

# Environmental Management of Firefighting Foam

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Environment, Natural Resources and Regional Development Committee  
CFA Fiskville Inquiry - October 2015

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## Impact Mechanisms & Risks

- Foam characteristics & impact mechanisms
- Queensland awareness and risk review
- Fluorinated organic compound issues
- Regulatory considerations & decisions
- Health issues & worldwide concern
- Foam performance & certification
- Soil and water contamination issues



Bruce Highway - CQ



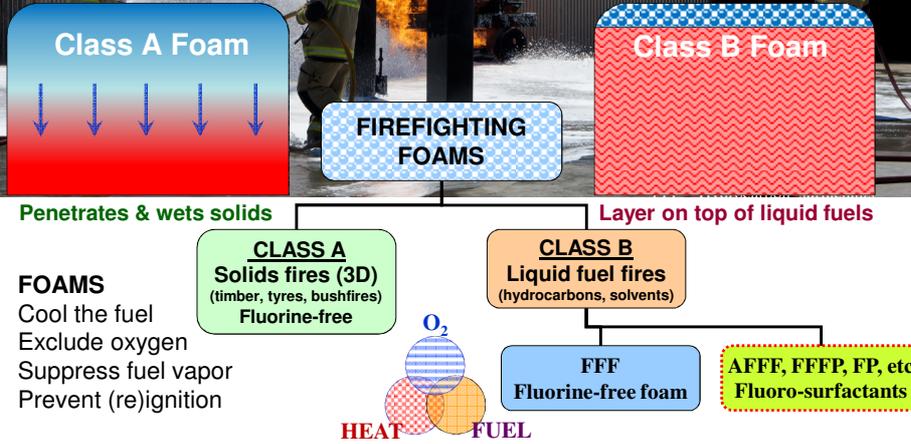
Montara platform WA 2009



Coode Island 1991

Queensland  
Government

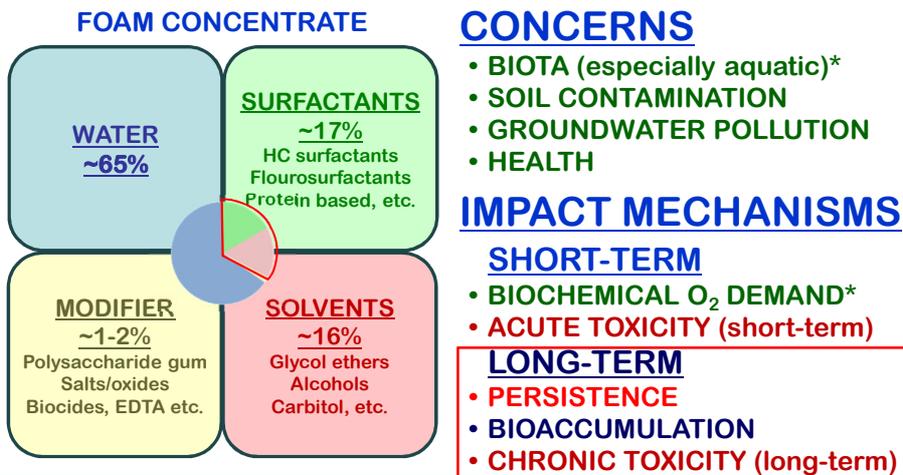
# Fire fighting foam types



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# Fire fighting foam composition



**FIREFIGHTING IS HIGHLY DISPERSIVE**

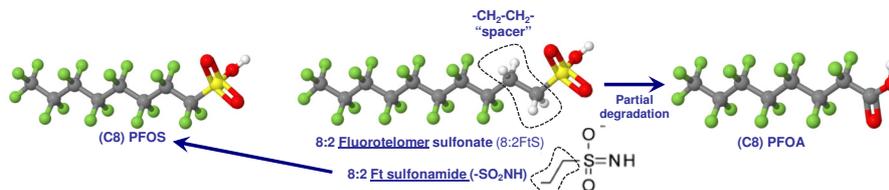
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## Fluorinated Organic Compounds (FOCs)

P  
B  
T

- **Persistence is extreme** (“indefinite” – non-degradable)
- **Bioaccumulative** for many compounds
- **Toxicity** (acute and chronic effects, > for longer C-chains)
- Environmental and health concerns since ~2000
- PFOS of primary concern (but 100s of similar FOCs)
- No alternatives to FOCs for foam until ~2003-2006
- Fluorotelomers and short-chain FOCs are similar



Fluorotelomers 1-4 orders of magnitude more toxic than per-f...  
HEALTH? - Spacer may allow binding in body lipids

