Legislation of Firefighting Foam Concentrates Containing PFAS

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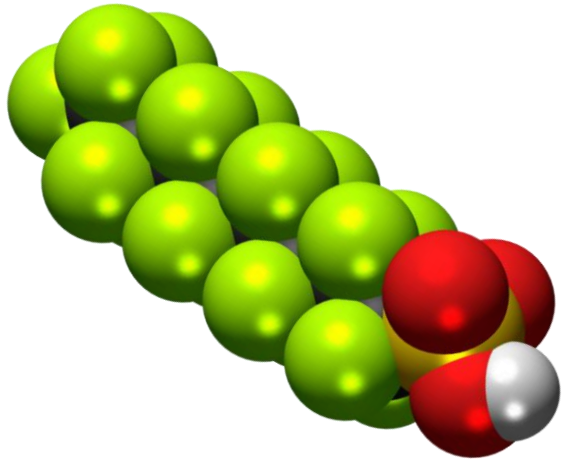
Restriction and prohibition of fluorinated foam concentrates containing PFAS

- Accelerated restriction and ban on sales, storage and usage of **PFAS** (perfluorinated and polyfluorinated compounds).
- Reasons: **health protection** of firefighters, population and the **environment.**

Properties or possible properties:

- **persistence in the environment**,
- **bioaccumulation** (in organisms and nature),
- **reproductive toxicity**,
- **carcinogenicity**,
- ingestion toxicity,
- aquatic toxicity,
- skin irritation.



Statistics: Usage and consumption of fire-fighting foam concentrates (FFFCs)

The Fire Rescue Service of the Czech Republic (FRS CR) and the year 2023

- 153 000 emergencies
- 17 332 fires (11,3 %)
- Usage of FFFCs
- In total: 564×, (3,3 % fires)
- Kind of usage:
  - wetting agent (378×),
  - low expansion foam (73×),
  - medium expansion foam (112×),
  - high expansion foam (1×).
- The average consumption (2014 – 2023): 56 tons

Types of synthetic fire-fighting foam concentrates (FFFCs)

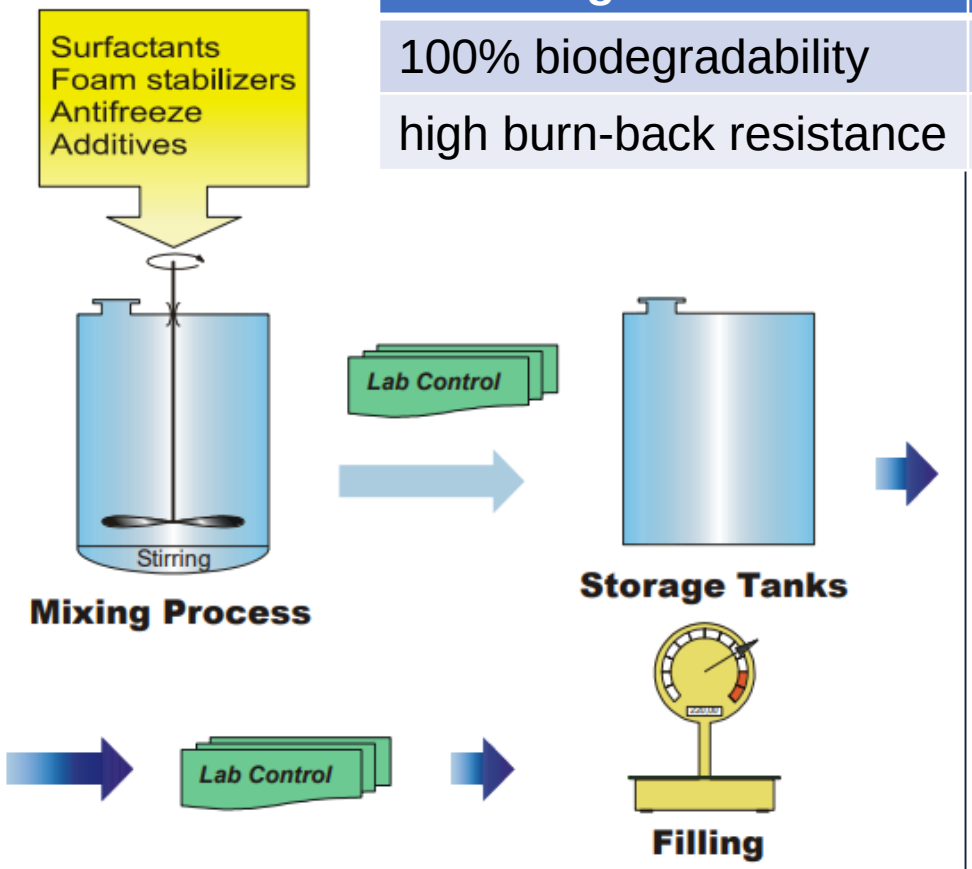
1. Multipurpose FFFCs (without PFAS) ✓
   - first generation of PFAS free FFFCs
   - used by the FRS CR for more than 20 years for the vast majority of interventions
2. Fluorinated FFFCs for extinguishing flammable liquids (with PFAS) ✗
   - unique properties for extinguishing flammable liquids
   - types: AFFF, AFFF/AR
3. New FFFCs for extinguishing flammable liquids (without PFAS) ✓
   - different properties
   - „Generally they work, but……“
   - types: FFF, FFF/AR

