Are you Asking the Right Question?

29 May 2018 Perth

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ENVIRON PTY LTD

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Quick Background Relevant to the Talk

- Current – AMSA project on firefighting foams
- Completed – Review of PFAS in Carpets and Rugs for US policy institute
- Completed – Advice to WA DFES on 6:2 FTSA in DFES firefighting foams
- Upcoming June 2018 – Discussion with US IC2 group - State of Washington, regulators, NGO etc on PFAS and fluorinated firefighting foam issues

- Member PFAS subject matter expert group consisting regulators, policy makers, toxicologists, epidemiologists, research scientists and lawyers from the US, Canada, UK and the EU.
- Publication PFAS papers
- Co-author and adviser for Queensland DES firefighting foam use policy 2016
- Adjunct Professor Murdoch University – PFAS
- Adjunct Associate Curtin University – Hazmat Response and Management
- Former Manager Pollution Response Manager DWER and member 3 WA emergency management committees and Perth Airport Emergency Group
- PhD UWA – soil science and catchment hydrology

Opening Remark

1. It is not just about PFOS, PFOS and PFHxS or 6:2, 8:2 FTSA

2. PFAS precursors break down or transform to Perfluroalky acids such as FTCA, FTUCA, PFCA and PFSA

3. No longer just about perfluoroalkyl chain length – short chain versus long chain

4. ALL fluorinated firefighting foams contain <u>P</u>er<u>F</u>luoro<u>A</u>lkyl <u>S</u>ubstances (PFAS) – <u>fluorine-free foams do not</u>

5. Dont get confuse between Class A and Class B firefighting foams – Class A do NOT or should NOT have PFAS

6. Time can be your Back to the Future headache and liability

Anger over Perth Airport toxic testing delays

Nick Butterly || The West Australian Wednesday, March 7, 2018 02:00AM

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DuPont, Chemours to pay $670 million over PFOA suits

Jeff Mordock, The News Journal Published 8:14 a.m. ET Feb. 13, 2017 | Updated 8:08 a.m. ET Feb. 14, 2017

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(Photo: DANIEL SATO/THE NEWS JOURNAL)

The $670.7 million settlement DuPont and Chemours will pay plaintiffs to settle 3,550 lawsuits related to the release of PFOA, a toxic chemical, is good news for the companies and the plaintiffs, at least according to legal experts and Wall Street analysts.

For the Wilmington-based companies, with a combined 7,500 workers in Delaware, the settlement removes the risk of uncertainty that comes with having to defend 40 lawsuits a year over the course of nearly a century.

BUSINESS | HEALTH | TOP STORIES

DUPONT PLANT ACCUSED OF RELEASING MORE TOXINS INTO RESIDENTIAL AREA

By Janene Pieters on July 20, 2016 - 08:30

Chemours: GenX polluting the Cape Fear since 1980

MOST POPULAR

1 Body found in Beaufort County
Aug 8 at 9:05 AM

2 16-year-old charged in Wilmington shooting death

ADMINISTRATION

5/29/20

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Pentagon Releases Contamination Data

By Sara Jerome
@sarmje

The Pentagon provided its most comprehensive report to date on the scope of its role in water contamination in a recent House Armed Services Committee hearing.

"The water at or around 126 military installations contains potentially harmful levels of perfluorinated compounds. The Defense Department identified 401 active and Base Closure and Realignment installations in the United States with at least one area where there was a known or suspected release of

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DoD: At least 126 bases report water contaminants linked to cancer, birth defects

By: Tara Copp   📅 April 26

U.S. Air Force and New Jersey state fire protection specialists from the New Jersey Air National Guard's 177th Fighter Wing battle a simulated aircraft fire at Military Sealift Command Training Center East in Freehold, N.J., on June 12. The foam used to put out aircraft fires has been tied to cancers and childhood development issues, and the military is working on developing a replacement. (Airman 1st Class Amber Powell/Air Force)

The water at or around at least 126 military installations contains potentially harmful levels of perfluorinated compounds, which have been linked to cancers and developmental delays for fetuses and infants, the Pentagon has found.

Discussions about how to address the HHS study involved EPA Administrator Scott Pruitt's chief of staff and other top aides, including a chemical industry official who now oversees EPA's chemical safety office. | AP Photo

White House, EPA headed off chemical pollution study

The intervention by Scott Pruitt's aides came after one White House official warned the findings would cause a 'public relations nightmare.'