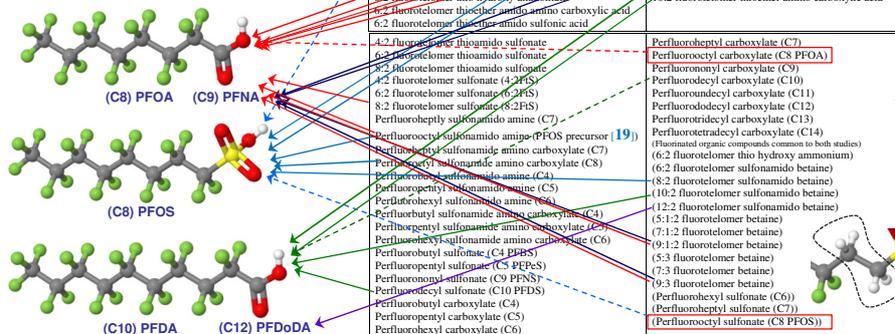
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## Fluorinated organic compounds

### Foam compositions

- No just PFOS & PFOA
- Complex formulations
- Fts transform to PFCs
- E.g. 8:2Ft → PFOA



TRANSFORMATION TO PER-FLUORINATED OF-CONCERN COMPOUNDS ONCE RELEASED

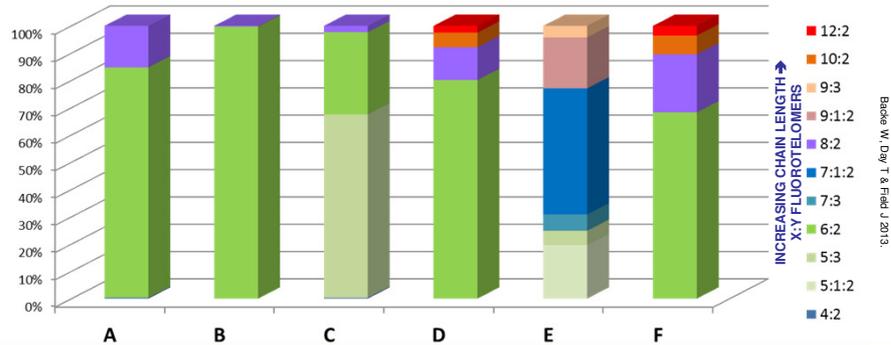
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## Fluorinated organic compounds

### Foam compositions

- Complex formulations (various mixes of C4 to C12 chain lengths)
- Do users know exactly what is in their particular stocks?
- Have foam types or different batches been mixed?



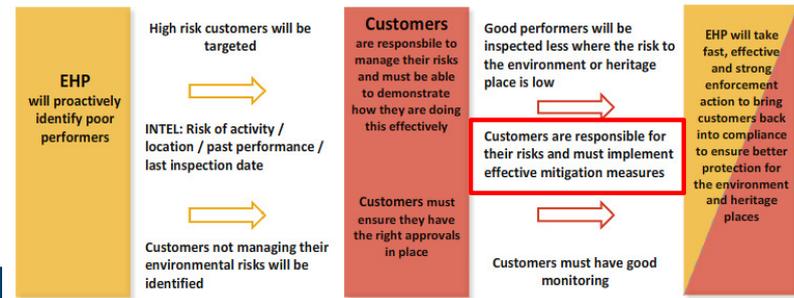
Backe W, Day T & Field J 2013.

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## Environmental Management of Foam

- Recognised as a risk by Queensland in 2011
- Review and clarification of issues (2012-13)
- Industry has not self-regulated effectively
- Regulatory Strategy model (around GED)
- Staged implementation needed



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## Regulatory position

The USER must take all necessary steps to prevent environmental harm (must be able to demonstrate ≈current *best practice*) by:

- Determining all relevant factors.
- Assessing all the relevant risks.
- **Obtaining all relevant information.**

The user carries the risk and liability.  
(The “Polluter Pays” principle)

BUT – Community/Government pay when the polluter can not pay (insolvent or legacy sites)

## Regulatory position (the draft Qld Policy)

- Applies to ALL FOAMS (persistent & non-P).
- Existing environmental legislative coverage.  
(Foam → Acute & Chronic environmental harm)
- Extensive review of current state of technical knowledge & best practice.
- Clarification of standards & requirements for users to meet their obligations.
- Foam risks not well understood by users, very limited information available.
- Consideration of *Ecologically Sustainable Development* & the Precautionary Principle.

