EU Guidance for transitioning to Fluorine-Free Firefighting Foams

This guideline is prepared by the European Commission, in collaboration with the European Chemicals Agency and experts from EU countries.

Disclaimer

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Glossary

Abbreviation / expression	Explanation /definition
AFFF	Aqueous film forming foam
AOF	Adsorbable organic fluorine
AR-FP	Alcohol-resistant fluoroprotein [foam]
AR-FFFP	Alcohol-resistant film-forming fluoroprotein foam
CBRN	Chemical, biological, radiological, and nuclear
CIC	Combustion Ion Chromatography
Class A foam	A foam used on solid combustible fires (e.g. wood, tyres, paper, bushfires)
Class B foam	A foam used on flammable liquid fires (e.g. hydrocarbons, solvents)
C_9-C_{14} PFCAs	C_9-C_{14} Perfluorocarboxylic acids Linear and branched perfluorocarboxylic acids with the formula C_nF_{2n+1}-C(=O)OH (where n=8–13), including their salts and related substances. This includes compounds where the perfluoro group (C_nF_{2n+1}) is directly or indirectly attached to another carbon atom. Excluded from this designation are substances where X=F, Cl, or Br and certain higher-chain derivatives (n>13)
C_9-C_{14} PFCAs-related substances	For the purposes of entry 68 Annex XVII, C_9-C_{14} PFCA-related substances are substances that, based on their molecular structure, are considered to have the potential to degrade or be transformed to C9-C14 PFCAs
DoD	Department of Defense
ECHA	European Chemicals Agency
EU	European Union
EOF	Extractable organic fluorine

[1] The Commission technical services were supported by the external contractor WSP E&IS GmbH and Ramboll Deutschland GmbH under contract N° 090202/2024/923692/SER/ENV.B2.

Abbreviation / expression	Explanation /definition
ESTCP	Environmental Security Technology Certification Program (based in United States of America)
F3	Fluorine-free foam
FFF	Firefighting Foam
FFFP	Film-forming fluoroprotein [foam]
FP	Fluoroprotein [foam]
GAC	Granular activated carbon
GPCR	Gas phase chemical reduction
HWI	Hazardous waste incinerators
IX	Ion Exchange
kg	kilogram
LoW	List of Waste
OECD	Organisation for Economic Co-operation and Development
PCBs	Polychlorinated biphenyls
PBT	Persistent, bioaccumulative and toxic
PFAS	Per- and polyfluoroalkyl substances
PFCA	Perfluorocarboxylic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonic acid, its salts and PFHxS-related compounds
PFHxS-related compounds	PFHxS-related compounds are any substances that contain the chemical moiety $C_6F_{13}S$- as one of its structural elements and that degrades to PFHxS.
pH	A measure of the acidity or alkalinity of a solution, ranging from 0 to 14. A pH of 7 is neutral, values below 7 indicate acidity, and values above 7 indicate alkalinity. It is determined by the concentration of hydrogen ions in the solution.
PFE	Portable fire extinguisher
PFOA	1) Perfluorooctanoic acid (as a specific substance; if the specific substance is meant, this is specified in the text) 2) Perfluorooctanoic acid (as a substance group): PFOA, its salts and PFOA-related compounds
PFOA-related compounds	PFOA-related compounds are any substances that degrade to PFOA, including any substances (including salts and polymers) having a linear or branched perfluoroheptyl group with the moiety $(C_7F_{15})C$ as one of the structural elements. Please check POPs Regulation for more information on which compounds are not included as PFOA-related compounds.
PFOS	Perfluorooctane sulfonic acid and its derivatives (PFOS) $C_8F_{17}SO_3X$ (X = OH, Metal salt (O-M+), halide, amide, and other derivatives including polymers)

Abbreviation / expression	Explanation /definition
PFOSF	Perfluorooctane sulfonyl fluoride
PFOS-related derivatives	PFOS-related derivatives refer to compounds that contain the $C_8F_{17}SO_3X$ structural unit, where X can be a hydroxyl group (OH), metal salt (O-M+), halide, amide, or other derivatives, including polymeric forms.
PFSA	Perfluorosulfonic acid
POP-PFAS	PFAS compounds that are classified as POPs under the Stockholm Convention
POPs	Persistent Organic Pollutants
ppb	parts per billion
PPE	Personal protective equipment
REACH	Registration, Evaluation, Authorisation, and Restriction of Chemicals (Regulation EC No 1907/2006)
RSL	Residual screening level
SCWO	Subcritical water oxidation
SDS	Safety Data Sheets
TOF	Total organic fluorine
TOPA	Total Oxidizable Precursor Assay
TOP	Total Oxidizable Precursor
UNEP	UN Environment Programme
UTC	Unintentional Trace Contaminant
UWWTD	Urban Wastewater Treatment Directive
WFD	Waste Framework Directive

Contents

1. About this guideline

1.1 Scope and objectives of this guideline

This guidance aims to support stakeholders in the transition from PFAS-containing firefighting foams to fluorine-free alternatives in line with upcoming per- and polyfluoroalkyl substances (PFAS)-related regulatory requirements under the POPs Regulation and REACH. This document consolidates existing guidance on best practices, technical challenges, and feasible solutions to facilitate compliance with these regulations. It provides information on available fluorine-free alternatives, methodologies for detecting and mitigating PFAS residues, and recommendations for environmentally sound disposal practices. Drawing on international experiences and regulatory insights, this guidance seeks to facilitate a well-informed and seamless transition while maintaining both fire safety and environmental protection standards. Importantly, the guidance is not prescriptive about the methods to achieve compliance but instead offers a range of options and illustrative case studies to support informed decision-making.

1.2 Target audience

This guidance is intended for operators responsible for transitioning from PFAS-containing firefighting foams to fluorine-free alternatives, with a particular focus on those requiring technical expertise in cleaning systems to achieve sufficient PFAS removal while minimising liquid use. It is also relevant for national competent authorities and enforcement authorities overseeing compliance with PFAS restrictions, who will need to inspect installations and assess the adequacy of decontamination efforts. By providing practical insights into effective cleaning methodologies, detection techniques, and waste management solutions, this document supports both operators and regulators in planning a safe, efficient, and regulatory-compliant transition.

1.3 User instructions

This guidance is structured to provide clear and practical information for operators and regulators navigating the transition away from PFAS-containing firefighting foams. It is structured so that you can find key background information on PFAS and specific legal obligations as well as detailed support on what you need to consider in case you use PFAS-containing foams. The following chapters and information are provided:

PFAS Background
This chapter provides a brief overview of PFAS, explaining what they are and why they raise concerns. It also explores the role of PFAS in firefighting foams, highlighting their applications and the associated risks.

Legal obligations for PFAS-containing firefighting foam
The legal landscape surrounding PFAS is evolving rapidly. While some PFAS are already regulated, some others are subject to ongoing legislative changes. This chapter outlines the current regulations and provides insight into upcoming legal developments that should be considered when replacing certain AFFF formulations.

Need for action
*This chapter provides key insights into the essential considerations when handling PFAS- containing foams. The first critical step is determining whether your foams contain PFOS, PFOA, PFHxA or other PFAS. This chapter guides you through the identification process and offers practical guidance on proper **storage**, **disposal**, **decontamination**, and transitioning to **fluorine-free alternatives** if PFAS are present.*
*For those aspects requiring more technical details, the annexes provide supplementary information. If you look for more support, **case studies** are provided as well as a **list of contact details** for national support.*

2. PFAS background

2.1 What are PFAS?

Per- and polyfluorinated alkyl substances (PFAS) have come under significant regulatory scrutiny due to their persistence and the potential hazards associated with certain compounds. The European Commission has recommended that actions at the EU level should be taken to ensure that the use of PFAS is phased out unless proven essential for society [1]. In general, the highly stable carbon-fluorine (C-F) bond and the unique physicochemical properties of PFAS make them valuable ingredients for products with high versatility, strength, resilience and durability. PFAS are used to fulfil a wide range of functions across industrial, professional, and consumer settings, including firefighting foams.

