface patterning that allows them to repel liquids effectively and be used as water repellent agents. An example silicone that may be used in treatment products is polydimethylsiloxane.
Silicon dioxide nanoparticles, in particular nano-amorphous silica, can be as an alternative to the use of PFASs in textiles. When nano-silica adheres to the textile, it forms nano-sized air pockets that water cannot penetrate, thus creating a hydrophobic or super hydrophobic surface.
Polyurethanes[6], a diverse class of polymers, can be used to form protective films on surfaces. Different fabrics or consumer goods may require the application of different polyurethanes to provide the specific intended function, such as water repellency or spot-removal.
Non-fluorinated acrylic polymers (or acrylates) can be applied to a wide range of textile products such as carpets, rugs, upholstery, handbags, purses, shoes, boots, wallets, belts, furniture, laundry, and car interiors.
Paraffin waxes can be used in treatments for textiles and leathers, where they consist of an emulsion of paraffins made up of metal salts and fatty acids like stearic acid. Paraffin emulsions containing metal ions create asymmetrical macromolecules with a polar head and hydrophobic tail. These molecules self-orient on textile surfaces, with the more polar metal salts binding to the textile surface and allowing the hydrophobic hydrocarbon chains to face outwards and protect the textile surface from water.
Derivatives of fatty acids (e.g. beeswax, mink oil, fatty acid modified melanine, emulsions of metal salts of fatty acids and paraffins) can be used as repellent treatments.
Titanium dioxide nanoparticles were identified as an alternative to PFASs in textile treatments due to their capacity to absorb energy from light and use that energy to react with and degrade organic contaminants, thus imparting self-cleaning properties. The hydrophobic nature of titanium dioxide also makes it useful in terms of preventing water-based stains.
During manufacturing of textiles and leather products
Dendrimers prevent water, soil, and dirt particles from sticking to the surface of textiles, thus imparting self-cleaning properties. Dendrimers[7] can have varied chemical compositions, they can be hydrocarbon-, polyurethane-, and siloxane-based.
Silanes[8] can be used to treat fabrics for water repellency. Silanes may also be modified with different functional groups so that they react with the textile surface. Various functional groups, particularly chlorine, impart silanes with the property to bind to both organic and inorganic molecules. Because of this, they may be used to modify many of the nanoparticles that are used to create hydrophobicity and other properties on textiles, such as silicon and titanium dioxide nanoparticles.
Surface coating resins based on melamine can be used as stain repellent treatments on textiles. Combinations of stearic acid, formaldehyde and melamine can also be used as repellent treatment for surfaces.

[5] Certain silicones can meet the definition of PFAS in Buck et al. (2011).

[6] Some polyurethanes meet the side-chain fluorinated polymer definition in Buck et al. (2011), and are thus PFASs.

[7] Some dendrimers can contain PFASs.

[8] Some silanes are fluorinated and meet the PFAS definition in Buck et al. (2011).

2.5.1 Access to information and public education

38. Parties and observers have submitted information on the access to information and public education:

(g) Swedish Chemicals Agency Guide on PFASs: https://www.kemi.se/kemiska-amnen-och-material/hogfluorerade-amnen---pfas/guide-om-pfas

(h) Overview of the work conducted by the Swedish Chemicals Agency: https://www.kemi.se/kemiska-amnen-och-material/hogfluorerade-amnen---pfas/kemikalieinspektionens-arbete-med-pfas

(i) PFAS-nätverk - Network with authorities, researchers, municipalities and regional counties established with the main objective to share knowledge and find solutions for the issues related to PFAS and to prevent future problems: https://www.kemi.se/kemiska-amnen-och-material/hogfluorerade-amnen---pfas/pfas-natverk

(j) PM 3/22 Overview of knowledge on PFAS (report commissioned by the Swedish Chemicals Agency): https://www.kemi.se/en/publications/pms/2022/pm-3-22-overview-of-knowledge-on-pfas

(k) Swedish Environmental Protection Agency – Information on PFAS: https://www.naturvardsverket.se/amnesomraden/miljofororeningar/organiska-miljogifter/hogfluorerade-amnen-i-miljon-pfas

(l) Report on PFAS in leachate from landfills (this report presents tools available to follow up and limit the outflow of PFAS from landfills): https://www.miljosamverkansverige.se/wp-content/uploads/2022-01-27-Rapport-PFAS-vid-deponier.pdf

(m) PFAS in drinking water and fish - risk management: https://www.livsmedelsverket.se/en/food-and-content/oonskade-amnen/miljogifter/pfas-in-drinking-water-fish-risk-management

(n) Swedish Food Agency recommendations on risk management measures for drinking water contaminated with PFAS (these recommendations are directed at drinking water producers, local authorities and consumers who have private wells or are consumers of locally caught fish): https://www.livsmedelsverket.se/en/food-and-content/oonskade-amnen/miljogifter/pfas-in-drinking-water-fish-risk-management

(o) Swedish County administrations information related to PFAS-related activities: https://ext-geoportal.lansstyrelsen.se/arcgis/apps/MapSeries/index.html?appid=5c0bd1b677a5400eb09c110e3393d72a

(p) In the Netherlands, the general public is informed through a special website of the national government at: https://www.rijksoverheid.nl/onderwerpen/pfas. Documents are reports are available at: https://www.rijksoverheid.nl/onderwerpen/pfas/documenten and https://www.rivm.nl/pfas.

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