## Regulatory position (the draft Qld Policy)

### The *Precautionary Principle* (in decision making)

#### Triggered by:

- ✓ threat of serious or irreversible environmental damage; and
- ✓ scientific uncertainty as to the nature and scope of the threat of environmental damage.

Justice Preston (2006) stated:

*"The function of the precautionary principle is, therefore, to **require the decision-maker to assume that there is, or will be, a serious or irreversible threat of environmental damage** and to take this into account, notwithstanding that there is a degree of scientific uncertainty about whether the threat really exists."*

REF 01

Chief Judge of the NSW Land and Environment Court, Justice Preston in  
*Telstra Corporation Limited v Hornsby Shire Council* [2006] NSWLEC

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## Regulatory position (the draft Qld Policy)

### *Precautionary Principle Considerations*

1. Spatial scale of the threat (local → global)
2. Magnitude of possible impacts (envir. & health)
3. Temporal scale of impacts (days → decades)
4. Manageability of possible impacts
5. Level of concern and supporting evidence
6. Reversibility of impacts
7. Difficulty and expense of remediation

***“Burden of proof for evidence for safety rests on the proposers of a new technology”***

REF 01

Chief Judge of the NSW Land and Environment Court, Justice Preston in  
*Telstra Corporation Limited v Hornsby Shire Council* [2006] NSWLEC

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## The Precautionary Principle Assessment

Assessment factors	Persistent compounds	Non-persistent compounds
<b>1 Spatial scale</b> of the threat	Local, regional, state-wide, national & global	Localised impacts
<b>2 Magnitude</b> of possible impacts	Wider environment & human health, chronic & acute effects	Local aquatic environment – acute effects only.
<b>3 Perceived value</b> of the threatened environment	High perceived values for natural environment & long-term local & broader human health	High perceived value for natural environment
<b>4 Temporal scale</b> of possible impacts	Long-term – Decades to inter-generational presence	Short-term – weeks to months.
<b>5 Manageability</b> of possible impacts	Very poor post release Highly dispersive	Treatable or by natural recovery processes
<b>6 Public concern &amp; scientific evidence</b>	Established & growing concerns with mounting evidence	Limited concern about harm based on established evidence
<b>7 Reversibility</b> of possible impacts	Not reversible or extremely long-term reduction	Reversible with remediation or natural recovery/decay

**ADVERSE EFFECTS**

**UNKNOWN INDICATIONS  
SUSPICIONS EMERGING EVIDENCE**

**SIGNIFICANT EVIDENCE  
CERTAINTY**

Queensland Government

## Health effects of FOCs exposure

Possible health (& env) effects:

- Reproductive impairment
- Chronic kidney disease
- Liver disease
- Endocrine disruption
- Developmental impairment
- Immune system depression
- Cholesterol elevation
- Vaccine interference
- Testicular & kidney cancer
- ADHD, &c.

**Elimination in humans ( $t_{1/2}$ ):**

- **C8, PFOS** – 5.4 years
- **C8, PFOA** – 2.3 to 3.8 yrs
- **C6, PFHxS** – 8.5 years ( $\approx$ C8)  
(! x 5 half lives [ $\downarrow$ ] 15-40 years)
- **Many similar compounds.**
- **Information only emerging about the behaviour and effects of a few.**



REF 02 to 07

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## Environmental Management of Foam Current International directions & concerns

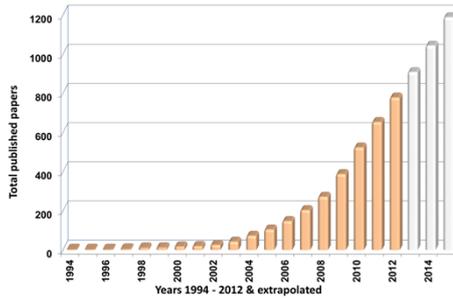
- **Emerging concerns on PFC adverse impacts (environment & health) e.g.:**
  - *Helsingør & Madrid Statements 2014*
  - **ECHA 2014 PFOA Restriction Proposal**

>2,500 papers on PFAS from 2001-2011  
Trojanowicz & Koc 2013

Significant increase in emerging information on fluorinated compounds in peer-reviewed scientific publications since 2008.

