

# Alternatives Assessment for Aqueous Film Forming Foams: Lessons Learned

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# A focus on alternatives assessment

Used for “informed substitution”

A process for identifying, comparing and selecting safer alternatives to chemicals of concern

Evaluates

- Hazard
- Exposure potential
- Lifecycle considerations
- Cost
- Performance

Facilitates informed consideration of the various pros/cons of alternatives to inform selection and adoption



# Background

- FY 2020 NDAA: Requires DoD to phase out use of PFAS-containing AFFF at military installations by October 1, 2024
- FY 2021 NDAA: Requires DoD to prioritize research on AFFF alternatives that utilize “green and sustainable chemicals that do not pose a threat to public health or the environment.”
- Project included several objectives, among them:
  - Understanding gaps in comprehensive alternatives assessments for AFFF.
  - Understanding lessons learned from existing efforts to accelerate development and adoption of safer alternatives to AFFF, including barriers and enabling factors.

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Conducted in collaboration with NEWMOA and MA TURI

# Alternatives Assessments on AFFF

Is it an alternatives assessment? Criteria used:

1. Evaluates commercially available alternatives
2. Evaluates hazard, cost and performance attributes
3. Uses standardized assessment criteria for attributes to systematically evaluate and compare alternatives to the incumbent
4. Includes fluorine-free alternatives and the incumbent product (AFFF)/chemical of concern

Refighting Capabilities Assessment of Commercially Available PFAS-Free Foam and Agents

WP19-5324

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Final Debrief

25 February 2021

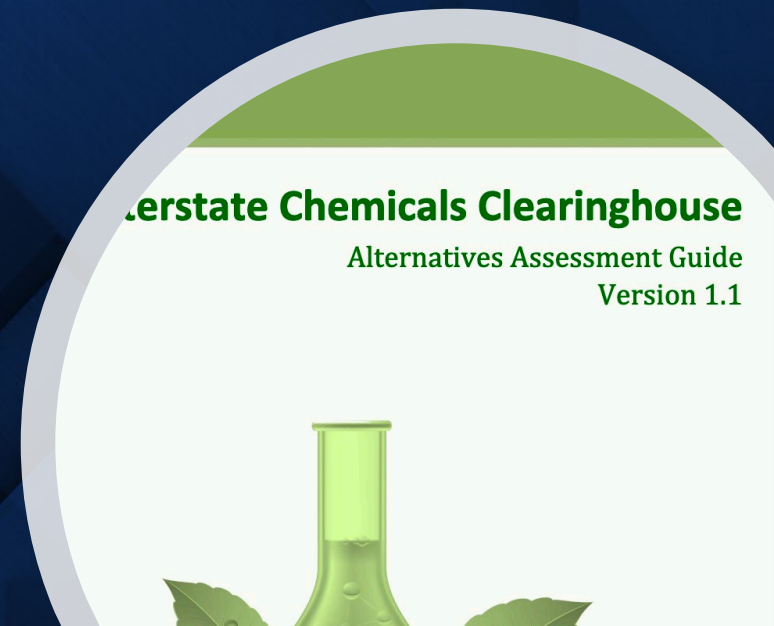
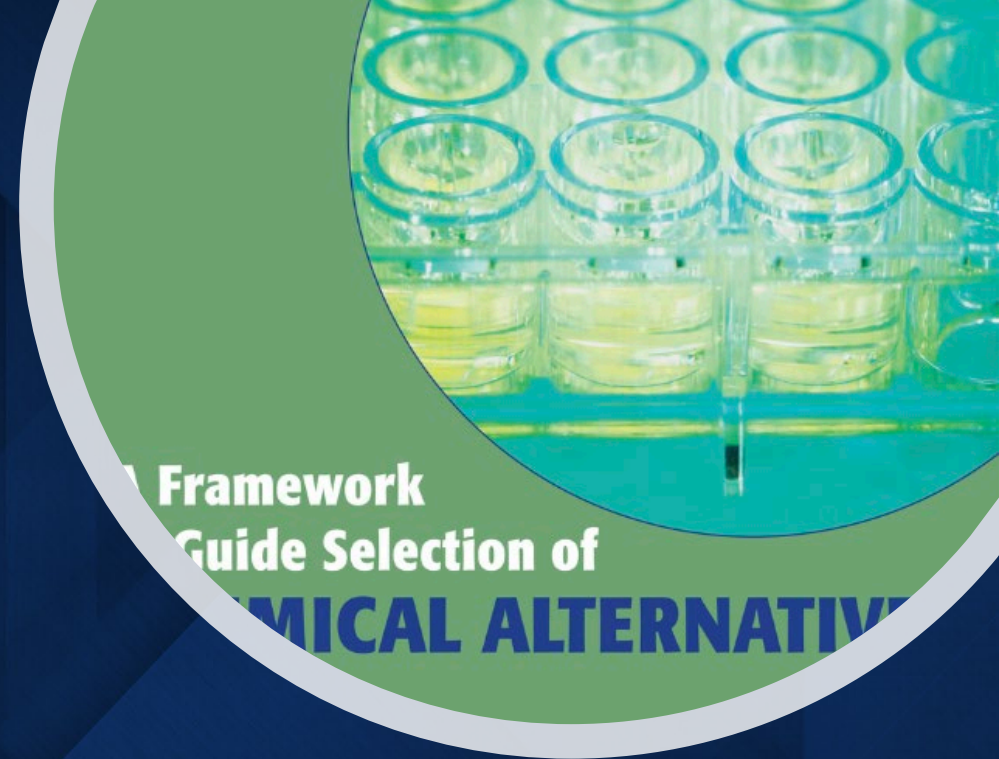