There is currently no internationally agreed definition of what constitutes 'PFAS'; this varies between publications and authors, and between different geographies or regulatory regimes. However, in 2021, the OECD (2021) [2] issued on a PFAS definition that has gained wide acceptance:
"fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF_3) or a perfluorinated methylene group (–CF_2–) is a PFASs" [2]. It is noted that the EU restriction proposal for all PFAS in firefighting foams uses the same definition.

In general, legacy firefighting foams used perfluoroalkyl sulfonates (PFSAs) including PFOS and PFHxS, while more modern firefighting foams use PFAS complex fluorotelomers that can eventually transform or degrade to perfluoroalkyl carboxylates (PFCAs) such as PFOA and PFHxA [3]. These PFSAs and PFCAs degrade very slowly if at all under typical environmental conditions.

2.2 What is the concern related to PFAS?

There are significant growing concerns relating to the toxicity and persistence of certain individual PFAS. PFAS are, or can degrade to, persistent chemicals. Some PFAS can accumulate in humans, animals, and the environment [4]. Their resistance to degradation, and high mobility in the environment mean that some PFAS are now ubiquitous in the environment, including remote environments such as the Arctic [5], [6]. Individual PFAS have been observed to contaminate water and soil, for example in most European Union (EU) countries, and it can be extremely difficult and costly to clean up such contamination [7].
A number of PFAS have been shown to display potentially toxic and/or bioaccumulative effects in humans. Health effects in humans that are associated with exposure to certain PFAS include increased cholesterol levels, impact on infant birth weights, effects on the immune system, increased risk for certain types of cancers, and thyroid hormone disruption [4]. Some PFAS are classified in Regulation (EC) No 1272/2008 (CLP Regulation) as toxic to reproduction, toxic to the liver, and as suspected carcinogens. It should also be noted that only a relatively small number of PFAS has been assessed for their health effects so far.

2.3 How and why are PFAS used in firefighting foam?

Fire-fighting foams with fluorinated surfactants like PFAS have been widely used for extinguishing fires in flammable liquids (Class B fires), for example oil, petrol, water-soluble hydrocarbons, and flammable water-soluble liquids like alcohols and acetone [8]. There are two major types of Class B foam:

1) Synthetic foams: including aqueous film forming foams (AFFFs) and alcohol-resistant aqueous film-forming foams (AR-AFFFs); and
2) Protein foams: including fluoroprotein (FP) foam, film-forming fluoroprotein (FFFP) foam, alcohol-resistant fluoroprotein (AR-FP) foam, and alcohol-resistant film-forming fluoroprotein (AR-FFFP) foam.

These foams have commonly been used in fire suppression, particularly in high-hazard situations such as fuel fires at airports or industrial sites. All Class B foams are designed to form a foam blanket on top of the fuel to extinguish flames, suppress vapour, cool the fuel and suppress ignition by sparks.

The primary role of PFAS in firefighting foams is to form a thin aqueous film between the fuel and the foam blanket that also spreads rapidly across the surface of burning liquids. This film helps suppress flammable vapours by cutting off the fire's fuel source, extinguish the flames and help to cool the fuel. Additionally, PFAS contribute to the stability of the foam, making it resistant to heat and fuel contamination. This stability allows the foam to maintain its effectiveness over time, reducing the risk of re-ignition. Certain PFAS chemicals, e.g. PFOS, PFHxS and traces of PFOA (or their related substances) were commonly used or present in older foam formulations. The presence of these specific PFAS in AFFF has been phased out over time due to their persistence in the environment and their potential health risks, although they might continue to be in use in some jurisdictions. Newer generations of PFAS, such as long-chain (≥C7) and short-chain (≤C7) complex fluorotelomers, continue to be used in the production of modern foam formulations.

The stability that makes PFAS effective in firefighting also contributes to their environmental and health risk. Their environmental persistence can lead to contamination of soil, surface waters, groundwater, drinking water and the food chain. As awareness of their persistence and potential toxicity has continued to grow, both regulatory efforts and industry initiatives have intensified to move away from PFAS-based foams in favour of less persistent fluorine-free alternatives. The transition away from PFAS-containing foams presents challenges and opportunities, requiring careful evaluation of performance, safety, and compatibility with existing firefighting systems.

2.4 Portable fire-extinguishers

Different types of portable fire-extinguishers (PFE) are available, requiring different considerations. While some PFE contain pre-mixed chemicals, others are equipped with separate containers inside the extinguisher with different substances that are mixed only when used. As PFE are usually re-usable it is important to check before re-use to determine if it previously contained a PFAS foam. In addition, regular services for unused PFE requires that the extinguisher be emptied and so it is important to ensure that proper disposal procedures are followed for any PFAS foam.

3. Legal obligations for PFAS in firefighting foam

You can find the legal texts via the following links:

- Regulation (EC) No. 1907/2006 (REACH Regulation)
- Regulation (EU) 2019/1021 (Persistent Organic Pollutants (POPs) Regulation)
- REACH Annex XVII Entry 68 - C_9-C_{14} PFCAs, its salts and related substances restriction
- REACH Annex XVII Entry 79 – PFHxA, its salts and related substances restriction
- REACH Annex XVII - PFAS in firefighting foams (to be adopted and published before the end of 2025). Link: Comitology Register

3.1 Current legislation

Countries globally have implemented measures to regulate (ban or restrict) the manufacture, placing on the market and use of PFAS, including those found in firefighting agents. In the EU, actions are primarily taken through Regulation (EC) No. 1907/2006[2] (REACH Regulation). However, Regulation (EU) 2019/1021[3] (Regulation on Persistent Organic Pollutant (POPs Regulation)) plays a significant role in addressing PFAS in firefighting agents, as it implements the Stockholm Convention[4] - an international agreement to protect human health and the environment from POPs that has already restricted some PFAS groups. REACH restrictions and POP listings operate independently, and if a REACH restricted substance is listed in the POPs regulation it will be removed from REACH. A full overview of the relevant restrictions and applicable dates, relating to PFAS in firefighting agents is provided in the Annex (section 7.4).

Stockholm Convention on POPs and POPs Regulation

The Stockholm Convention entered into force in May 2004 and aims to protect human health and the environment from persistent organic pollutants (POPs). The EU is a party to the Stockholm Convention and implements the rulings of the Convention under the EU POPs Regulation. Three PFAS are regulated under the Convention: PFOA, PFOS, and PFHxS, their salts and related compounds. These PFAS, listed under the Stockholm Convention are referred to (for brevity) in this guidance as "POP-PFAS".

If a substance is listed as a POP under the Stockholm Convention, it is eventually added to the EU's POPs Regulation. This has occurred for the Stockholm Convention listings of specific PFAS: PFOS (its salts and PFOS-related compounds), PFOA (its salts and PFOA-related compounds) and PFHxS (its salts and PFHxS-related compounds).

PFHxS and PFOS have historically been used in firefighting foams, however with their addition to the Stockholm Convention, their use was prohibited in the EU. PFOA was likely not intentionally uses in fire-fighting foams, but might be present because as un-intentional by product during production of other PFAS. Current legislative thresholds are provided in Annex 7.4.