Grandjean & Clapp 2015

Industry knowledge (cancers) since 1997  
US (Ohio) PFOA compensation trial evidence in 2015



REF 04 & 08

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After Trojanowicz & Koc, *Microchim Acta* (2013) 180:957–971

## Helsingør & Madrid Statements

Chemosphere 114 (2014) 337-339 & Dioxin 2014 Symposium, Madrid, 2014

### Scientific community concerns:

- **Widespread occurrence of fluorinateds**
- **Extreme persistence**
- **Lack of decline & increasing exposure**
- **Impacts of fluorinated alternatives**
- **Lack of info & testing for 100s of FOCs**
- **Lack of transparency by manufacturers**
- **Health & environmental impacts of FOCs**
- **Synergistic effects likely but unknown**
- **World-wide & tighter regulation needed**
- **Problematic & costly waste disposal**
- **Suggest cease use of all FOCs**
- **Develop non-toxic alternatives**



REF 09 & 10

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## Non-persistent foam performance (FFF)

- **All foams are performance tested to the same standards according to the intended application.**
- **Certified for every major application including:**  
LAST Fire (tanks), EN1568(1-4), DEF(Aust) 5706, ICAO Level B&C, AS5062, IMO (shipping) and reputedly US Mil Spec/UK Defence Specification.
- **Tests are by carried out to strict standards by independent certifying agencies.**  
(MPA Dresden, CAAi UK, FM Approvals, Underwriters Laboratories Inc., SP Technical, Resource Protection International, SP Sweden, DNV Norway, CSIRO Activfire, etc).
- **Foams are specific to particular uses and must be used correctly to work as intended.**

## Non-persistent foam performance (FFF)

Industry Application	Australia/New Zealand	FFF meets required specifications
<b>LAST Terminal Facilities &amp; Refineries</b> hydrocarbons, blends and polar solvents	LAST Fire Test & EN1568 (some UL / FM for fixed systems)	Yes
<b>Aviation</b> hydrocarbon fuels	ICAO & EN1568	Yes
<b>Offshore</b> hydrocarbon fuels, some methanol polar solvent	ICAO & EN1568	Yes
<b>Fire Services</b> hydrocarbons, blends and polar solvents	ICAO & EN1568	Yes
<b>Defence</b> (Army, Air Force, Navy)	DEF(Aust)5706 / ICAO Level B	Yes <sup>(Note 2)</sup>
<b>Royal Australian Navy</b> <sup>(Note 3)</sup>	US Mil Spec / UK Defence Spec	Yes <sup>(Note 2)</sup>
<b>Ports, Tugs and ships</b>	EN1568 / DNV	Yes
<b>Oil and Gas Industries</b>	LAST Fire Test & EN1568 (some UL / FM for fixed systems)	Yes
<b>Mines</b>	EN1568	Yes
<b>General Industry</b> Chemical Industries, Power Stations, etc	EN1568 & LAST Fire Test (some UL / FM for fixed systems)	Yes
<b>Mining Heavy Vehicles</b>	AS5062	Yes
<b>Hand Held Extinguishers</b>	AS1841	Provisional <sup>(Note 5)</sup>

Note 2 – Legacy US MilSpec specifies FOC content in addition to performance standards, changes being considered  
 Note 5 – Approved EU, under consideration in Australia

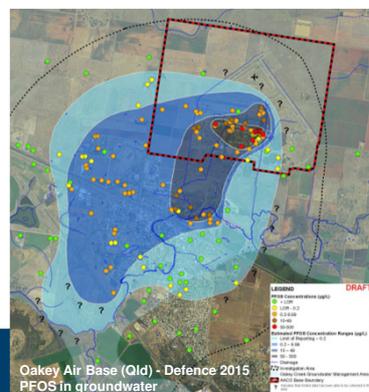
## Non-persistent foam uptake

- **Queensland Fire Service since 2003**
- **Most Queensland sea ports since 2014**
- **AirServices Australia since 2010**
- **Overseas airports ~90**
- **North sea offshore oil & gas platforms (~40)**
- **Fire brigades (5 Aust, 19 overseas)**
- **Petroleum producers ~20**
- **Other corporations ~47**



## Legacy issues & contaminated sites

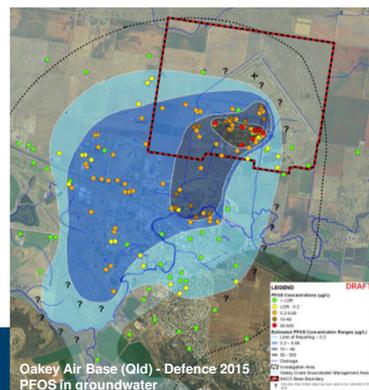
- **Multiple sites with legacy contamination of soils, waterways and groundwater.**
- **Need for investigation & clean-up standards.**
- **CRC-CARE project considering screening values for PFOS, PFOA & possibly fluorotelomers.**
- **\*USEPA drinking water Provisional Health Advisory**
  - **PFOS 0.2 µg/L**
  - **PFOA 0.4 µg/L.**