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# Review methodology

- Existing assessments were compared to two widely accepted alternative assessment frameworks that were developed to support informed substitution activities:
  - US NRC (2014)
  - IC2 frameworks (2017)
- This critical review focused on:
  - methods used in the alternatives assessment,
  - endpoints evaluated
  - how issues of uncertainty and data gaps were addressed



Component	What it involves
<b>Scoping, problem formulation, identifying alternatives for consideration</b>	Establishes the scope of and plan for the assessment. Identifies stakeholders to engage and decision rules that will guide the assessment. Gathers data on the chemical of concern, its function and application. <b><i>Asks the question: Is this function necessary? If so, what other alternatives should be considered?</i></b>
<b>Hazard/comparative exposure assessment</b>	Evaluates <b><i>human health and ecological hazards</i></b> and assesses <b><i>intrinsic exposure potential</i></b> .
<b>Technical feasibility assessment</b>	Assesses the <b><i>performance</i></b> of alternatives against the needs established during the problem formulation step above.
<b>Economic feasibility assessment</b>	Assesses the <b><i>economic</i></b> feasibility of alternatives.
<b>Other life cycle considerations</b>	Addresses additional <b><i>potential up-stream or downstream ecological and human health hazards</i></b> as well as <b><i>other potential trade-offs</i></b> such as energy, climate change impacts, and natural resources.
<b>Decision making</b>	Combines information from previous steps to evaluate trade-offs and preferences to <b><i>identify acceptable alternatives</i></b> . Establishes an <b><i>implementation and adoption plan</i></b> . Where no alternatives are currently viable by <b><i>initiating R&amp;D</i></b> to develop new alternatives or improve existing ones and.

European Commission DG Environment / European Chemicals Agency (ECHA)

**The use of PFAS and fluorine-free alternatives in fire-fighting foams**

Final report  
Specific contracts No 07.0203/2018/791749/ENV.B.2 and ECHA/2018/561



## Only one assessment meet inclusion criteria for an alternatives assessment

- Report commissioned by the European Chemicals Agency, undertaken by Wood, Ramboll and Cowi)
- Aim of the ECHA study was to collect information to support risk management options, including information necessary for the consideration of alternatives in a restriction proposal.

# ECHA Assessment – Short List of Alternatives Considered

Total of 168 alternatives originally were identified.

- Streamlined using stakeholder engagement

Siloxane alternatives excluded because of health and safety concerns associated with the class.

