


Updated EHS Summary of PFOA for the MA TURA Science Advisory Board Meeting – November 30, 2016

335-67-1 	Perfluorooctanoic acid Synonym ¹ s: 4-02-00-00994 (Beilstein Handbook Reference); AI3-19341; BRN 1809678; CCRIS 4386; EINECS 206-397-9; Hexanoyl fluoride, 3,3,4,4,5,5,6,6,6-nonafluoro-2-oxo-; NSC 95114; Pentadecafluorooctanoic acid; Pentadecafluoro-n-octanoic acid; Pentadecafluoro-1-octanoic acid; Perfluorocaprylic acid; Perfluorooctanoic acid; Perfluoroheptanecarboxylic acid; Perfluorooctanoic acid; PFOA; HSDB 7137; UNII-947VD76D3L RTECS #²:RH0781000 EINECS #³: 206-397-9 Molecular Weight⁴: 414.064 Molecular Formula⁵: C8-H-F15-O2
PHYSICAL CHARACTERISTICS	
<i>Primary Use</i>	PFOA is used primarily to produce its salts, which are used as essential processing aids in the production of fluoropolymers and fluoroelastomers; In fire-fighting applications, cosmetics, greases and lubricants, paints, polishes and adhesives /Fluorinated surfactants/ ⁶
<i>Physical state, odor at room temperature & pressure</i>	White to off-white powder ⁷ White solid with pungent odor ⁸
<i>Melting point; Boiling point</i>	54.3 deg C; 192.4 deg C ⁹
<i>Solubility</i>	In water, 9.50X10+3 mg/L at 25 deg C (est) ¹⁰
<i>Specific Gravity</i>	1.792 g/mL at 20 deg C ¹¹
SAFETY/PHYSICAL HAZARDS	
<i>Vapor Pressure</i>	5.25X10-1 mm Hg at 25 deg C ¹² 0.15 mm Hg ¹³
<i>Flammability</i>	Flammability: 0. 0 = Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand. ¹⁴
<i>Flashpoint</i>	Not found
<i>Flammability Rating</i>	Flammability: 0. 0 = Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand. ¹⁵
<i>Auto Ignition Point</i>	Not found
<i>Combustion products</i>	Hazardous decomposition products formed under fire conditions - Carbon oxides, Hydrogen fluoride ¹⁶
<i>Explosivity (UEL, LEL, shock sensitive)</i>	Not found
<i>Oxidizer</i>	Not found
<i>Corrosivity</i>	Not found
<i>pH</i>	Not found
<i>Reactivity</i>	Materials to avoid: Bases, Oxidizing agents, Reducing agents; When heated to decomposition it emits toxic vapors of /fluorine/. ¹⁷
<i>Viscosity</i>	Not found

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<i>Odor Threshold</i>	Not found
<i>Particle size, shape, respirable fraction</i>	Not found
<i>Other physical hazards associated with process: Heat, gases under pressure, noise, vibration, ergonomic hazard</i>	Not found
HEALTH HAZARDS	
Acute Toxicity	
<i>Oral LD₅₀</i>	Not found
<i>Dermal LD₅₀</i>	Not found
<i>Inhalation LC₅₀</i>	Not found
<i>Intraperitoneal LD₅₀</i>	Rat = 189 mg/kg ¹⁸
Chronic or Sub-chronic Toxicity	
<i>IARC rating</i>	2B (in preparation)¹⁹
<i>Carcinogenicity</i>	Not found on Prop 65; NTP studies underway
<i>Neurotoxicity</i>	Not mentioned in HAZMAP; Not on Scorecard list
<i>Developmental/Reproductive Toxicity</i>	Not found on Prop 65; Part of group 'Perfluorinated Alkyl Compounds (pfas), Long-chain' indicating developmental and reproductive effects (US EPA – Risk Management Actions & TSCA Work Plans) ²⁰ ; Many reproductive effects studies listed in RTECS
<i>Genotoxicity/Mutagenicity</i>	2 tumor promotion studies listed in CCRIS, but may be pertaining to another substance (Need to pull original study) From NTP: <ul style="list-style-type: none"> • 4 days Comet Assay (Gavage) (G91070B) On Test <ul style="list-style-type: none"> ○ Rats: Sprague Dawley • Micronucleus (G91070) Completed <ul style="list-style-type: none"> ○ Rats: Harlan Sprague-Dawley ○ Male Positive ○ Female Negative • Salmonella (A98283) Completed <ul style="list-style-type: none"> ○ Equivocal²¹
<i>Endocrine Disruption</i>	Found on TEDX list of Potential Endocrine Disruptors ²² On SIN (Substitute It Now) List for Endocrine Disruption, ChemSec ²³
<i>Other organ toxicity</i>	Toxic Pneumonitis, Skin Burns [HazMap] Not found [NIOSH-PG]
Skin, Eye and Respiratory Effects	
<i>Irritant – Skin, Eye, or Respiratory</i>	Skin, eye and respiratory tract irritant ²⁴
<i>Corrosive – S, E, or R</i>	Skin burns; Toxic Pneumonitis ²⁵
<i>Permanent Damage – S, E, or R</i>	Research pending...
<i>Sensitizer – S & R</i>	Not found in AOEC database
<i>Asthmagen – Initiator or Exacerbator</i>	Not found in AOEC database