\*REF 11  
 CRC-CARE (Contamination Assessment & Remediation of the Environment)  
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## Legacy issues & contaminated sites

- Current engagement across agencies to determine appropriate and consistent contamination assessment standards.
- **Australian soil screening criteria not established.**
- Suggestion for Health Investigation Levels (HIL) for PFOS\*:
  - Residential 4 mg/kg
  - Commercial 400 mg/kg
 (However, may not take into account PFC mobility, e.g. Oakey)



\*REF 11

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### REFERENCES

- REF01** - Justice Kevin Bell, Supreme Court of Victoria, 2010. *"The precautionary principle: what is it and how do courts use it to protect the environment?"* Environment Defenders Office Seminar Series 2010
- REF02** - Sarah Dee Geiger, Jie Xiao, & Anoop Shankar, 2013. *Positive Association Between Perfluoroalkyl Chemicals and Hyperuricemia in Children.* Am J Epidemiol. 2013;177(11):1255–1262
- REF03** - Philippe Grandjean and Esben Budtz-Jørgensen, 2013. *Immunotoxicity of perfluorinated alkylates: calculation of benchmark doses based on serum concentrations in children.* Environmental Health 2013, 12:35, 1-7.
- REF04** - Philippe Grandjean and Richard Clapp, 2015. *Perfluorinated Alkyl Substances: Emerging Insights Into Health Risks.* NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy 1–17.
- REF05** - The National Institute of Environmental Health Sciences, 2012. *Perfluorinated Chemicals (PFCs).* 1-4.
- REF06** - Michigan Department of Community Health, 2014. *HEALTH CONSULTATION - Technical Support Document for Assessment of Perfluorinated Chemicals and Selection of a Perfluorooctane Sulfonate (PFOS) Reference Dose as the basis for Michigan Fish Consumption Screening Values (FCSVs).* 1-66.
- REF07** - Anoop Shankar, Jie Xiao and Alan Ducatman, 2011. *Perfluoroalkyl Chemicals and Chronic Kidney Disease in US Adults.* Am J Epidemiol. 2011;174(8):893–900.
- REF08** - ChemistryWorld (Rebecca Trager), 2015. *DuPont found liable for cancer case.* Web article. 13 October 2015.
- REF09** - Martin Scheringer, Xenia Trier, Ian T. Cousins, Pim de Voegt, Tony Fletcher, Zhanyun Wanga, Thomas F. Webster. *Helsingør Statement on poly- and perfluorinated alkyl substances (PFASs).* Chemosphere 114 (2014) 337–339
- REF10** - Blum, Arlene and 13 others. 2014 "The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs)" Dioxin 2014 Symposium.
- REF11** - Australian Department of Defence, 2015. *Army Aviation Centre Oakey Environmental Investigation Fact Sheet 3.*
- REF12** - Giorgio De Nola, Alan Bull, Anthony Lane - Cardno, 2015. *PFOS and PFOA: Screening criteria and what health investigation levels might look like.* Cleanup 2015 Conference Melbourne 13-16 September 2015.

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<b>PFOS</b> Health Guidelines	Drink water µg/L (ppb)	Soil Residential mg/kg (ppm)	Soil Commercial/Industrial mg/kg (ppm)
Australia	None yet	None yet	??
Germany	0.1		
USEPA	0.2	6	
Minnesota Department of Health	0.3		
Minnesota Pollution Control Agency		2.1	
Norway SFT		0.1	
Canada	0.3		
UK	>0.3		
Dutch National Institute for Public Health and the Environment	0.65 ng/L (ppt) fresh water		
Minnesota Pollution Control Agency		1.1	14

Source – Summary by Dr Jimmy SEOW WA.

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<b>PFOA</b> Health Guidelines	Drink water µg/L (ppb)	Soil Residential mg/kg (ppm)	Soil Commercial/Industrial mg/kg (ppm)
Australia	None yet	None yet	??
New Jersey US	0.04		
Germany	0.1		
Minnesota Department Health	0.3		
Minnesota Pollution Control Agency		2.1	
Canada	0.3		
USEPA	0.4	16	
West Virginia	0.5		
North Carolina	0.63		
UK	>0.3		
Minnesota Pollution Control Agency		1	14

Source – Summary by Dr Jimmy SEOW WA.

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**Non-persistent foam used on tanker rollover into tidal mangrove area (Gladstone)**

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