By **ANNIE SNIDER** | 05/14/2018 12:43 PM EDT | Updated 05/14/2018 02:05 PM EDT

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The Game Changers

1. July 2016 – Queensland Foam Policy
2. South Australia EPA foam policy
3. US State of Washington new law restricting sale of fluorinate
4. Germany proposing to restrict short-chain PFAS under REACH Article 57
5. 8 May 2018 US 115th Congress Bill Section 203 announcement shall not require the use of fluorinated chemicals to meet the performance standards
6. ATSDR proposal drinking water health values nearly six times more stringent than the USEPA

So where do PFAS precursors come from

- Fluorotelomer alcohol (FTOH), (N-EtFOSE), (N-MeFOSE) used in the synthesis of various fluorosurfactants and as intermediaries in the manufacture of variety of fluoropolymer products which is then used in a wide range of products
  - E.g. 8:2 fluorotelomers transformed to PFOA
- Fluorotelomer phosphates PAPs – surface treatments
- PFAS precursors in firefighting foams
- PFAS precursors in many industrial processes

Fluorotelomers in foam- Examples:

- 6:2 FTS, 8:2 FTS, 10:2 FTS, 12:2 FTS and other long chain FTS

- 6:2, 8:2, 10:2 and 12:2 fluorotelomer sulfonamide alkylbetaine (FTAB)

- 6:2 fluorotelomer sulfonamide alkylamine (FTAA)

- Perfluoroalkyl betaine (1157)

- Perfluoroalkyl amine oxide (1183)

- 4:2, 6:2, 8:2 fluorotelomer thioamido sulfonate (FTSAS)

- Fluorotelomer thioether amido sulfonate (FtTAoS)

What is a precursor?

Polyfluroalkyl substances that can undergo transformation to form ***per***fluoroalkyl acids

8:2 FtTAoS (precursor) → 8:2 FtS (intermediate) → PFOA (terminal endpoint)
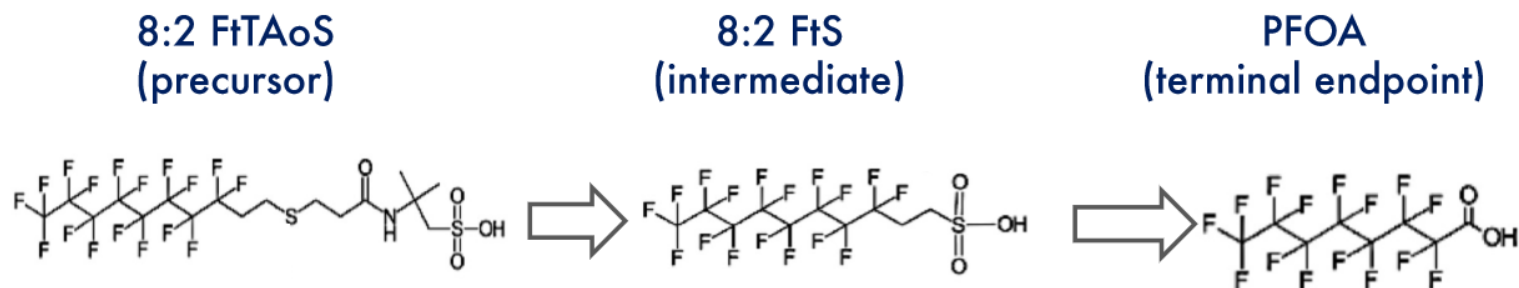
Figure adapted from Ref. 2

2. Harding-Marjanovic, Katie C., et al. "Aerobic biotransformation of fluorotelomer thioether amido sulfonate (Lodyne) in AFFF-amended microcosms." *Environmental science & technology* 49.13 (2015): 7666-7674.