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<i>Skin Absorption, Kp</i>	Danger of cutaneous absorption ²⁶				
<i>LOAEL</i>	Research pending...				
<i>NOAEL</i>	Research pending...				
<i>Benchmark Dose Response (BMD)</i>	Research pending...				
<i>Metabolites</i>	PFOA is not metabolized and there is evidence of enterohepatic circulation of the compound. ²⁷				
<i>Synergistic or Antagonistic Effects</i>	Not found				
Environmental and Human Health Exposure and Risk Values					
<i>RfC/RfD</i>	Not found				
<i>ATSDR-MRL</i>	Oral, Int., 0.00002 mg/kg/day ²⁸				
<i>Adverse Effect Levels: DNEL, PNEC, PNEL</i>	Not found [HSDB]				
Health Based Exposure Limits					
<i>NIOSH-REL/IDLH/Ceiling Limits</i>	Not found [NIOSH-PG]				
<i>OSHA-PEL</i>	Not found				
<i>ACGIH TLV-TWA</i>	Not found				
<i>TLV-STEL</i>	Not found				
<i>Biomonitoring Action Limits</i>	Research pending...				
<i>Drinking Water Standards</i>	Perfluorooctanoic Acid (PFOA) Drinking Water Health Advisory: 70 ppt. ²⁹				
<i>Other</i>	Add NJ and MN guidelines				
ENVIRONMENTAL & ECO-SYSTEM HAZARDS					
PBT	Priority Persistent Pollutant – Tier 1 (Oregon Department of Environmental Quality); Persistent Organic Pollutant (POP) – under review (Stockholm Convention on Persistent Organic Pollutants (POPs) – Annex A, B & C and under Review (UNEP) ³⁰				
PBT Profiler (Additional information from this site is available in the SAB Current Research folder)					
<i>Water</i>	180	<i>Sediment</i>	1,600*	<i>BCF</i>	56
<i>Soil</i>	360**	<i>Air</i>	31	<i>Fish ChV</i>	1.3
*30% in this medium; **53% in this medium					
<i>K_{ow}</i>	log K _{ow} = 4.81 (est) ³¹				
<i>BCF</i>	56 (est.)				
<i>Ecological/Aquatic Toxicity: LC₅₀, EC₅₀, ErC₅₀, NOAEC/NOEC</i>	17 results in HSDB; 15,500 ug/L for 96-hr, <i>Siriella armata</i> (Mysid) 20 deg C, saltwater, static ³²				
<i>Breakdown/degradation /combustion products</i>	AEROBIC: Perfluorooctanoic acid , present at 100 mg/L, reached 5% of its theoretical BOD in 4 weeks using an activated sludge inoculum at 30 mg/L in the Japanese MITI test(1). Organic fluorochemical compounds, such as perfluorooctanoic acid , are expected to be resistant to biodegradation(2). A related compound, perfluorooctane sulfonic acid, was found to not degrade under aerobic or anaerobic conditions(3). ³³ The rate constant for the vapor-phase reaction of perfluorooctanoic				

