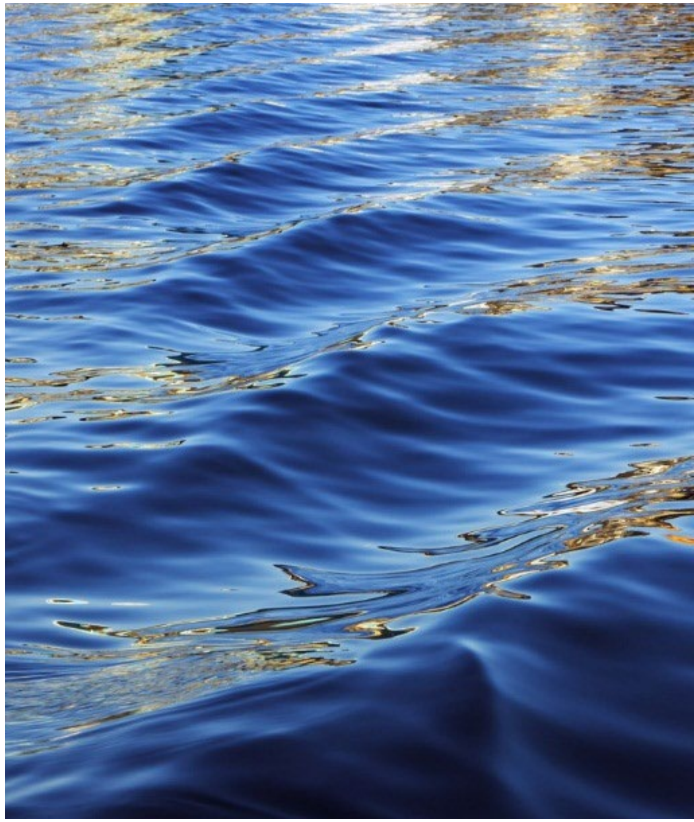
Reported PFAS uses under TURA and safer (non-PFAS) alternatives

Heather Tenney, February 2024



TURA PFAS TIMELINE

- TURA SAB Reviewed PFAS from 2016-2020
- Recommended listing a large category of PFAS
- The SAB reviewed various health impacts as well as a number of degradation/transformation pathways, through which a PFAS precursor breaks down into one of the end degradation products.
- Identified sectors of expected use in Massachusetts
- Guidance and education of companies
- TURA brings preventative approach to other efforts
- First reporting July 2023

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TURA SAB PFAS Evaluation

To understand the characteristics of a range of PFAAs, the SAB examined eight substances of varying chain lengths: PFNA (C9); PFOS and PFOA (C8); PFHpA (C7); PFHxA and PFHxS (C6); and PFBA and PFBS (C4).

The SAB then reviewed two ethers (GenX and ADONA), and phosphonic and phosphinic acids (PFPA and PFPiAs) of varying chain lengths.

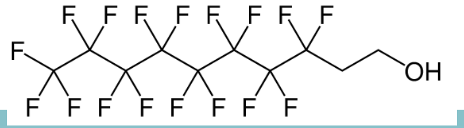
The SAB reviewed various health impacts as well as a number of degradation/transformation pathways, through which a PFAS precursor breaks down into one of the end degradation products.

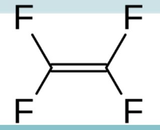
PFAS Precursors and End Degradation Products