The composition of PFAS free fire-fighting foam concentrates (type FFF/AR)

Generally, they work, but each user must check and evaluate compatibility of FFF/AR with their proportioners and other equipment.

Ingredients:

- **Surfactants**
  - **Alkylsulfate**
  - **Alkylethersulfate**
  - **Alkylpolyglycoside**
- **Foam stabilizers**
  - **Fatty alcohol**
  - **Fatty acid amide**
  - **Aminoxide**
- **Anti-freeze**
  - **Glycols**
  - **Glycolethers**
  - **Urea**
- **Additives**
  - ~~**Fluoro surfactants**~~
  - **Polymer film builder**

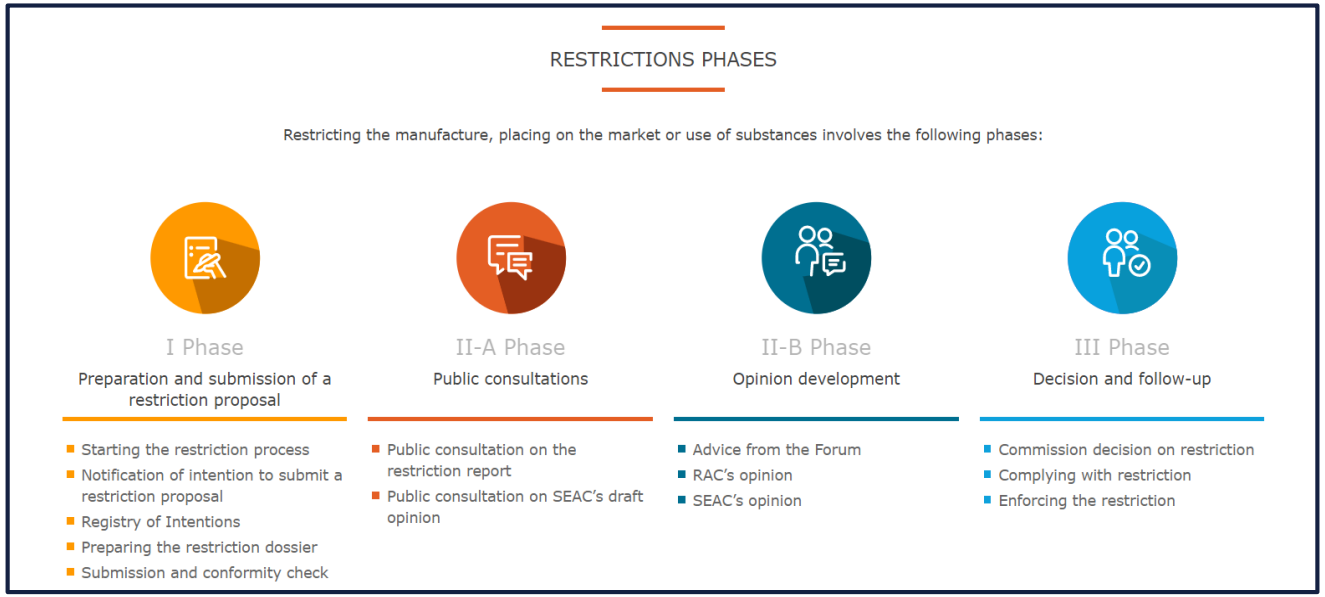


Advantages	Disadvantages
100% biodegradability	high viscosity
high burn-back resistance	expected lower universality of usage