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	<p>acid with photochemically-produced hydroxyl radicals has been estimated as 5.2×10^{-13} cu cm/molecule-sec at 25 deg C(SRC) using a structure estimation method(1). This corresponds to an atmospheric half-life of about 31 days at an atmospheric concentration of 5×10^5 hydroxyl radicals per cu cm(1). The occurrence of this compound in remote regions is the result of the long-range transport via the gas-phase of direct releases to both the atmospheric and aquatic environments(2). Organic fluorochemical compounds, such as perfluorooctanoic acid, are expected to be resistant to hydrolysis and photolysis(3). The aqueous photochemical half-life of perfluorooctanoic acid was measured as 256, >5000 and >25,000 years on the ocean surface, open ocean mixing layer and coastal ocean, respectively(4).³⁴</p> <p>Special hazards arising from the substance or mixture: Carbon oxides, Hydrogen fluoride³⁵</p>
<p><i>Other observable ecological effects (e.g. BOD)</i></p>	<p>Research pending...</p>
<p><i>Fate and Transport considerations</i></p>	<p>TERRESTRIAL FATE: Based on a classification scheme(1), log Koc values of 1.92-2.59(2), indicate that perfluorooctanoic acid is expected to have high to moderate mobility in soil(SRC). The pKa values of -0.5 to 4.2(3), indicate that perfluorooctanoic acid will exist entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts(4). Volatilization from moist soil is not expected because the acid exists as an anion and anions do not volatilize(SRC). Perfluorooctanoic acid is not expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 0.0316 mm Hg at 19 deg C(5). A 5% of Theoretical BOD using activated sludge in the Japanese MITI test(6) suggests that biodegradation is not an important environmental fate process in soil(SRC).³⁶</p> <p>AQUATIC FATE: Based on a classification scheme(1), log Koc values of 1.92-2.59(2), indicate that perfluorooctanoic acid is expected to adsorb to suspended solids and sediment(SRC). pKa values of -0.5 to 4.2(3) indicate perfluorooctanoic acid will exist entirely in the anion form at pH values of 5 to 9 and, therefore, volatilization from water surfaces is not expected to be an important fate process(SRC). Organic fluorochemical compounds, such as perfluorooctanoic acid, are expected to be resistant to hydrolysis and photolysis(4). According to a classification scheme(5), BCFs of <5.2-9.4 in carp(6) and 100-230 in mullet(7), suggest bioconcentration in aquatic organisms is low to high. Utilizing the Japanese MITI test, 5% of the Theoretical BOD was reached in 4 weeks(8) indicating that biodegradation is not an</p>

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	important environmental fate process in water(SRC). ³⁷ ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), perfluorooctanoic acid , which has a vapor pressure of 0.0316 mm Hg at 19 deg C(2), is expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase perfluorooctanoic acid is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be 31 days(SRC), calculated from its rate constant of 5.2X10-13 cu cm/molecule-sec at 25 deg C(SRC) that was derived using a structure estimation method(3). Organic fluorochemical compounds, such as perfluorooctanoic acid , are expected to be resistant to photolysis(4). ³⁸
<i>Factors affecting bioavailability</i>	"...PFOA relative bioavailability was mainly affected by lipid content in foods..." ³⁹
Global Environmental Impacts	
<i>Ozone Depletion Potential (ODP)</i>	Not on EPA Ozone Depleting Substances List
<i>Global Climate Change</i>	Not found
<i>Greenhouse Gas Production</i>	Not relevant (solid form)
<i>Acid Rain Formation</i>	Not found
Special Reports	
<i>EU</i>	Substance of Very High Concern (SVHC) and included in the candidate list for authorization ⁴⁰

Notes on chemical research: Not found in NIOSH-PG

¹ www.expub.com; Chemical Identity Page for Perfluorooctanoic acid.

² www.expub.com; RTECS for Perfluorooctanoic acid.

³ ECHA – European Chemicals Database, Accessed online, 9/8/16, <https://echa.europa.eu/information-on-chemicals>

⁴ U.S. National Library of Medicine, ChemIDplus, a Toxnet Database, entry for "Perfluorooctanoic acid ", accessed online at: <https://chem.sis.nlm.nih.gov/chemidplus/rn/startswith/335-67-1>

⁵ U.S. National Library of Medicine, ChemIDplus, a Toxnet Database, entry for "Perfluorooctanoic acid ", accessed online at: <https://chem.sis.nlm.nih.gov/chemidplus/rn/startswith/335-67-1>

⁶ HSDB: Record for Perfluorooctanoic acid, CASRN: 335-67-1, Accessed online, 9/8/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~9xCrMX:1>

⁷ HSDB: Record for Perfluorooctanoic acid, CASRN: 335-67-1, Accessed online, 9/8/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~9xCrMX:1>

⁸ HAZMAP: Record for Perfluorooctanoic acid, Accessed online, 9/8/16, <https://hazmap.nlm.nih.gov/category-details?id=6596&table=copytblagents>

⁹ HSDB: Record for Perfluorooctanoic acid, CASRN: 335-67-1, Accessed online, 9/8/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~9xCrMX:1>