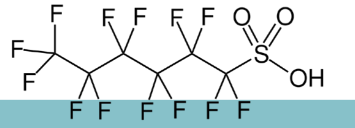
PRECURSORS

Raw Materials

8:2 FTOH	TFE and PFAAs

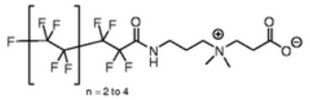


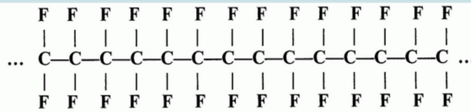


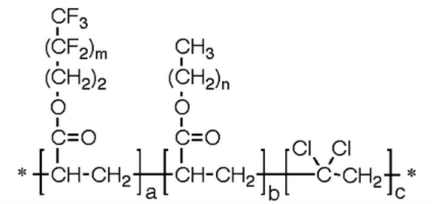


Commercial Products

Surfactants, e.g., AFFF	PTFE (Teflon); side chain polymers



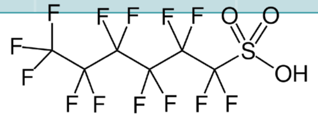




Transient degradation intermediates

Terminal Degradation Products - PFAAs

PFBA	PFBS	PFHxA	PFHxS	PFHpA	PFOA	PFOS	PFNA	GenX	PFPAs



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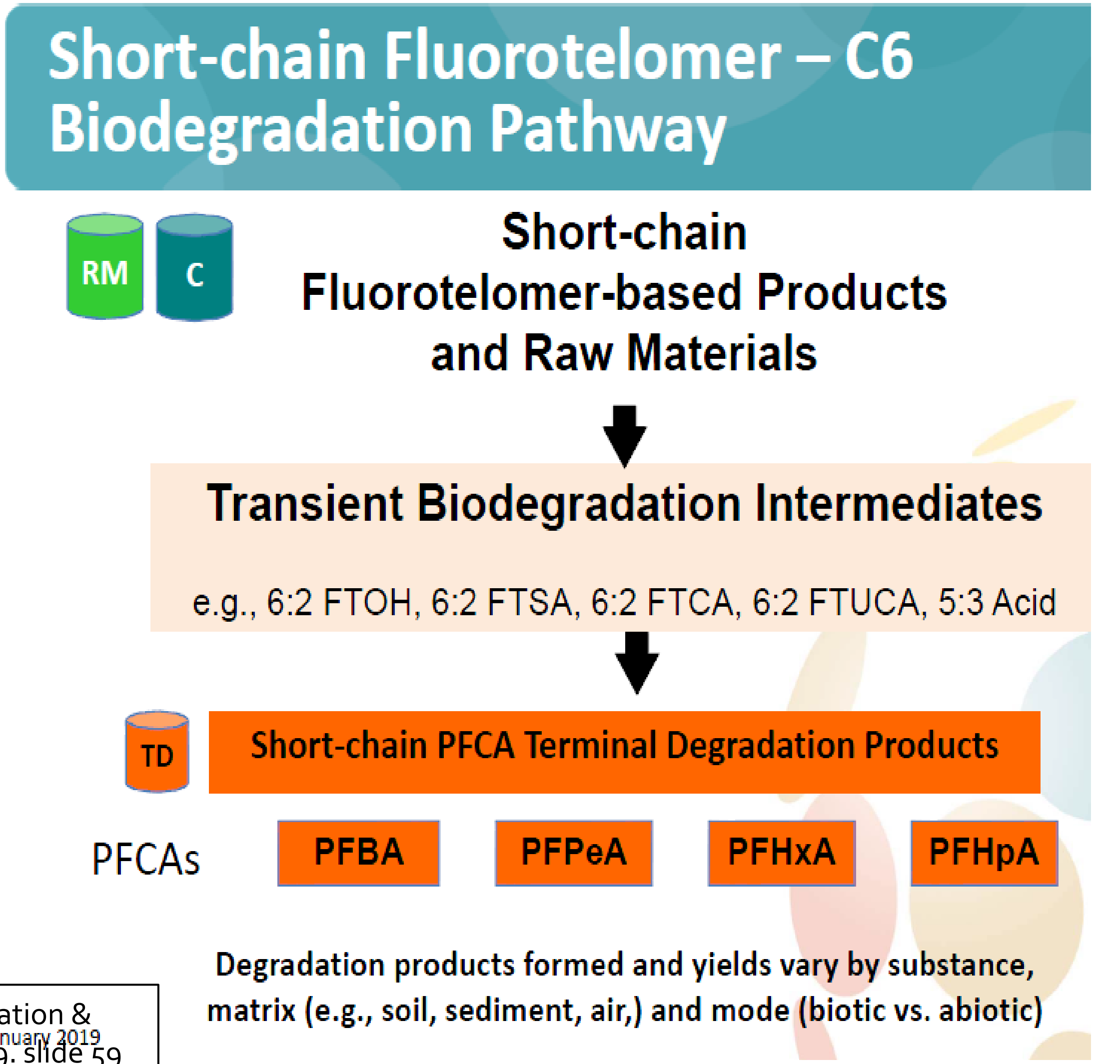
Short-chain Fluorotelomer Biodegradation Pathway



Korzeniowski & Buck; "The PFAS Universe: Uses, Classification & Degradation" Webinar for IC2 & MA TURI. 30 January 2019. slide 59

anuary 2019

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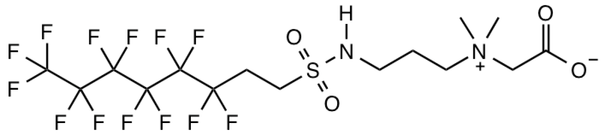
6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) (34455-29-3)
Aqueous photolysis