10

Fluorotelomers in foam- Receptors and Precursors

- **Found in river, groundwater, drinking water, soil, sediments, training sites etc**

- **E.g. Table 13 Field and Seow 2017**

- **Precursors that transform or degrade to FTSA and to PFAA (perfluoroalkyl acids)**

- **E.g. Table 12 - Field and Seow 2017**

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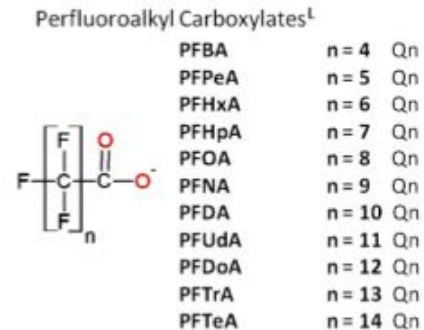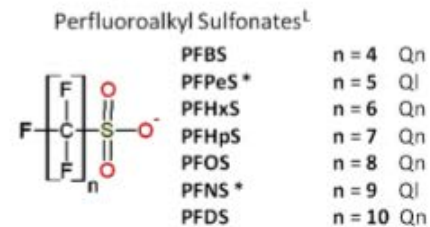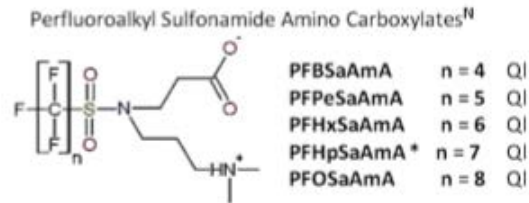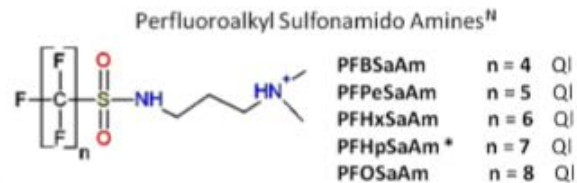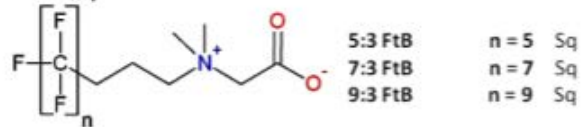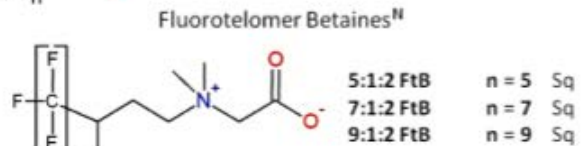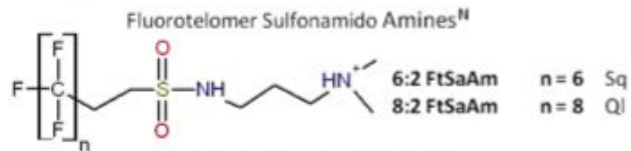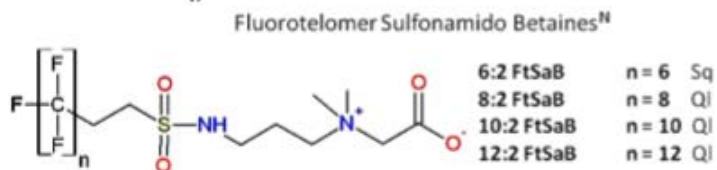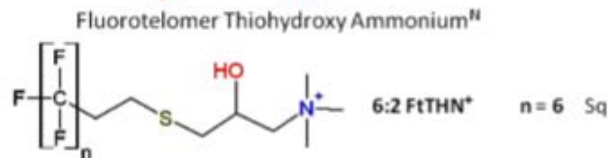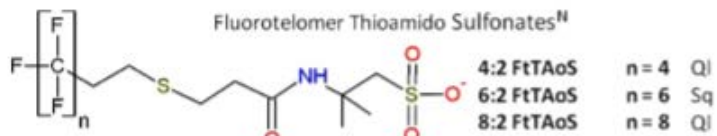
Backe et al 2013 detected various types of PFAS in foams and in groundwater contaminated by AFFF

Table 12. Structures of potential FtSA precursors, including those found in AFFFs, industrial products, and as degradation intermediates.