The use of PFOA-containing firefighting foams already installed in systems for Class B liquid fuel fires is permitted until 4 July 2025. A draft delegated act[5] is extending this deadline until 3 December 2025. These foams, however, are already strictly prohibited for training and may only be used for testing if all releases are contained. As of 1 January 2023, their use is limited to sites where releases can be fully contained, and stockpiles must be managed in compliance with Article 5 of the POPs Regulation.

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2 Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency. Source: EUR-Lex - 02006R1907-20241010 - EN - EUR-Lex

3 Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (recast). Source: EUR-Lex - 02019R1021-20241017 - EN - EUR-Lex

4 https://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx

5 Chemical pollutants – limits and exemptions for perfluorooctanoic acid (PFOA)

The Stockholm Convention (and hence the EU POPs Regulation) also require that, upon listing under the Convention, Parties take appropriate actions to manage stockpiles and wastes (Article 6), to ensure that stockpiles, products, articles and wastes containing POPs, are managed in a manner protective of human health and the environment. This also includes a requirement to develop strategies for identifying stockpiles, products and articles, and wastes containing chemicals listed under the Convention.

EU REACH Regulation

Under the EU REACH Regulation, several PFAS are already restricted. In addition, there is an ongoing broad proposal to restrict all remaining PFAS in firefighting foams, which includes all PFAS that match the definition applicable in the EU legislative framework and are not already regulated in the POPs or REACH regulations.

PFHxA, its salts and related substances

The production, placing on the market and use of perfluorohexanoic acid (PFHxA), its salts and PFHxA-related substances are restricted in the EU[6]. This restriction impacts firefighting foams, as complex 6:2 fluorotelomers, that are PFHxA-related substances, have often been used instead of PFOS and PFHxS since their restriction under REACH (and POPs Regulation) and are thus key components of some modern firefighting foams.

The restriction prohibits concentrations of PFHxA equal to or greater than 25 µg/kg (25 ppb) for the sum of PFHxA and its salts, or 1,000 ppb for the sum of PFHxA-related substances. It applies from April 10, 2026, for training and testing purposes, except for functional test if all releases are contained, and for public fire services. Public fire services are exempted when using these foams for industrial fire scenarios under specific conditions, in facilities covered by the Seveso III Directive. From October 10, 2029, the restriction will extend to civil aviation, including airports.

C_9-C_{14} PFCAs, their salts and related substances

C_9-C_{14} PFCAs can result from the degradation of the related complex C_8 to C_{14} fluorotelomers occurring as fluorosurfactants in firefighting foams, particularly since the discontinuation of the PFOS. A restriction under entry no. 68 of Annex XVII of the REACH Regulation has been in force since February 2023, prohibiting the manufacturing, placing on the market and use of firefighting foams containing these substances. An exemption allows the use of foams already filled into mobile or stationary systems before that date, provided all releases are contained and disposed of responsibly, including during testing. This exemption remains valid until July 4, 2025. After this date, firefighting foams containing C_9-C_{14} PFCAs are only allowed if the concentration is below 0.025 mg/kg (25 ppb) for the combined C_9-C_{14} PFCAs and their salts, or below 0.26 mg/kg (260 ppb) for C_9-C_{14} PFCA related substances.

[6] Regulation (EU) 2024/2462 amends the REACH Regulation accordingly (entry no 72 of Annex XVII). https://eurlex.europa.eu/eli/reg/2024/2462/oj/eng

3.2 Upcoming legislation

As it becomes increasingly clear that replacing one PFAS with another for the use in firefighting foams is not a sustainable solution, regulatory restrictions on per- and polyfluoroalkyl substances (PFAS) continue to expand. Following on the previous phase-out of PFOA and related substances, further restrictions are already in place for PFHxA and broader measures under REACH are expected to cover all PFAS in firefighting foams. This regulatory trend underscores the need to consider long-term approaches that move away from PFAS-based solutions. Transitioning to alternative PFAS compounds may result in repeated replacement cycles as new restrictions are introduced, and potentially to greater costs and more frequent operational disruptions. Investing in fluorine-free alternatives is recommended to comply better with evolving regulations and support a stable firefighting strategy.

Addition of substances to the Stockholm Convention (and POPs Regulation)

Long-chain perfluorocarboxylic acids (PFCAs, C_9-C_{21}), their salts and related compounds

The Stockholm Convention has decided to list long-chain perfluorocarboxylic acids (PFCAs, C_9-C_{21}) as POPs, as decided in May 2025 during the 12th Conference of the Parties of the Stockholm Convention. This will enter into force in late 2026 and will be integrated into EU law under the POPs Regulation, which will ban long-chain PFCAs in firefighting foams with no exemptions. This inclusion will also lead to the deletion of entry 68 in Annex XVII of the REACH Regulation, which currently covers C_9-C_{14} PFCAs.

Amendments to the EU REACH Regulation

Restriction for PFAS in Firefighting Foams

In January 2022, ECHA submitted a dossier for a restriction on all PFAS in firefighting foams, following a request from the European Commission. The assessment of ECHA's Scientific Committees concluded that PFAS use in firefighting foams poses uncontrolled risks to health and the environment, and a restriction under REACH is necessary[7]. The restriction will ban the placing on the market and use of firefighting foams with PFAS concentrations above 1 mg/L, with sector-specific transition periods ranging from 18 months to 10 years based on usage. Further, requirements such as management plans, appropriate storage/disposal and product and waste labelling for PFAS concentrations above 1 mg/L will also apply.

The restriction is expected to be adopted and published in the Official Journal in the second half of 2025[8]. It will enter into force only after the publication. This guidance already includes the relevant provisions of this restriction.

A summary table of legal provisions can be found in the **Annex (section 7.4)**.

7 Registry of restriction intentions until outcome - ECHA (europa.eu)

8 The restriction was voted by EU Member States in the REACH Committee on 29 April 2025. It is now undergoing the scrutiny of the Council and the European Parliament. It is expected to be adopted and enter into force in the second half of 2025. The voted legal text is available in the EU Comitology register.

3.3 PFAS-containing firefighting foam management plans

The restriction on PFAS in firefighting foams (Commission Regulation (EU) …/…)[9] allows the use of PFAS in firefighting foams for several applications for some years. A transitional period of 5 years is foreseen for civil aviation, new civilian ships, defence (except military vessels) and any other use not specifically mentioned in the restriction. A transitional period of 10 years is foreseen for civilian ships with firefighting foams already on board, Seveso III establishments, installations of the offshore oil and gas industry and military vessels.

Users of PFAS containing firefighting foams in those applications shall establish a 'PFAS-containing firefighting foams management plan' specific for the place of use of the firefighting foams containing PFAS. The place of use of the foam is dependent on the specific case at hand and can be anything, like an installation, establishment or vessel.

This management plan will ensure that appropriate measures are adopted and documented at the place of use, and it will facilitate enforcement of the restriction. The management plan should include information on, among other things, use conditions and volumes, collection and adequate treatment of the firefighting foams, cleaning of the equipment, plans in the event of accidental leakage/spillage and a strategy for substituting firefighting foams containing PFAS with fluorine-free firefighting foams.

Users have to review the management plan annually and keep it available for at least 15 years for inspection by competent authorities.