L.J. Trouborst, 2016. *Aqueous photolysis of 6:2 fluorotelomer sulfonamide alkylbetaine*

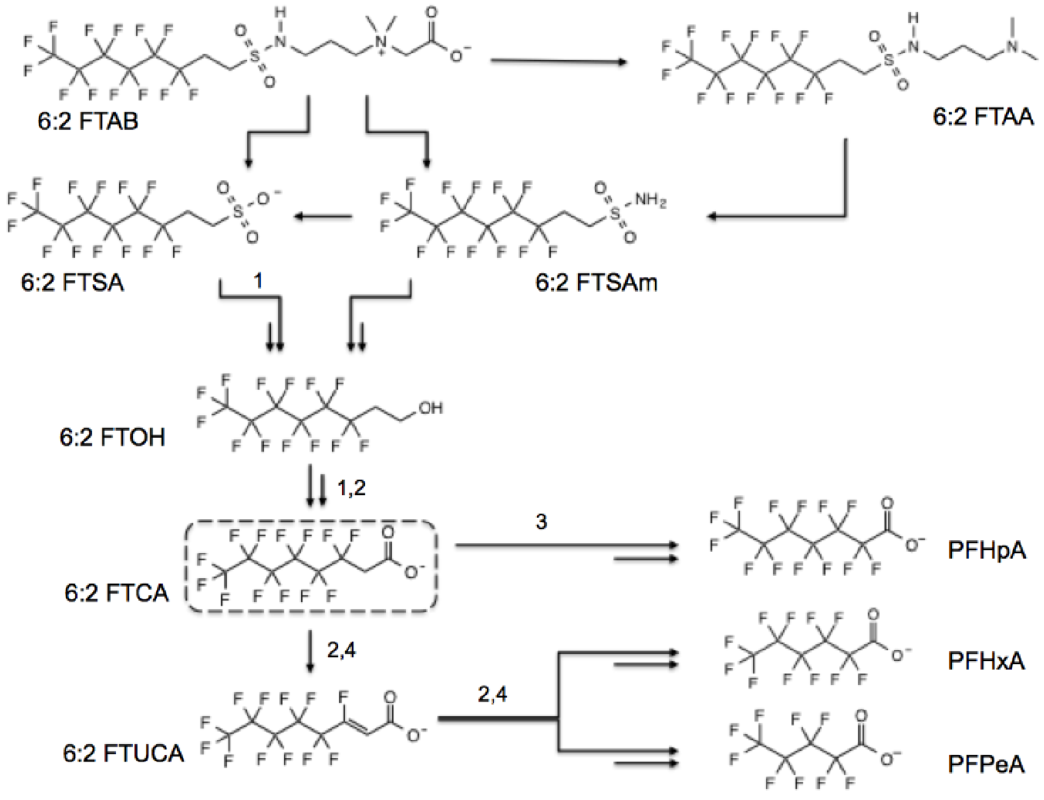


Figure 2.6: Proposed aqueous photodegradation for 6:2 FTAB. Double arrows indicate that a reaction occurs in multiple steps. Only 6:2 FTCA, in the dashed box, was not

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Degradation Pathways

Substance	Type	Terminal Degradation Product
Perfluorohexyl Iodide		PFHxA
C3 Dimer Acid Fluoride	Hydrolysis	Deprotonated HFPO-DA
6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB)	Aqueous Photolysis	PFHpA, PFHxA, PFPeA
Long chain Urethanes, acrylates, etc. based on EtFOSE - N-ethyl perfluorooctane sulfonamide ethanol	Aerobic biodegradation in activated sludge	PFCA, PFSA, PFASi, FASA, FASAA
Perfluoroalkyl Phosphinic Acid (PFPiA)	Oxidation	Perfluoroalkyl Carboxylic Acids (PFCA)
Sulfonamide derivatives: e.g., Urethane Polymers - Perfluoroalkyl sulfonamido ester	Oxidation	PFOS
PFBS salts; sulfonic acid halides; sulfonic alkyl/olefinic/aryl esters,Sulfonamides; sulfones and side-chain fluorinated polymers containing the PFBS moiety. Perfluorobutane sulfinic acid also represents a precursor to PFBS through oxidation to the required sulfonic acid group	Abiotic	PFBS
HFE-7100 and 7200/8200	Atmospheric Degrad	PFBA

TURA Listing

Those PFAS that contain:

- a perfluoroalkyl moiety with three or more carbons (e.g., $–C_nF_{2n}–$, $n \geq 3$; or $CF_3–C_nF_{2n}–$, $n \geq 2$) or
- a perfluoroalkylether moiety with two or more carbons (e.g., $–C_nF_{2n}OC_mF_{2m}–$ or $–C_nF_{2n}OC_mF_m–$, n and $m \geq 1$),

wherein for the example structures shown, the dash (–) is not a bond to a hydrogen and may represent a straight or branched structure, and that are not otherwise listed.