The summary of legislation

Restriction and prohibition of fluorinated foam concentrates containing <u>all PFAS</u>

- **European legislation is still not issued.**
- **Multi-step legislative process.**
- **Regulation comes into force in next years.**



Restriction and prohibition of fluorinated foam concentrates containing <u>selected groups of PFAS</u>

- **European legislation has been issued and must be follow.**

1. **STOCKHOLM CONVENTION** on Persistent Organic Pollutants.
2. **REGULATION (EU) 2019/1021** OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on persistent organic pollutants.
3. **COMMISSION DELEGATED REGULATION (EU) 2020/784** of 8 April 2020 amending Annex I to Regulation (EU) 2019/1021 of the European Parliament and of the Council as regards the listing of perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds.
4. **COMMISSION REGULATION (EU) 2021/1297** of 4 August 2021 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards perfluorocarboxylic acids containing 9 to 14 carbon atoms in the chain (C9-C14 PFCAs), their salts and C9-C14 PFCA-related substances.
5. **COMMISSION DELEGATED REGULATION (EU) 2023/1608** of 30 May 2023 amending Annex I to Regulation (EU) 2019/1021 of the European Parliament and of the Council as regards the listing of perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds.
6. **Commission Regulation (EU) 2024/2462** of 19 September 2024 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards undecafluorohexanoic acid (PFHxA), its salts and PFHxA-related substances.

Commission Regulation (EU) 2024/2462 of 19 September 2024 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards undecafluorohexanoic acid (PFHxA), its salts and PFHxA-related substances.

Shall not, from 10 April 2026 be placed on the market, or used, in a concentration equal to or greater than 25 ppb for the sum of PFHxA and its salts, or 1 000 ppb for the sum of PFHxA-related substances, in:

(a)
firefighting foams and firefighting foam concentrates for training and for testing, except functional testing of the firefighting systems provided that all releases are contained;
(b)
firefighting foams and firefighting foam concentrates for public fire services, except where those services intervene at industrial fires at establishments covered by Directive 2012/18/EU of the European Parliament and of the Council and they use the foams and the equipment for that purpose only.

Shall not, from 10 October 2029 be placed on the market, or used, in firefighting foams and firefighting foam concentrates for civil aviation (including in civilian airports) in a concentration equal to or greater than 25 ppb for the sum of PFHxA and its salts, or 1 000 ppb for the sum of PFHxA-related substances.

Limits for PFAS

Name of substance or group of substances	Abbreviation	Legislative limit
Perfluorooctane sulfonic acid its salts and perfluorooctane sulfonyl fluoride	PFOS	10 mg/kg, (0,001 %)
Perfluorooctanoic acid (PFOA), its salts	PFOA	0,025 mg/kg, (0,0000025 %)
PFOA-related compounds	–	1 mg/kg, (0,0001 %)
Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds	PFHxS	0,1 mg/kg, (0,00001 %)
Perfluorocarboxylic acids containing 9 to 14 carbon atoms in the chain (C9-C14 PFCAs), their salts and	C9-C14 PFCA	25 ppb
C9-C14 PFCA-related substances	–	260 ppb
Undecafluorohexanoic acid (PFHxA), its salts	PFHxA	25 ppb
PFHxA-related substances	–	1 000 ppb
All PFAS	PFAS	1 ppm (expected)

PFAS analysis

- **Liquid chromatography with mass spectrometry (LC/MS)**
- **Analysis of 26 individual chemical compounds:**
  - PFBuA, PFPeA, PFHxA, PFHpA, PFOA, PFNoA, PFDeA, PFUnA, PFDoA, PFTrA, PFTeA **(C4-C14),**
  - PFBuS, PFPeS, PFHxS, PFHpS, PFOS, PFNoS, PFDeS, PFUnS, PFDoS, PFTrS **(C4-C13),**
  - PFOSA, MePFOSA, EtPFOSA, MePFOSE, EtPFOSE**.**
- **Total Oxidizable Precursor Assay for PFAS precursors (TOPA)**
- **Estimation of the sum of all PFAS.**

The main goals of analysis:

1. **Verification of sample composition**

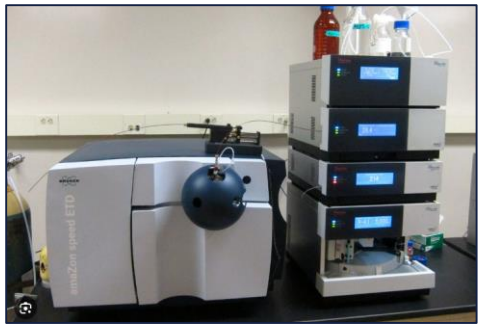
PFAS free vs. PFAS containing concentrates

2. **Verification of compliance with current and future legislation**

Comparison of analysis results with legislation limits.