The management plan needs to provide information on the following aspects:

i.1	Use volumes on site	Documenting the amount of PFAS containing firefighting foam available in the firefighting system and in storage.
i.2	Use conditions on site	Documenting how the emissions to the environment and direct and indirect human exposure to firefighting foams are reduced to as low a level as is technically and practically possible.
ii.	Collection and adequate treatment of waste	Documenting the procedure for collection and adequate treatment to ensure - the separate collection of stock of not-utilised firefighting foams and PFAS-containing waste, including wastewater[10], originating from the use of firefighting foams, where technically and practically possible; and - the handling of the fire-fighting foams for adequate treatment in such a way that the PFAS content is destroyed or irreversibly transformed.
iii.	Cleaning and maintenance of the equipment	Documenting the details on the type and methods of cleaning and maintenance of the equipment (see section 4.5).
iv.	Accidental leakage/spillage	Plans to be implemented in the event of accidental leakage/spillage of firefighting foam including where relevant, the documentation of the follow-up actions.
v.	Strategy for substitution	A strategy for substituting firefighting foams containing PFAS with fluorine-free firefighting foam, which should include expected timelines for different stages (i.e. choice of a suitable foam,

9 COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment
Please note that this restriction has not been adopted and is not in force yet. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).

10 Water resulting from cleaning operations is considered wastewater

		testing, cleaning of the system, replacement of the foam). This strategy will help the user to be able to meet the legal deadlines for phasing out the use of PFAS containing firefighting foams. The transition needs to be prepared well in advance since there are no 'one-size fits all' solutions in replacing PFAS containing firefighting foams. Various fluorine-free foams are commercially available. For example, an overview of different fluorine-free alternatives in firefighting foams is provided in the report from Wood et al, 2020[11]. Please note that new developments are not reflected in this report.
vi	Other relevant information	

If you are interested you may watch the official video published by the European Chemicals Agency or read on EU legal actions on ECHA's dedicated website.

4. Need for action when transitioning to PFAS free systems

A fundamental assessment of the existing firefighting system is required as the basis for action when transitioning to PFAS-free alternatives. Understanding what the existing system contains at present and what it may have contained in the past is a key to developing a cost-efficient transition process, with justified actions. Both the evaluation as well actions taken should be well-documented. This is important information to be able to provide to environmental inspectors who will have to assess whether the evaluation and a possible cleaning has been made in an appropriate manner.

In the following subchapters, guidance is provided on individual steps you might need to consider. Depending on your intended action (e.g., to replace PFAS containing foams in equipment by PFAS free one) not all steps might be relevant for your individual situation.

4.1 Determine if your firefighting foam(s) contain PFAS

Firstly, there is a need to identify and determine if your firefighting foam does contain PFOS, PFOA, PFHxA, PFHxS or other PFAS. This refers to both foam concentrate, and premix used, including in portable fire extinguishers. Although you will probably know your foam extinguishing agents you may not know the detailed composition of what they contain and if one of the above mentioned regulation(s) applies to them.

4.2 Review product documentation for PFAS indicators

To determine if you are impacted by any of the legal requirements related to PFAS, check the container labelling and the product's technical or safety data sheets (SDS) for mentions of terms such as "AFFF", "FP", "FFFP", "-AR" variants, "PFOA", "PFOS", "PFAS", "fluor" or the correct chemical names or identifiers, such as CAS/EC numbers. Check also section "5. FIRE-FIGHTING MEASURES" of the SDS for any mention on fluorinated by-products during fire. Some more details on such identifiers are listed in the Annex (section 7.7). Make sure the documents you are looking at are from the same year you

[11] https://echa.europa.eu/documents/10162/6755610/pfas_flourine-free_alternatives_fire_fighting_en.pdf

bought the foam, as the composition may change over time, but the trade name remains the same. Note that the manufacturer's standard SDS or other standard information may not provide clear answers, and the absence of such information does not necessarily mean that the firefighting foam does not contain PFAS. Phrases such as "film forming" or "surface active" may omit information or not provide clear answers, and the absence of such information does not necessarily mean that the firefighting foam does not contain PFAS. Phrases such as "film forming" or "surface active" may also indicate the presence of PFAS but are not necessarily evidence of PFAS and should be checked with the supplier. Descriptions such as "PFOS and PFOA free" are not reliable as these are only two of many other similar PFAS that may be in the formulation. PFAS might not be an intended ingredient but could be from cross-contamination in the manufacturing process. This can be true even if the foam is indicated as "fluorine-free" or "PFAS-free." In any case, you should contact your supplier for more information as a next step.

4.2.1 Contact the supplier or manufacturer of the firefighting foam(s)

The manufacturer and/or supplier is responsible for providing users with information on the ingredients and test results of their firefighting foam products. Ensure that any analytical methods used to detect relevant PFAS (including related substances) in a firefighting agent are verified and always seek for written confirmation of these details.

When consulting with your supplier, you should make sure to have the following information available for them:

- The exact name of the product – many foams are variations of the same product and share a common name. The precise name can be found on the container label and related SDS.
- Batch or lot number, if known.
- Date of manufacture, if known, or date of purchase.
- The container size may also be relevant.

You should ask the supplier the following questions:

- Does my firefighting foam contain any PFAS compounds at above 25 ppb? Current legislation including restriction dates are provided in Annex 7.4. A limited assurance such as "PFOA-free" is not an assurance of PFAS-free.
- Does my firefighting foam contain PFOS (perfluorooctanesulfonic acid), PFOA (perfluorooctanoic acid), PFHxS, their salts or related compounds?
- Is the firefighting foam subject to restrictions under the POPs Regulation or the REACH Regulation? For example substances such as PFOS (perfluorooctanesulfonic acid), PFOA
- If PFAS are present in the firefighting foam, which substances are present and at what concentration?
- Can you provide the analytical data confirming these results?

If you do not receive a satisfactory response, consider consulting a laboratory (third step) to test the product and/or change supplier.

4.2.2 Get the foam analysed by a suitable lab

Analysing PFAS in firefighting foam can be challenging due to the complex mixtures of various PFAS used in these foams. Conventional targeted analytical methods typically can measure 20-35 specific PFAS, but they do not capture the complete spectrum of potentially present PFAS. Many PFAS constituents, including complex fluorotelomer PFAS frequently present in firefighting foam, remain undetected by the standard laboratory analyses. The Total Oxidisable Precursor (TOP) Assay addresses this gap by oxidizing unknown PFAS precursors into PFAS compounds that can be analysed by conventional targeted methods. Another possibility to address this gap is the measurement of total organic fluorine (TOF) by Combustion Ion Chromatography (CIC). However, this method does not provide any information on the specific identities of PFAS compounds in the sample, thus it is best used as a screening tool for potential PFAS contamination. TOF also captures non-PFAS fluorinated compounds and can therefore overestimate the amount of PFAS in the mixture. Nevertheless, it is less expensive than TOPA and could provide sufficient information on whether the foam concentrate contains PFASs. Adsorbable Organic Fluorine (AOF) gives a better estimate of PFAS.

Choosing the appropriate testing methodology may also depend on the requirements set by authorities, regional regulations and facility requirements, with the best approach often being a mix of different techniques. More information on the different methodologies for determining PFAS levels in firefighting foam is available in Annex (section 7.1). PFAS testing should be carried out by accredited laboratories to ensure accuracy and reliability. Note that while many laboratories can analyse PFAS in environmental samples, foam (concentrate or premix) analysis may not be readily available. It is recommended that the selected laboratory has experience with foam (concentrate) analysis and can help in the interpretation of results as it is crucial to verify that concentrations of restricted substances are below thresholds to ensure that the firefighting foam comply with regulatory limits. If PFAS content is uncertain, adopting a precautionary approach is recommended to ensure compliance with restrictions and disposal requirements.