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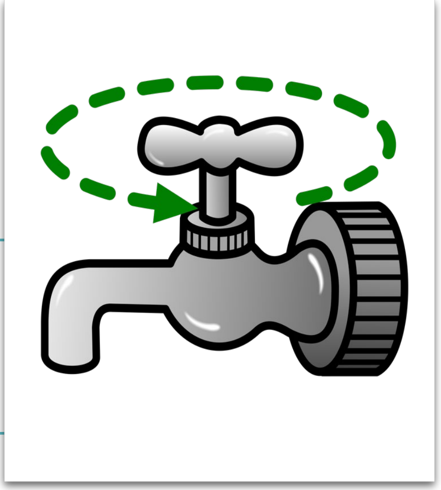
Prevention



Evaluate use and function. Is it necessary?

Identify process improvement opportunities

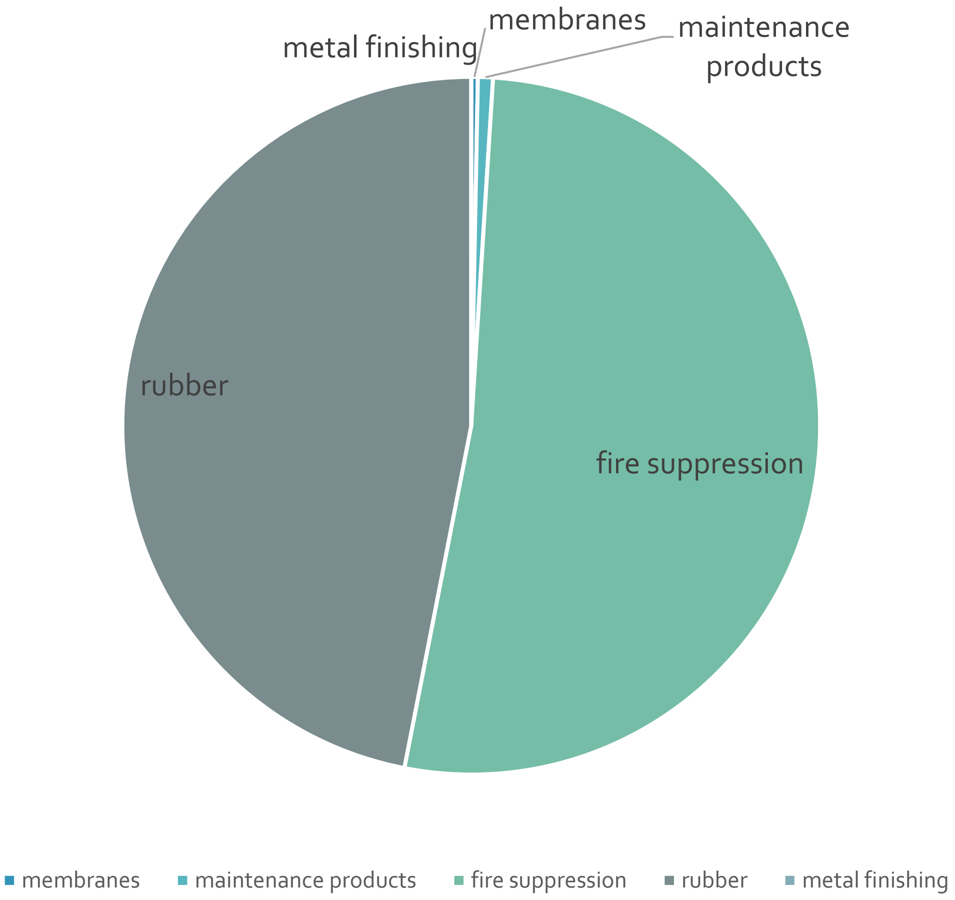
Evaluate safer alternatives

Focus program resources: technical assistance, grants, research, information

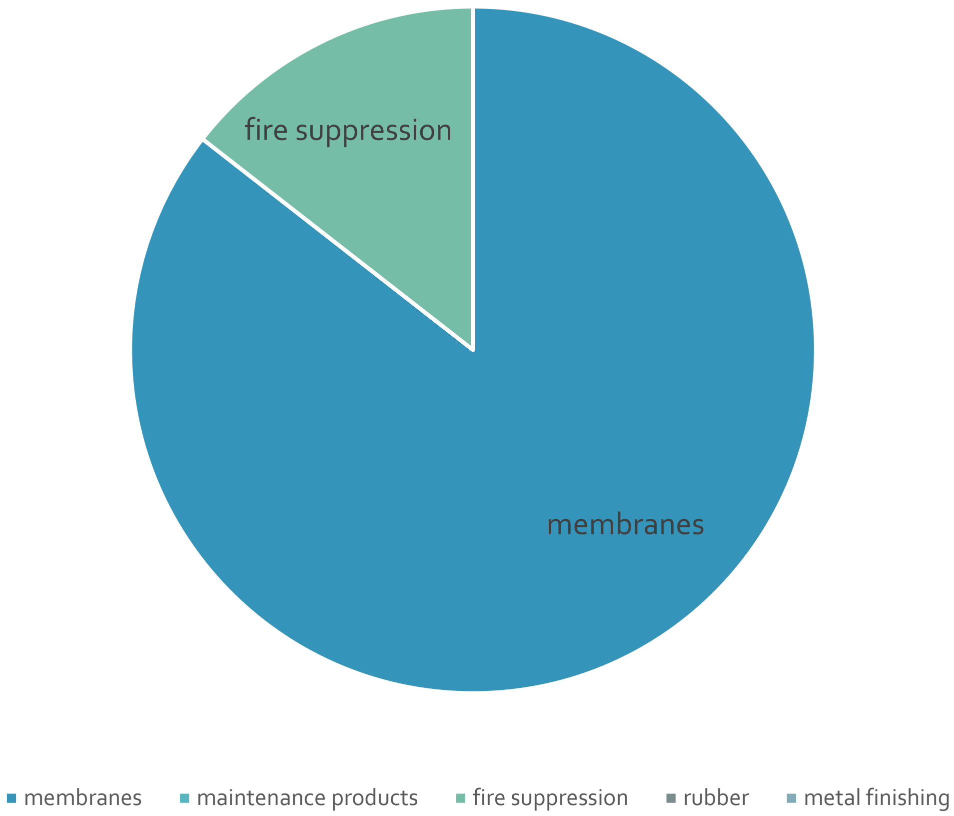
Right-to-Know reporting on use and byproduct

Use and Release of PFAS by TURA Filers

2022 Preliminary PFAS Use by TURA Filers



2022 Preliminary PFAS Releases by TURA Filers



Safer Alternatives

https://www.youtube.com/watch?v=EOAa1YwAiy4

TRANSENE COMPANY, INC.

SUMMARY

Transene worked with the Toxics Use Reduction Institute (TURI), the Massachusetts Office of Technical Assistance (OTA), and the University of Massachusetts Lowell (UMass Lowell) to find safer alternatives

Transene Company, a manufacturer of advanced materials for the electronics industry, wanted to find viable alternatives to perfluoroalkyl substances (PFAS) use in semiconductor manufacturing in response to customer demands for PFAS-free products. Because PFAS have unique properties that can be difficult to replace, Transene's president, Christopher Christuk, turned to TURI and the University of Massachusetts (UMass) Lowell for help.

PFAS, a class of thousands of chemicals, are often dubbed "forever chemicals" because they never fully break down in the environment. Found in a wide array of consumer and industrial products such as waterproof fabrics, food packaging, dental floss and nonstick cookware, PFAS are associated with numerous health risks, including cancer, liver damage, decreased fertility and increased risk of asthma and thyroid disease.

Surfactants based on PFAS are widely used for etching in the semiconductor industry because they are extremely stable even under strongly acidic and alkaline conditions. Although effective, the toxicity and high persistence of PFAS necessitate

PFAS Alternatives- Transene

PFAS-based surfactant in microelectronics etching products

18 month research time

>90% of customers have adopted

Alternative costs $80/gallon versus $2400/gallon for PFAS

PFAS Alternatives- Current research

Automotive fabrics

Coating for food packaging

PFAS Alternatives –Additional activities

Firefighter turnout gear – working toward PFAS-free gear with urging of firefighters

Public education on where PFAS are used in consumer products and ways to find PFAS-free products

Funding testing of consumer products using PIGE

Thank you

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Toxics Use Reduction Institute
University of Massachusetts Lowell