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- ¹⁸ CIDP: Chem ID Plus, Accessed online, 9/8/16 at: <https://chem.sis.nlm.nih.gov/chemidplus/rn/335-67-1>
- ¹⁹ IARC: http://monographs.iarc.fr/ENG/Classification/latest_classif.php
- ²⁰ ChemHAT: Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <http://www.chemhat.org/en/chemical/335-67-1/perfluorooctanoic-acid-pfoa-c-8>
- ²¹ NTP: Genetic Toxicology tests for Perfluorooctanoic acid; Page last updated 8/26/16, Accessed online, 9/9/16: <http://ntp.niehs.nih.gov/testing/status/agents/ts-m040004.html>
- ²² TEDX: Record for Perfluorooctanoic acid, Accessed online 9/8/16 at: <http://www.endocrinedisruption.com/endocrine-disruption/tedx-list-of-potential-endocrine-disruptors/chemicalsearch?>
- ²³ ChemHAT: Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <http://www.chemhat.org/en/chemical/335-67-1/perfluorooctanoic-acid-pfoa-c-8>
- ²⁴ HAZMAP: Record for Perfluorooctanoic acid, Accessed online, 9/8/16, <https://hazmap.nlm.nih.gov/category-details?id=6596&table=copytblagents>
- ²⁵ HAZMAP: Record for Perfluorooctanoic acid, Accessed online, 9/8/16, <https://hazmap.nlm.nih.gov/category-details?id=6596&table=copytblagents>
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- ²⁸ ATSDR: Agency for Toxic Substances and Disease Registry – Minimal Risk Levels (MRLs) – March 2016; Accessed online 9/8/16 at: http://www.atsdr.cdc.gov/mrls/pdfs/atsdr_mrls.pdf
- ²⁹ US EPA: Fact Sheet PFOA & PFOS Drinking Water Health Advisories. November 2016. Accessed online 11/23/16, https://www.epa.gov/sites/production/files/2016-06/documents/drinkingwaterhealthadvisories_pfoa_pfos_updated_5.31.16.pdf
- ³⁰ ChemHAT: Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <http://www.chemhat.org/en/chemical/335-67-1/perfluorooctanoic-acid-pfoa-c-8>
- ³¹ HSDB: Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>
- ³² HSDB: Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>
- ³³ HSDB: [(1) NITE; Chemical Risk Information Platform (CHRIP). Biodegradation and Bioconcentration. Tokyo, Japan: Natl Inst Tech Eval. Available from, as of March 21, 2016: <http://www.safe.nite.go.jp/english/db.html> (2) Hansen KJ et al; Environ Sci Technol 35: 766-70 (2001) (3) Moody CA, Field JA; Environ Sci Technol 34: 3864-70 (2000)] **PEER REVIEWED** Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>
- ³⁴ HSDB: [(1) Meylan WM, Howard PH; Chemosphere 26: 2293-99 (1993) (2) McMurdo CJ et al; Environ Sci Technol 42: 3969-3974 (2008) (3) Hansen KJ et al; Environ Sci Technol 35: 766-70 (2001) (4) Vaalgamaa S

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et al; *Sci Total Environ* 409: 3043-8 (2011)] **PEER REVIEWED** Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>

³⁵ HSDB: [Sigma-Aldrich; Safety Data Sheet for Perfluorooctanoic acid. Product Number: 171468, Version 4.8 (Revision Date 12/28/2015). Available from, as of January 27, 2016:

<http://www.sigmaaldrich.com/safety-center.html> **PEER REVIEWED** Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>

³⁶ HSDB: [(1) Swann RL et al; *Res Rev* 85: 17-28 (1983) (2) Sapulvado JG et al; *Environ Sci Technol* 45: 8106-112 (2011) (3) Goss KU; *Environ Sci Technol* 42: 456-8 (2008) (4) Doucette WJ; pp. 141-188 in *Handbook of Property Estimation Methods for Chemicals*. Boethling RS, Mackay D, eds. Boca Raton, FL: Lewis Publ (2000) (5) Bhatarai B, Gramatica P; *Environ Sci Technol* 45: 8120-8 (2011) (6) NITE; Chemical Risk Information Platform (CHRIP). Biodegradation and Bioconcentration. Tokyo, Japan: Natl Inst Tech Eval. Available from, as of March 21, 2016: <http://www.safe.nite.go.jp/english/db.html> **PEER REVIEWED** Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>

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³⁸ HSDB: [(1) Bidleman TF; *Environ Sci Technol* 22: 361-367 (1988) (2) Bhatarai B, Gramatica P; *Environ Sci Technol* 45: 8120-8 (2011) (3) US EPA; Estimation Program Interface (EPI) Suite. Ver. 4.1. Nov, 2012. Available from, as of March 21, 2016: <http://www2.epa.gov/tsca-screening-tools> (4) Hansen KJ et al; *Environ Sci Technol* 35: 766-70 (2001)] **PEER REVIEWED** Record for Perfluorooctanoic Acid, CASRN: 335-67-1, Accessed online, 11/23/16, <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~4XvTvG:1>

³⁹ Li 2015; Li K, et al. In Vivo Bioavailability and In Vitro Bioaccessibility of Perfluorooctanoic Acid (PFOA) in Food Matrices: Correlation Analysis and Method Development. *Environmental Science & Technology*, 2015, **49(1)**, pp. 150-158.

⁴⁰ ECHA – European Chemicals Database, Accessed online, 11/23/16, <https://echa.europa.eu/information-on-chemicals>