3. **Checking the effectiveness of decontamination**

„How clean is really clean.“



Results of analysis (no. 1)
Ideal Examples PFAS free vs. PFAS containing FFFC

PFAS free Multipurpose FFFC

PFAS	C (PFAS) µg/kg (ppb)	Limits µg/kg (ppb)	Oxidizable precursors µg/kg (ppb)	Limits µg/kg (ppb)
PFBuA	< 2,0	-	-	-
PFPeA	< 2,0	-	-	-
PFHxA	< 2,0	25	-	1000
PFHpA	< 2,0	-	-	-
PFOA	< 2,0	25	-	1000
PFNoA	< 2,0	-	-	-
PFDeA	< 2,0	-	-	-
PFUnA	< 2,0	-	-	-
PFDoA	< 2,0	-	-	-
PFTrA	< 5,0	-	-	-
PFTeA	< 10	-	-	-
PFBuS	< 2,0	-	-	-
PFPeS	< 2,0	-	-	-
PFHxS	< 2,0	100	-	1000
PFHpS	< 2,0	-	-	-
PFOS	< 2,0	10000	-	-
PFNoS	< 2,0	-	-	-
PFDeS	< 2,0	-	-	-
PFUnS	< 2,0	-	-	-
PFDoS	< 10	-	-	-
PFTrS	< 10	-	-	-
PFOSA	< 2,0	10000	-	-
MePFOSA	< 2,0	10000	not measured	-
EtPFOSA	< 2,0	10000	not measured	-
MePFOSE	< 10	10000	not measured	-
EtPFOSE	< 10	10000	not measured	-
Sum C9-C14 PFCAs or Sum OP for C9-C14 PFCAs	< 20	25	-	260
Total oxidizable precursors			-	1000 (expected)

PFAS containing AFFF/AR

PFAS	C (PFAS) µg/kg (ppb)	Limits µg/kg (ppb)	Oxidizable precursors mg/kg (ppm)	Limits mg/kg (ppm)
PFBuA	3000	-	-	-
PFPeA	810	-	970	-
PFHxA	7000	25	220	1
PFHpA	870	-	63	-
PFOA	6100	25	140	1
PFNoA	72	-	-	-
PFDeA	900	-	-	-
PFUnA	44	-	-	-
PFDoA	350	-	-	-
PFTrA	< 50	-	-	-
PFTeA	200	-	-	-
PFBuS	1300	-	-	-
PFPeS	980	-	-	-
PFHxS	11000	100	-	1
PFHpS	1200	-	-	-
PFOS	48000	10000	-	-
PFNoS	< 20	-	-	-
PFDeS	< 20	-	-	-
PFUnS	< 20	-	-	-
PFDoS	< 100	-	-	-
PFTrS	< 100	-	-	-
PFOSA	< 20	10000	-	-
MePFOSA	< 20	10000	not measured	-
EtPFOSA	< 20	10000	not measured	-
MePFOSE	< 100	10000	not measured	-
EtPFOSE	< 100	10000	not measured	-
Sum C9-C14 PFCAs or Sum OP for C9-C14 PFCAs	1600	25	-	0,26
Total oxidizable precursors			1400	1 (expected)