Structure	Source/Reference	Acronym OR trade name
	AFFF(D'Agostino and Mabury, 2014;Place and Field, 2012;Weiner et al., 2013)	FtTAoSFluorotelomer thioamido sulfonates
	FtTAoS degradation intermediate(Weiner et al., 2013;Harding-Marjanovic et al., 2015) and in AFFF(Harding-Marjanovic et al., 2015)	FtTAoS-sulfoxide
	FtTAoS degradation intermediate(Weiner et al., 2013;Harding-Marjanovic et al., 2015)	FtTAoS-sulfone
	AFFF(D'Agostino and Mabury, 2014;Place and Field, 2012;Moe et al., 2012)	FtSAB (fluorotelomer sulfonamide betaine)
	AFFF(D'Agostino and Mabury, 2014;Place and Field, 2012)	FtSAAm fluorotelomer sulfonamide amines

Field and Seow 2017 – Table 12

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Table 1. Newly Discovered PFASs Found in AFFFs and CPs

Class Number	Structure	$n^{a,b}$	Acronym[c]	Confidence Level[d,e]	AFFF/CP Found In
1		3-6	N-SP-FASA	2b	B, C
2		3-8	N-SPAmP-FASA	2b	A, B, C, F
3		3-9	N-SHOPAmP-FASA	3[f]	C, D, E, F, G
4		4-6	N-SPHOEAmP-FASA	3	B, C
5		3-8	N-SPAmP-FASAPS	2b	A, B, C
6		3-6	N-diHOPAmHOB-FASA	3	B, C, O
7		2-6	N-diHOPAmHOB-FASAPS	3	A, B, C
8		2-8	N-HOEAmP-FASAPS	2b	A, B, C
9		2-8	N-HOEAmP-FASE	2b	A, B, C, D, E
10		4-6	N-HOEAmHOP-FASA	3	B, C
11		2-8	N-HOEAmP-FASA	2b	A, B, C, D, E
12		4-8	N-TAmP-N-MeFASA	3	B
13		3-8	N-TAmP-FASA	3	A, B, C, D, E, F, G
14		3-6	N-TAmP-FASAP	3	D, E, F, G
15		4-6	N-CMAmP-FASAP	2b	D, E, F, G
16		3-6	N-CMAmP-FASA	2b	D, E, F, G
17		6, 8, 10	CMAmEt-FA	2b	L
18		4, 6, 8	CMAmB-FA	3	L
19	$C_{n+8}H_{16}O_2SN_2F_{2n+1}$	6, 8, 10	Not applicable	4	I, J
20	$C_{n+10}H_{20}O_7SN_2F_{2n+1}$ or $C_{n+10}H_{18}O_4SN_2F_{2n+1}$	Un-known	Not applicable	5	I, J

Barzen-Hanson et al 2017 – Newly discovered PFASs in AFFF

CP – commercial products

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PFAS analysis

- **Many methods, e.g., HPLC – MS-MS, LC-QTOF, FAB-MS, TOP Assay Total Oxidisable Precursor Assay, Total Organic Fluorine (TOF), Absorbable Organic Fluorine (AOF), Particle Induced Gamma-ray Emission (PIGE)**

- **Standard protocols, e.g., US EPA Method 537, ISO 25101, USEPA LEAF - Leaching Environmental Assessment Framework**

Foam SDS incomplete

- SDS and Technical Information do not say what is the fluorosurfactant

- Some SDSs don't even declare it has fluorosurfactants

- BOD/COD data at times missing

Foam X SDS fluoroadditives not specified

HAZARDOUS COMPONENTS

CAS-No.	Chemical name	Quantity	Classification
107-41-5	2-methylpentane-2, 4-diol	5 - 10 %	Xi R36/38
7646-85-7	Zinc chloride	1 - 5 %	Xn C N R22-34-50-53
64-17-5	Ethanol	1 %	F R11
	Water and other non-hazardous ingredients, including fluroadditives	84 – 94 %	

	FOAM X Protein Foam μg/L
PFBS	0
PFPeS	0
PFHxS	0
PFHpS	0
PFOS	0
PFDS	0
PFBA	432
PFPeA	37
PFHxA	1042
PFHpA	11
PFOA	18
PFNA	2
PFDA	2
PFUnDA	0
PFDoDA	0
PFTrDA	0
PFTeDA	0
FOSA	0
MeFOSA	0
EtFOSA	0
MeFOSE	0
EtFOSE	0
MeFOSAA	6
EtFOSAA	0
4-2-FtS	370
6-2-FTS	123500
8-2-FTS	146
10-2-FtS	46