You have identified PFAS in your firefighting foam?

Whether a particular foam concentrate is regulated depends on whether it exceeds the limits for the regulated substances. If so, you should start substituting in accordance with your legal obligations. It is important to confirm that the concentrations of the restricted substances are below the regulatory limits, as there are fluorinated foams that are not currently regulated. Some manufacturers have been using compliant raw materials since 2014 to meet the current limits, some have adopted those later. Newer agents may also not yet be subject to the current regulations, but will be affected by the upcoming bans, so you should consider starting substitution now.

You do not have PFAS in your firefighting foam?

If you have fluorine-free firefighting foam and the foam has not been contaminated from old foams in the system at levels exceeding the limit values, you are ahead of the current legal requirements! Still, be cautious when disposing of the foam. It will contain surfactants, solvents and other organics that may impact the environment negatively. Furthermore, there is a risk of increasing concentrations of PFAS in the fluorine-free foam unless the system has been cleaned properly.

You are not sure if you have PFAS in your firefighting foam?

If you are unsure, and unable to find out, you should adopt a precautionary approach and assume that your foam may contain PFAS, to be sure to comply with the restrictions and disposal requirements.

4.3 Storage and use of existing stocks of PFAS-containing firefighting foams and concentrates

Management of stockpiles[12] is stipulated under the POPs Regulation (Article 5 (2)). The holder[13] of a stockpile shall inform the competent national authority in which country the stockpile is located of the nature and size of the stockpile in case the following conditions are met:

- The stockpile is greater than 50 kg.
- The stockpile is consisting of/or containing POP-PFAS listed in Annex I in concentrations above the limit value for unintentional trace contamination as specified in the relevant entries of Annex I.

[12] Substances, mixtures or articles accumulated by the holder that consist of or contain any substance listed in Annex I or II (as defined in the POPs Regulation)

[13] In this context the holder is meant to be the owner.

- The use of POPs is allowed as a specific exemption under the POPs Regulation.

This obligation currently applies to stockpiles of firefighting foams exceeding 50 kg and containing PFOA, its salts and PFOA-related compounds, as these substances still have specific exemptions allowing use under the POPs Regulation. More specifically, the use of PFOA-containing firefighting foams already filled in mobile or stationary systems will be allowed until 3 December 2025[14], in sites where all releases can be contained.

Therefore, if you own more than 50 kg of firefighting foam containing POP-PFAS exceeding the concentration limits (as outlined in Table 1), **you as the holder of the stockpile must report to the national competent authority**.

Table 1. UTC levels as defined for PFOA in the Annex I of the POPs Regulation[15].

POP-PFAS substance(s)	Concentration limit values		
	mg/kg	% by weight	ppb
Existing PFOA-based FFF			
PFOA or any of its salts	1	0.0001	1000
PFOA-related compounds*	10	0.001	10000

*any individual PFOA-related compound or a combination of PFOA-related compounds

This obligation does not apply to POP-PFAS such as PFHxS and PFOS (and their related substances) as they are fully banned in the EU in firefighting foams. Therefore, any foam containing these substances at levels above the UTC should be treated as waste (see chapter 4.4). This means that the POPs must be destroyed or irreversibly transformed without undue delay. Disposal or recovery operations that may lead to recycling, recovery, reclamation or reuse of such substances is strictly prohibited. POPs waste cannot be notified as a stockpile.

The national competent authority responsible for the POPs Regulation can be found on ECHA's website[16].

The initial notification must occur within 12 months of the regulation's applicability to that substance (the date when the substance was entered in Annex I or II of the POPs Regulation) or any relevant amendments. Notifications must be updated annually until the permitted use deadline. Holders must manage stockpiles in a safe, efficient, and environmentally sound manner in line with Directive 2012/18/EU[17], with measures to protect human health and the environment.

Be aware that the formats for submitting notifications on stockpiles may differ based on the specific requirements of each Member State. Therefore, it is essential to check and follow the appropriate formats for the country in which the stockpile is located before submission. Few examples of formats for reporting and corresponding procedures are provided in the Annex (section 7.2).

Regarding other PFAS, their use will be subject to the requirements of the REACH restriction on PFAS in firefighting foams (see section 3.2 and 3.3).

See

14 The use of PFOA-containing firefighting foams already installed in systems for Class B liquid fuel fires is permitted until 4 July 2025. A draft delegated act is extending this deadline until 3 December 2025 see: Chemical pollutants – limits and exemptions for perfluorooctanoic acid (PFOA).

15 These specific UTC limits for PFOA in firefighting foams are set in a draft delegated act that will enter into force in July 2025 see Chemical pollutants – limits and exemptions for perfluorooctanoic acid (PFOA)

16 List of national Inspectorates published on ECHA's website. Source: https://echa.europa.eu/de/contacts-of-the-member-state-competent-authorities

17 Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1).

Figure 1 for a timeline of key dates related to the notification of POP-containing stockpiles.

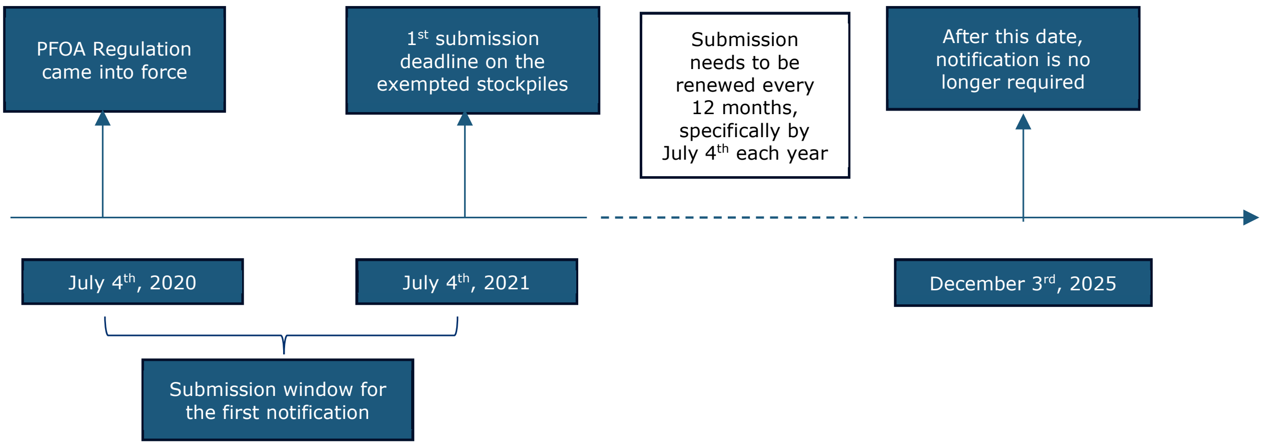

Figure 1. Key dates for the notification of stockpiles containing POP-PFAS.

4.4 Disposal of firefighting foam(s) containing PFAS

When FFF and related materials become waste – e.g., foam concentrates, pre-mix, fire-water runoff, – they must be correctly identified and classified in accordance with EU waste legislation. Proper classification determines if the waste is POPs-waste or hazardous or non-hazardous and which waste code from the European List of Waste (LoW) applies. This classification is essential for ensuring proper labelling, compliant transport, management and environmentally sound disposal.