Results of analysis (no. 2)
TOPA is essential

PFAS containing AFFF/AR

PFAS	C (PFAS) µg/kg (ppb)	Limits µg/kg (ppb)	Oxidizable precursors g/kg	Limits g/kg
PFBuA	1500	-	2,3	-
PFPeA	240	-	5,8	-
PFHxA	4500	25	1,7	0,001
PFHpA	47	-	0,29	-
PFOA	< 2,0	25	-	0,001
PFNoA	< 2,0	-	-	-
PFDeA	< 2,0	-	-	-
PFUnA	< 2,0	-	-	-
PFDoA	< 2,0	-	-	-
PFTrA	< 5,0	-	-	-
PFTeA	< 10	-	-	-
PFBuS	< 2,0	-	-	-
PFPeS	< 2,0	-	-	-
PFHxS	< 2,0	100	-	0,001
PFHpS	< 2,0	-	-	-
PFOS	< 2,0	10000	-	-
PFNoS	< 2,0	-	-	-
PFDeS	< 2,0	-	-	-
PFUnS	< 2,0	-	-	-
PFDoS	<10	-	-	-
PFTrS	< 10	-	-	-
PFOSA	< 2,0	10000	2,3	-
MePFOSA	< 2,0	10000	not measured	-
EtPFOSA	< 2,0	10000	not measured	-
MePFOSE	< 10	10000	not measured	-
EtPFOSE	< 10	10000	not measured	-
Total oxidizable precursors			10	0,001 (expected)

PFAS free

PFAS containing

PĚNIDLO	TYP	Viskozita	Výroba	Fluorované látky celkově [g/kg]
Sthamex 3% F-15	S (víceúč.)	N	07/2018	<0,000005
Foam Master 3F 3/3	FFF/AR	P	11/2018	<0,00005
M51+	FFF (víceúč.)	N	02/2019	0,00077
Fomtec MB5-20	S (víceúč.)	N	06/2018	0,000093
Orchidex ME 3%	S (víceúč.)	N	-	0,000745
Moussol-APS F-15 3%	AFFF/AR	P	08/2017	2,7
Moussol-APS F-15 3%	AFFF/AR	P	01/2016	2,84
Moussol-APS 3/6 F-15 3%	AFFF/AR	P	05/2015	2,89
Moussol-APS 3/6 F-15	AFFF/AR	P	05/2015	3,32
Foamtech HX 3%	AFFF	N	-	4,44
Fomtec ARC 1x3 NV	AFFF/AR	N	03/2016	8,08
Sthamex AFFF 1%	AFFF	N	-	8,67
Moussol APS LV 1/3 F-15	AFFF/AR	N	-	9,44

Total concentration of PFAS

PFAS free vs. PFAS containing FFFC

Results of analysis (no. 3)
Issues with strict limits

- **Fluorinated AFFF/AR, Moussol APS LV 1/3 F-15**
- **The same sample was analysed 2x in different accredited laboratories.**

1. **Results from ALS Laboratories Prague for PFOA and its salts:**
   Numbers: 34,9 µg/kg (ppb), limit: 25 µg/kg (ppb) ✖
   Statement: The sample does not meet the legislative requirements.

2. **Results from RECETOX for PFOA and its salts:**
   Numbers: 20,2 µg/kg (ppb), limit: 25 µg/kg (ppb) ✓
   Statement: The sample meets the legislative requirements.

Conclusion: The limits are very strict and the uncertainty around the legislative limit can be higher.

Results of analysis (no. 4)
Are really the fluorine free concentrate without PFAS?

- **Representative batch of analysed PFAS free concentrates.**
- **Stored in original packaging and opened immediately before sampling.**
- **Expected legislation limit: 1 ppm (1 mg/kg).**

Fluorine free FFFC FFF/AR	Total oxidizable precursors (LC/MS, TOPA)	
Sample 1	**1,600 ppm (m/m)**	✗
Sample 2	< LOQ	✓
Sample 3	**3,000 ppm (m/m)**	✗
Sample 4	< LOQ	✓
Sample 5	**0,570 ppm (m/m)**	✓
Sample 6	< LOQ	✓
Sample 7	< LOQ	✓
Sample 8	< LOQ	✓
Sample 9	< LOQ	✓
Sample 10	< LOQ	✓

Summary and conclusion

- **Chemical analysis to estimate the concentration of PFAS is essential.**

The main goals of analysis:

1. Verification of sample composition.
2. Verification of compliance with current and future legislation.
3. Checking the effectiveness of decontamination.

- The PFAS legislation is set relatively generally, there is a lack of implementing regulations and a binding methodology for the concentration determination of PFAS.
- **FRS CR: member of the new advisory group for the EC.**

Main tasks:

- Draft implementation regulation and methodology directly for firefighters.
- TOPA as a referee analytical method.
- Feasibility of legislation may be more difficult to implement, especially with regard to unnecessarily strict and low legislative limits → increasing the limits is appropriate.