1. Angus Fire Respondol ATF 3-6%
2. Solberg Re-Healing Foam RF3x6 ATC
3. Solberg Re-Healing RF1 1%
4. Dr. Sthamer Mousool FF 3x6 F-15
5. Dr. Sthamer FOAMOUSSE 3% F-15
6. ECOex SAS Ecopol Premium
7. Orchidex BlueFoam 3x3



# Notable Lessons Learned

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**Broaden the assessment scope to not limit the functional use for AFFF alternatives to just film forming foams.** Only film forming foams were included, which precludes other alternatives that can extinguish flames via other processes/ mechanism.



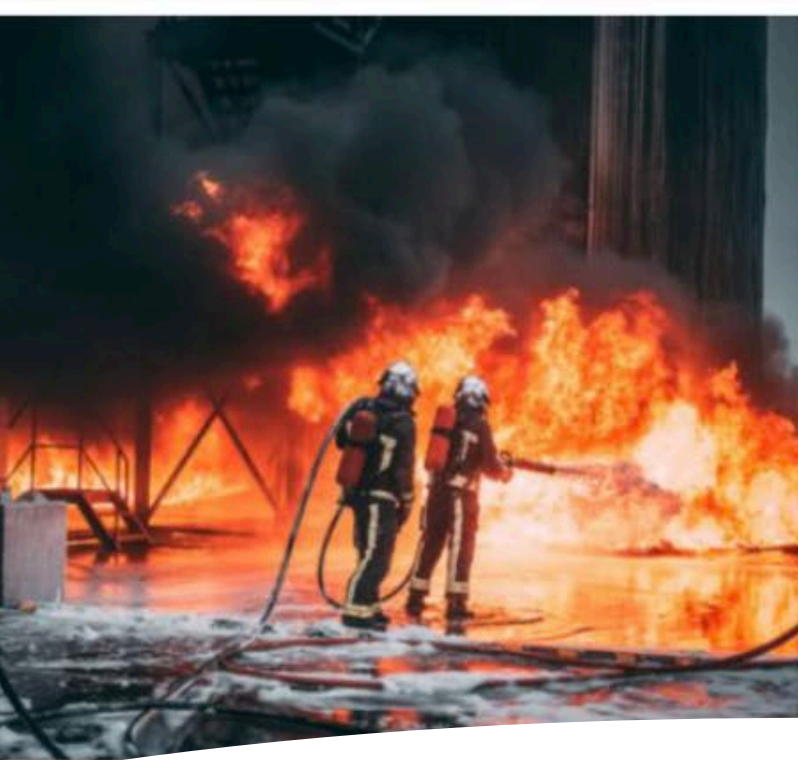


Photo credit: Arjan Bruinstroop AIFireE, NFPA 2021 Workshop

## Notable Lessons Learned

**Incorporate case studies into alternatives assessment practice.** Use of case studies in the ECHA assessment added greater understanding of specific performance and economic assessment criteria.

# Notable Lessons Learned

**ANGUS FIRE** JetFoam 3%  
Safety Data Sheet  
according to Regulation (EC) No. 1907/2006 (REACH) with its amendment Regulation (EU) 2015/830  
Date of issue: 01/12/2014 Revision date: 16/04/2021 Supersedes: 02/12/2020 Version: 2.3

**SECTION 1: Identification of the substance/mixture and of the company/undertaking**

1.1 Product identifier  
Product form: Mixture  
Product name: JetFoam 3%  
Product code: FC 05 08  
Type of product: Firefighting foam concentrate (Fluorine Free)

1.2 Relevant identified uses of the substance or mixture and uses advised against

1.2.1 Relevant identified uses  
Industrial/Professional use spec: Industrial  
Use of the substance/mixture: For professional use only  
Firefighting foam concentrate

1.2.2 Uses advised against  
No additional information available

1.3 Details of the supplier of the safety data sheet  
ANGUS FIRE Ltd  
Station Road  
LA2 7NA Bortham - United Kingdom  
T +44(0) 1524 264000 - F +44(0)1524 264180  
general.enquiries@angus.co.uk - www.angusfire.co.uk