This chapter provides practical guidance for operators and waste managers on how to manage and dispose of FFF-related materials containing PFAS. The following waste streams are addressed:

1. PFAS-containing firefighting foam (concentrate[18] and premix[19])
2. PFAS-containing firefighting run-off water (a mix of premix and possibly other materials)
3. PFAS containing water from cleaning of equipment (including PPE)
4. PFAS containing system components (different parts of the firefighting system)
5. PFAS containing soil
6. PFAS containing equipment (e.g. PPE)

The following sections are structured into three steps: (1) identifying and classifying the waste, (2) ensuring proper labelling and waste description, and (3) selecting appropriate disposal and handling options based on the applicable legal framework and the nature of the waste stream.

[18] A specially formulated, concentrated liquid product designed to be diluted with water at specific proportions to produce firefighting foam solutions or premixes.

[19] A ready-to-use solution obtained by mixing foam concentrate with water at a predetermined ratio before storage or use.

4.4.1 Identify and classify waste

Correct identification and classification of FFF-related materials containing PFAS is the foundation for compliant waste management. Depending on their composition, concentration, and context of use, PFAS-containing materials may fall under different legal categories: non-hazardous waste, hazardous waste, or waste containing POPs. Misclassification can lead to inappropriate disposal, regulatory non-compliance, and harm to health or the environment.

Waste or wastewater

Under normal circumstances, determining whether a PFAS-containing liquid qualifies as wastewater typically involves assessing specific PFAS substances present and their concentrations. This allows for a comparison against local discharge limits. A liquid may be classified as wastewater only if all the following conditions are met:

- Liquid does not qualify as POPs-waste (see Annex IV of the POPs regulation)
- Intended for discharge into a sewer or wastewater treatment plant (WWTP),
- WWTP operator has explicitly confirmed acceptance of the liquid,
- PFAS concentrations meet local discharge thresholds,
- The WWTP is legally authorised to accept such industrial or PFAS-containing wastewater.

However, this approach does not apply to PFAS in firefighting foams as the REACH restriction overrides the usual wastewater classification process and introduces stricter requirements specifically for wastewater resulting from the use of PFAS-containing firefighting foams and cleaning of the equipment.

According to the REACH restriction on PFAS in firefighting foams[20], **PFAS-containing wastewater originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L** must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**.

Point 7 (c) of the expected entry in Annex XVII to REACH [21] states that users shall:

"***ensure the separate collection*** *of stock of not-utilised firefighting foams and PFAS-containing waste, including wastewater, originating from the use of firefighting foams, where technically and practically possible,* ***and ensure their handling for adequate treatment in such a way that the PFAS content is destroyed or irreversibly transformed***".

Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).

Determine if the waste must be classified as hazardous waste

A PFAS-containing waste must first be assessed to determine whether it qualifies as hazardous waste under the WFD. This involves evaluating all hazardous constituents present (e.g. combustion by-products), not solely PFAS. Independently of this classification, operators must additionally verify whether POP concentration limits defined in Annex IV of the POPs Regulation are met or exceeded (see next section). Both assessments are mandatory and complementary; if both sets of criteria are met, operators must comply simultaneously with hazardous waste and POP-specific management requirements.

20 COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

21 ANNEX to the COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams. Source : https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470079/102503/3/attachment

A waste is classified as hazardous if it displays one or more of the hazardous properties (HP1 to HP15) listed in **Annex III of the WFD**. This determination is based on the properties of the substances it contains, and on their **classification under the CLP Regulation**[22].

In practice, regarding PFAS, if the waste contains PFAS that have harmonised hazard classifications (e.g. carcinogenic, toxic for reproduction, or very toxic to aquatic life) specified in the CLP Regulation, and if their concentrations exceed the applicable thresholds listed in the Annex III of the WFD, the waste must be classified as hazardous. However, for the classification, also other substances present in the waste must be taken into consideration. In practice, the classification needs to be done based on the List of Waste 2000/532/EC, Annex III of the Waste Framework Directive and the CLP Regulation. Specific guidance is available in Commission notice on technical guidance on the classification of waste (2018/C 124/01)[23]

Even if no individual PFAS in the waste is listed in Annex IV of the POPs Regulation, a hazardous classification may still apply due to its toxicological or environmental profile.

Where no harmonised classification exists (e.g. for PFHxS), operators must rely on available toxicological data and self-classification to assess whether the waste displays hazardous properties or consult national guidance where available.

Note: While PFAS persistence, mobility, and bioaccumulation are key environmental concerns, persistence alone is not currently a standalone hazardous property under the WFD. However, it may contribute to ecotoxicity (HP14) or be indirectly relevant under proposed PMT criteria being introduced in the CLP Regulation. These have not yet been integrated into hazardous waste rules.

For practical purposes, if uncertainty exists about the classification, a precautionary approach is recommended: the waste should be treated as hazardous until further information is available.

Determine if the waste qualifies as waste containing POPs

A waste containing POPs means a waste containing at least one of the substances listed in Annex IV of the POPs Regulation, irrespective whether it exceeds the concentrations limits specified in that Annex. Two types of wastes containing POPs can be differentiated:

1. Wastes containing the substance(s) below the concentration limits specified in that Annex IV
2. Wastes containing the substance(s) at or above the concentration limits specified in that Annex IV

Once the waste has been assessed for hazardous properties under the WFD (see previous section), operators must also determine whether it is a waste which contains POPs and has therefore to be managed according to the obligations of the EU POPs Regulation.

After determining the PFAS concentrations in the waste or if they are uncertain, it must be assessed whether the waste exceeds the concentration limits for POPs set out in Annex IV of the POPs Regulation. If so, Article 7 of the Regulation requires that the waste be disposed of or recovered in a manner that ensures the destruction or irreversible transformation of the POP content.

These legal requirements apply independently of whether the waste is classified as hazardous or non-hazardous under the WFD. The POPs Regulation does not establish a separate waste classification or

[22] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006. Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008R1272-20250201

[23] see https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOC_2018_124_R_0001

formal waste category but instead imposes specific management obligations for waste exceeding the concentrations limits specified in its Annex IV.

PFAS which are POPs, are listed in the POPs Regulation. For PFAS in waste, the currently relevant Annex IV concentration limits are shown in the following table.

Table 2. List of POPs-PFAS and concentration limits as defined in Annex IV the POPs Regulation (status: March 2025).

POP	Concentration limit
PFOA, its salts and PFOA-related compounds	1 mg/kg (PFOA and its salts) 40 mg/kg (sum of PFOA-related compounds)
PFHxS, its salts and PFHxS-related compounds	1 mg/kg (PFHxS and its salts) 40 mg/kg (sum of PFHxS-related compounds)
PFOS and its derivatives	50 mg/kg

These concentration limits are stringent – e.g., 1 mg/kg is 0.0001%. For context, firefighting foam stock from the 2000s could contain thousands of mg/kg of PFOS, PFHxS or PFOA.

Discussions are ongoing regarding further regulatory updates for long-chain PFAS (C9-C21 PFCAs)[24].

Assign a waste code (European List of Waste)

A key tool used for waste classification in the EU is the LoW, as laid down in the Commission Decision on the list of waste[25]. Once the waste is characterized, including an assessment of whether it displays any hazardous properties (such as flammability, ecotoxicity, or carcinogenicity), a proper LoW code must be selected. Many entries appear in **mirror pairs** – one code for the hazardous version of a waste and another for the non-hazardous version. PFAS-containing firefighting foam wastes often fall under such so called mirror entries[26].

While the European LoW is harmonised at EU level, Member States may publish national guidance on how to assign LoW codes in specific contexts. In case of uncertainty:

- Consult national waste authorities or databases,
- Refer to waste acceptance criteria of licensed disposal or incineration facilities,
- When applicable, document your rationale for selecting the code.