## PFOA 18 ppb or 18,000 ppt

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Impurity – PFOA, PFNA – the long chain C8

Houtz PhD 2013 (Houtz, Higgins, Field, Sedlak - Persistence of PFAA precursors in AFFF-impacted GW & soil - ES&T 2103, 47, 8187-8195)

5/29/2018

	Foam product	mmol/L PFBA (C4)	PFPeA (C5)	PFHxA (C6)	PFHpA (C7)	PFOA (C8)	PFNA (C9)	Sum
Chemguard 2008	A1	6.4	11	3.2	1.1	0.3	0.4	22.4
Chemguard 2010	A2	5.9	11	3.5	1.2	0.3	0.4	22.3
Ansul 1986	B1	5.7	10	5.2	4	1.2	0.6	26.7
Ansul 1987	B2	5.6	10	5.2	3.5	1.2	0.5	26
Ansul 2009	B3	6.5	11	3.9	0.9	0.3	0.1	22.7
Ansul 2010	B4	3.6	6	2.3	0.6	0.1	0.1	12.7
Buckeye 2009	C1	6.9	8.9	7.1	7.3	3.4	1.4	35
National Foam 2005	D1	4.1	8	2.6	1.9	0.7	0.7	18
National Foam 2005	D2	4.2	7.4	2.6	2.2	0.7	0.8	17.9
National Foam 2008	D3	5.9	12	3.5	3.2	0.9	1	26.5

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Summary of PFAS Laboratory Data, Sep 2013 to May 2014	PFBS	6:2 FtS	PFHxA	PFHxS	PFHpA	8:2 FtS	PFOS	PFOA	PFOSA	PFNA	PFDA	Total PFCs	
Daniel Hirth ecoforum 2014	C4	C6	C6	C6	C7	C8	C8	C8	C8	C9	C10		
	C4 - PFBS	C6 - 6:2 FtS	C6 - PFHxA	C6 - PFHxS	C7 - PFHpA	C8 - 8:2 FtS	C8 - PFOS	C8 - PFOA	C8 - PFOSA	C9 - PFNA	C10 - PFDA		Sampled
Tyco/Ansul Ansulite ARC 3-6%	0	145	170	0	0	0	0	79	0	0	0	394	30/01/2014
Angus Fire FP70 Plus	0	244	1.27	0	0	125	0.66	22.1	0	0	0	393	30/01/2014
Chemguard T-Storm F-603B		1,166	558		6		4	155		10		1,899	2/05/2014
Chemguard T-Storm F787B		931	40.8			20		152		7.8		1,152	2/05/2014
Chemguard T-Storm FC-601A		1,811	2,360	6.7	87.6	625		196		17.4	4.4	5,108	2/05/2014
Chemguard T-Storm WC103		2,714	188		127	170		190		7.4	21.5	3,418	2/05/2014
Sample-N	1390	4240	2800	8900	0	0.53	35,800	1260	0	0	0	54,391	27/09/2013
Sample-S	0.01	4520	1160	22.8	0	1280	149,000	330	0	0	0	156,313	27/09/2013
Sample-W	0.01	254	0	0	0	0.05	67	22.2	0	0	0	343	27/09/2013
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	ug/L	
EQL	0.02	0.1	0.02	0.02	0.02	0.5	0.02	0.02	0.02	0.02	0.02		

Hirth et al 2014 – look out for the residual PFOS and PFOA and PFNA in the foam with PFAS make up

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To think about

1. Are you doing a point in time only measurement (snap shot) or continuous over a period of time to monitor the contamination
2. Do you <u>know</u> the <u>latest</u> information – science, regulation and policy to act upon or give proper advice
3. Did you provide <u>informed advice </u>to your clients or Board the latest information – science, regulation, policy, thinking
4. Did you <u>forewarn</u> your clients or Board of potential changes in regulation and policy for their decision making or <u>just use </u>the regulation and policy of the day and assume they wont change for some time
5. Did you advice your clients of the <u>risks</u> and <u>consequence</u> of not complying to <u>global best practice let alone legislation and policy </u>and thinking to prevent PFAS impact from their operation
6. Did you consider worst case scenario of class actions and liability for your client or your organisation or even yourself
7. How did you advise your client or Board on closure to reduce risks and liability

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