1.4 Emergency telephone number  
Emergency number: +44(0) 1524 264000 (Standard office hours: Monday to Friday 8:30am - 4:30pm GMT)  
Contact person: EH&S Manager

Country	Organisation/Company	Address	Emergency number	Comment
United Kingdom	National Poisons Information Service (Birmingham Centre)	Dudley Road B177QH Birmingham City Centre	0344 892 0111	

**SECTION 2: Hazards identification**

2.1 Classification of the substance or mixture  
Classification according to Regulation (EC) No. 1272/2008 [CLP]  
Serious eye damage/eye irritation, Category 1 H318  
Full text of H statements - see section 16

Adverse physicochemical, human health and environmental effects  
No additional information available

2.2 Label elements  
Labelling according to Regulation (EC) No. 1272/2008 [CLP]  
Hazard pictograms (CLP)



Signal word (CLP): Danger

Hazardous ingredients: Amphiphilic surfactant blend; Anionic surfactant blend

Hazard statements (CLP): H318 - Causes serious eye damage

Precautionary statements (CLP): P280 - Wear eye protection, protective clothing, protective gloves  
P303+P361+P353 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
P501 - Immediately call a doctor.

**SAFETY DATA SHEET**  
Based on Regulation (EC) No. 1907/2006 (REACH) Article 31 and Annex II

**RE-HEALING FOAM RF3 3%**

**1. Identification of the substance/preparation and of the company/undertaking**

1.1 Identification of the substance or preparation:  
Product name: RE-HEALING FOAM RF3 3%  
Synonyms: RE-HEALING FOAM RF3; RE-HEALING FOAM 3%  
CAS No.: N.A.  
EC index No.: N.A.  
EINECS No.: N.A.  
RECS No.: N.A.  
NFA code: N.D.  
Molecular weight: N.A.  
Formula: N.A.

1.2 Use of the substance/preparation:  
Fire extinguishing medium concentrate

1.3 Company/undertaking identification:  
SULBERG SCANDINAVIAN AS - NORWAY  
OIEVOLLSTANDA  
5938 Sabevågen  
Tel: +47 56 34 97 00  
Fax: +47 56 34 97 01  
e-mail address: linc@recticfoam.com

1.4 Emergency telephone:  
+47 97640000 (24h/24h)

**2. Hazards identification**  
- Irritating to eyes

**3. Composition/information on ingredients**

Hazardous ingredients	CAS No. EINECS/ELINCS No.	Conc. (%)	Hazards (R-phrases)	Hazard symbol
2-(2-butoxyethoxy)ethanol	112-34-5 203-961-6	<20	36 (1)(2)	X1
starch	9005-25-8 232-679-6	>1	- (2)	-
tri(2-hydroxyethyl)ammonium dodecylsulfate	139-96-8 205-388-7	<20	36/38 (1)	X1
alpha-sulfo-omega-hydroxy-poly(oxy-1,2-ethanediyloxy-11-allyl ether, sodium salt	96130-61-9	<5	38-41 (1)	X1
1-propanaminium, 3-amino-N-(carboxymethyl)-N,N-dimethyl-, N-ocoo acyl derivative, hydroxide, inner salt	61789-60-0 263-058-8	<20	36 (1)	X1
1-propanaminium, N-(3-aminopropyl)-2-hydroxy-N,N-dimethyl-3-sulfo-, N-ocoo acyl derivative, hydroxide, inner salt	68139-30-0 268-761-3	<2,5	36/38-51/53 (1)	X1/N
N-glycylglycine, oligomers, decyl acyl glycozide	68516-73-1 500-220-1	<5	41 (1)	X1
croscel	57-50-1 200-334-9	>1	- (2)	-

(1) For R-phrases in full, see heading 16

Examine a broader set of hazard endpoints using measured and modeled data sources rather than depending solely on Safety Data Sheets (SDS).

Using reviews of primary research studies will go further in terms of understanding specific hazard traits beyond those noted on an SDS.