Summary – Recommended steps

1. Determine the source and composition of the waste (e.g., unused product, portable fire extinguishers, run-off, PPE).
2. Identify the appropriate LoW chapter and code that matches the waste origin. Refer to technical guidance on waste classification[27].
3. Confirm whether the waste is hazardous, based on the hazardousness assessment (see previous section).
4. Use the asterisked version of the LoW code if the waste contains hazardous substances above threshold.
5. Document the rationale and retain records (especially if classification may be challenged or inspected).

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24 However, it is important to note that many of these longer-chain PFAS, e.g. C9–C20 PFCAs already meet the definition of 'PFOA-related substances' under the EU POP Regulation (EU 2019/1021). Consequently, the existing POP concentration limits for PFOA and its related substances (1 mg/kg) already directly applies to these compounds. Future regulatory updates might expand or further clarify these restrictions, but existing obligations already apply.

25 Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste. Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32014D0955

26 Mirror entry logic: Many waste codes have an asterisk (*) indicating hazardous. A "mirror entry" is a situation where one waste description can be either hazardous or non-hazardous depending on composition. Typically, the hazardous code will explicitly mention "…containing hazardous substances…" and the alternate code will say "other than those mentioned in …".

27 E.g. European Commission (2018). Commission notice on technical guidance on the classification of waste Source: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018XC0409(01)

In the Annex (section 7.3) typical codes for various firefighting foam related waste streams are outlined.

4.4.2 Ensure proper labelling and waste description

Before sending waste for disposal, it is essential to correctly describe the waste in the accompanying documentation, such as the consignment note. Accurate documentation must include at least the following information:

- The name of the substance(s) present in the waste (e.g., PFAS specification)
- Waste code
- Whether waste is classified as hazardous waste, as POPs waste, or both
- If available, PFAS concentration expressed as the sum of PFAS that have been measured.

Please keep in mind that according to the WFD, hazardous waste must also be correctly packaged and labelled during collection, transport, and temporary storage following applicable international and EU standards. Additionally, when the REACH restriction on PFAS in firefighting foams enters into force, the labelling requirements of paragraph 9 will apply to PFAS containing waste[28]. When transferring hazardous waste within a Member State, it must be accompanied by an identification document, which can be in electronic format, and must contain the required regulatory information. When hazardous waste or POPs waste is shipped across borders, operators must comply with the requirements set out in the Waste Shipment Regulation[29]. This Regulation governs intra-EU transfers as well as exports outside the EU, implementing the Basel Convention and the Ban Amendment. Exports of hazardous and POPs waste to non-OECD countries are generally prohibited, while intra-EU shipments are subject to prior written notification, consent procedures, and traceability obligations. For more detailed conditions and exemptions, operators should consult the Waste Shipment Regulation and coordinate with national competent authorities.

Providing an accurate description of waste ensures that the waste is treated appropriately according to its properties and the applicable legal framework. Incorrect or incomplete descriptions significantly increase the risk of environmental harm, legal non-compliance, or worker exposure.

Therefore, properly identifying and documenting waste ensures that it is directed to the correct treatment or disposal process, preventing environmental harm, health risks, and legal issues.

4.4.3 Ensure proper disposal and handling of waste

Disposal of hazardous waste

If a PFAS-containing material meets the criteria for hazardous waste under the WFD, it must be managed accordingly. This classification is based on the presence of hazardous properties (HP1 to HP15), as assessed via the CLP Regulation and described in Annex III of the WFD.

Hazardous PFAS-containing waste must be treated at a licensed hazardous waste facility authorised to handle such substances. While destruction or irreversible transformation is not legally mandated as it is for POPs waste, in practice, high-temperature incineration or other appropriate thermal treatment is often required to prevent environmental release, depending on the waste composition and local permitting conditions.

Operators must ensure that hazardous PFAS waste is:

- Correctly classified, labelled, and documented in accordance with the requirements of Article 17 of the WFD, including the use of a valid European LoW code,
- Accompanied by an identification document when transported across borders, and, when transferred within a Member State Article 19 (2).

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[28] ANNEX to the COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams. Source : https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470079/102503/3/attachment

[29] Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste, amending Regulations (EU) No 1257/2013 and (EU) 2020/1056 and repealing Regulation (EC) No 1013/2006. Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1157

- Stored and transported safely, in line with Articles 13 and 17 of the WFD, to prevent release or exposure.

Producers of hazardous waste must keep chronological record regarding the quantity, nature, origin, and, where relevant, the destination (where it's being sent for treatment), frequency of collection, mode of transport and treatment method of the waste produced (see Article 35 WFD). Please note that this is implemented in many countries, with specific national rules, sometimes requiring use of standardized documents like waste tracking forms, electronic registries, etc.

Mixing of hazardous waste is prohibited under Article 18 of the WFD, unless all of the following conditions are met simultaneously:

- It is carried out by an authorised facility,
- uses best available techniques (BAT),
- does not increase environmental or human health risks, and
- is technically necessary for proper treatment.

If unlawful mixing has occurred, and the hazardous waste can be separated, this must be done. If separation is not technically feasible, the entire mixture must be treated as hazardous waste (WFD Article 18(2)).

Note: PFAS-containing hazardous waste can pose a risk of long-term environmental contamination. Operators are encouraged to follow national guidance and BAT-based solutions for its safe and effective destruction.

Disposal of waste containing POPs

Waste at or above Annex IV concentration limits

Waste containing POPs at or above the concentration limits defined in Annex IV of the POPs Regulation must be disposed of or recovered without undue delay and in accordance with Part 1 of Annex V, using methods that ensure the destruction or irreversible transformation of the POP content. This requirement applies regardless of the physical form of the waste (e.g. foam, contaminated liquids, or solids) if the POPs exceed the concentration limits.

Key Obligations and Technical Guidance on Management of waste containing POPs:

- **Destruction or irreversible transformation required**: Waste containing POPs above Annex IV thresholds must undergo treatment that ensures the POP content is destroyed or transformed so that the remaining waste and releases no longer exhibit POP characteristics.
- **Prohibition of recycling and preparation for reuse:** wastes containing POP in concentrations above those indicated in Annex IV, must not be recycled, reclaimed, or prepared for reuse, as this could reintroduce persistent pollutants into new products or the environment.
  Note: continued direct reuse of existing products—without waste treatment—is not prohibited.

Dilution is not an environmentally sound method: The UNEP Technical Guidelines clearly state that "the mixing and blending of wastes […] solely for the purpose of generating a mixture with a content […] below [POP threshold values] is not environmentally sound".

To achieve destruction or irreversible transformation, internationally recognised methods include [9]: hazardous waste incineration (HWI), gas phase chemical reduction (GPCR), cement kiln co-incineration and supercritical and subcritical water oxidation (SCWO).

If treatment does not fully destroy PFAS and residual concentrations remain at or above the Annex IV concentration limits, the waste must be treated accordingly. Operators must avoid environmentally unsound practices such as dilution for the purpose of reducing concentrations below concentration limits.

In exceptional cases, if destruction is not environmentally preferable, permanent storage — including in hazardous waste landfills — may be permitted, provided that all conditions under Part 2 of Annex V of the POPs Regulation are met, including environmental preferability, waste stabilisation, and compliance with applicable EU landfill legislation (for details see Article 7(4)(b)) and is in line with national legislation on storage of hazardous waste.

Waste below Annex IV concentration limits

If the concentration of POPs in the waste is below the concentration limits defined in Annex IV, the waste may be managed according to relevant Union and national waste legislation, in line with Article 7(4)(a) of the POPs Regulation. This means that the POP content of the waste must not necessarily be treated in accordance with Article 7(2) of the POPs Regulation (destruction or irreversible transformation). However, such waste underlies relevant regulation and may e.g. still need to be assessed for classification as hazardous waste under the Waste Framework Directive.