# Notable Lessons Learned

Augment the ECHA assessment in the near future and on an ongoing basis as needed to stay current.

Additional alternatives assessments that are more comprehensive, that consider the emergence of newer commercially available alternatives are needed.

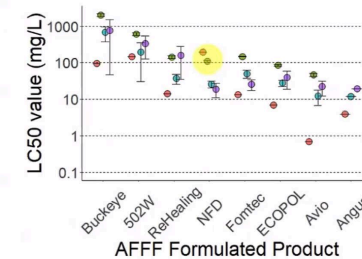
~60 sec ext. gas @ 2 gpm - 0.07 gpm/ft<sup>2</sup>

#	Manufacturer	Agent Type	Gasoline				Jet A			
			2 gpm		3 gpm		2 gpm		3 gpm	
			Ext (sec)	Burn-back (sec)	Ext (sec)	Burn-back (sec)	Ext (sec)	Burn-back (sec)	Ext (sec)	Burn-back (sec)
B	Buckeye MILSPEC 3%	AFFF	30	501	24	584	16	712	12	817
1	National - Avio Green	Foam	57	262	45	244	30	365	20	507
1A	Angus - Jet Foam	Foam	49	244	42	285	19	357	15	537
1B1	National Universal Green AR-FFF	Foam	145	189	84	242	30	245	26	314
1B2	Angus -AR-FFF	Foam	156	196	77	246	33	257	29	322
2	Solberg - RE-HEALING RF3	Foam	53	726	45	1019	33	690	22	1008
3	Fomtec - Enviro USP	Foam	58	434	37	678	24	647	15	767
3A	Fomtec - AR-FFF	Foam	128	246	73	282	32	232	27	334
4	Bio-ex - ECOPOP N F3 HC	Foam	No	-	No	-	No	-	114	311
4A	Bio-ex - ECOPOP A	Foam	57	278	52	372	26	350	18	407
5	Dr. Sthamer - MOUSSOL FF 3x6	Foam	77	240	65	335	25	445	21	539
5A	Dr. Sthamer - VA Pure XLV ICAO	Foam	77	170	55	225	27	352	15	285
6	vs FOCUM - Silvara APC 3x3	Foam	126	189	71	252	22	424	16	445
10	Perimeter Sol. - Auxquimia ICAO	Foam	No	-	123	0	26	363	20	412
11	FireBull FFF	Foam	84	208	67	501	22	507	17	648
15A	GreenFire GFFF	Foam	107	70	62	94	32	156	25	212
16	XAERUS - 3LV	Foam	No	-	No	-	103	35	87	68
7	Amiran - Flame Out	Wetting	-	-	No	-	-	-	95	40
8	Pyrocool - Pyrocool FEF	Wetting	No	-	124	153	29	203	20	277
9	Novacool - Novacool UEF Foam	Wetting	No	-	104	39	32	232	27	334
12	F-500	Wetting	No	-	No	-	57	55	35	165
13	FIREREIN - Eco-Gel A/B	Wetting	No	-	No	-	No	-	No	
14	ATIRA Sys. - Strong Water	Wetting	No	-	No	-	No	-	No	
15	GreenFire WA	Wetting	No	-	No	-	36	177	29	198



## Key Points

- PFAS-free AFFF were generally more acutely toxic than the PFAS-containing AFFF (Buckeye)
  - EPA toxicity category – Slightly toxic
- Consistency among results using the same species and among closely related taxa
- Marine species more sensitive than freshwater species
- Data submitted to *Environmental Science and Technology*



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SYM #S

CUI

## Draft Per- and Polyfluoroalkyl Substances -Free Foam Sustainability Analysis

20 August 2021

Prepared for:

Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) Weapons Systems and Platforms (WP) Program Area

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Reston, Virginia 20191  
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adoption: paths  
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- Establish collaborative performance testing/  
demonstration sites.
- Issue a comprehensive and collaborative  
implementation strategy.
- Enhance education and training.
- Establishing systems for ongoing monitoring.



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# Thank you

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