Disposal of non-hazardous waste

If a PFAS-containing waste does not meet the hazardous waste criteria defined in Annex III of the WFD, it may be classified as non-hazardous waste.

However, this does not exempt it from other regulatory obligations. In particular, if the waste exceeds the concentration limits for POPs under the POPs Regulation, it must be managed in accordance with Article 7 of that Regulation — even if it is not classified as hazardous under the WFD.

The applicable disposal pathway depends on the physical form of the waste:

According to the REACH restriction on PFAS in firefighting foams[30] PFAS-containing waste (such as wastewater arising from the use of PFAS-containing FFF or cleaning water) originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted** (see chapter Waste or wastewater).

- Solid non-hazardous waste, such as mildly contaminated PPE or inert components, may be disposed of in non-hazardous landfills or, in some Member States, thermal treatment facilities. It must be classified using the appropriate LoW code, and packaging/labelling requirements may still apply depending on local rules.
- Mixed or embedded waste (e.g. equipment with internal PFAS residues) should be evaluated to determine if decontamination, dismantling, or disposal as a whole is the best approach, taking into account national guidance.

Operators should confirm acceptance criteria with disposal facilities and check with local authorities to ensure compliance. The upcoming sections provide examples of disposal practices for each waste type resulting from the use of PFAS-containing firefighting foams.

Disposal of waste type in question

[30] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

Disposal of PFAS-containing FFF (concentrate or premix)

If you hold or manage FFF that may contain PFAS restricted under EU law (e.g. under POPs or REACh Regulation), you are responsible for ensuring that it is correctly identified and, if necessary, disposed of in an environmentally sound manner **without undue delay**, in line with Article 7 of the POPs Regulation and relevant national obligations. Follow the steps above to properly classify waste. This will allow you to choose a proper method for disposal.

According to the REACH restriction on PFAS in firefighting foams[31], **PFAS-containing wastewater** (including both not-utilised firefighting foams and PFAS-containing waste) **originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L** must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**.

Biological wastewater treatment has been rated as inadequate for PFAS removal, while incineration at temperatures above 1,100°C is recommended.

Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).
Currently, high-temperature incineration is the most widely recognized disposal method for PFAS-containing waste. This includes:

- hazardous waste incinerators (HWI),
- and cement kilns,

as outlined in the technical guidance documents to the Basel Convention [9], [10]. Cement kilns have emerged as a promising method for the destruction of perfluorinated alkyl substances (PFAS). Research showed that an excess of calcium can catalyze PFAS destruction and capture the fluorine within normal cement kiln process parameters [11], [12]. This is reflected also in the UNEP Guideline [10].

Other emerging or less common techniques include:

- Gas phase chemical reduction (GPCR): A process converting PFAS to non-toxic end products.
- Supercritical water oxidation (SCWO): A high-pressure, high-temperature method that degrades PFAS effectively.

In Europe, standard incinerators must reach at least 850°C for two seconds as required by the Industrial Emission Directive[32]. For hazardous waste containing more than 1% organic halogenated substances (such as PFAS-based firefighting foams), the minimum required temperature is at least 1,100°C to ensure complete breakdown.

Cement kilns operate between 800°C and 1,800°C. At their hottest point (1,800°C) for 17 to 21 seconds, they can break down PFAS compounds, including CF_4 which is particularly resistant to decomposition [13].

Disposal at lower temperatures may lead to incomplete PFAS degradation and the formation of harmful by-products. Other disposal options, such as wastewater treatment or landfills, are also not effective for destroying PFAS. Therefore, high-temperature incineration remains the recommended method for safe disposal of PFAS-containing firefighting foams.

In addition to incineration, Technical Guidelines from UNEP recommend following methods for waste containing PFAS at concentrations of 50 mg/kg or higher [33]. These include:

31 COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

32 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial and livestock rearing emissions (integrated pollution prevention and control) (Recast). Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0075-20240804

33 Technical Guidelines

- gas phase chemical reduction (GPCR) – a chemical process that reduces PFAS compounds into non-toxic compounds.
- supercritical water oxidation (SCWO) – a process using high-pressure, high-temperature water to degrade PFAS compounds.

More information on the disposal of existing foam concentrates or PFAS-containing liquid can be found in the transition manual from the Arctic Council [14], including a simple process flowchart that can be followed for an identification of foam stocks, containment and assessment of suitable disposal options. Additionally, another guidance document, the ITRC guidance [15] provides insights into available disposal technologies.

It is important to note that the site's location plays a crucial role when determining the cost and availability of disposal options. Therefore, it is essential that you consult with the competent authority in your region and assess the most current and appropriate disposal solutions at the time of implementation.

Disposal of PFAS-containing firefighting run-off water (a mix of premix and possibly other materials)

Firefighting run-off water, often generated during fire incidents or testing exercises, can contain a mix of PFAS-contaminated foam, water, and residues from burned materials. This waste stream typically presents high levels of PFAS and must be carefully collected (see box below), assessed and treated to prevent environmental contamination.

Before selecting a treatment option, the run-off water must be:

- Classified under the WFD to determine whether it is hazardous or non-hazardous waste (see Section Determine if the waste must be classified as hazardous waste); and
- Assessed for POPs content in accordance with the POPs Regulation. If PFAS listed in Annex IV are present above concentration limits, it must be destroyed or irreversibly transformed

For PFAS-containing run-off water, treatment methods can be divided into two categories: destructive and non-destructive techniques. Given the large volumes of contaminated water, non-destructive methods such as Granulated Activated Carbon (GAC) and Ion Exchange (IX) are suggested for consideration, as they effectively capture PFAS without breaking them down. However, in most cases, even after initial treatment, the final steps will involve incineration to destroy the PFAS compounds, especially when dealing with POPs waste as POPs Regulation requires destruction of PFAS. Refer to ECHA's background document for more information on availability, costs, and technical performance of the available methods in the EU [13].

Practical considerations for capturing PFAS-containing run-off water

To prevent the release of PFAS-contaminated run-off into the environment, appropriate containment systems must be in place during fire incidents, training exercises, or decontamination activities. Both national and international guidance documents outline the following practical solutions [12], [13]:

- Dedicated retention basins or tanks (open or closed), which are impermeable and sized to accommodate expected firewater volumes.
- Sealable drainage systems connected to internal wastewater infrastructure, designed to prevent release into public sewers.
- Bunded areas or physical barriers, such as ramps, raised thresholds, or shut-off valves, that allow for the controlled retention of liquids within the operational zone.
- Use of designated underground containment structures, such as basement areas, provided they meet safety and sealing standards.
- Watertight, temporary containment options, such as inflatable berms or portable tanks, may be used in field conditions, as highlighted by chapter 3.10.5 of ITRC (2023) [12], especially where permanent systems are not feasible.
- Volume reduction methods such as allowing firewater to evaporate in secure containment basins, leaving behind a PFAS-concentrated residue for subsequent disposal at a certified hazardous waste facility.
- On-site infrastructure must be permanent, operational at all times, and not rely on temporary measures like fire brigade pumps or mobile tanks.

These systems must comply with applicable national requirements and must not allow discharge into municipal wastewater systems or the environment.

Further, absorbents for smaller spillage of foam or foam concentrates and containment of spillage contaminated soil might be considered.

Most PFAS are not effectively removed in conventional WWTPs and can pass through and contaminate surface water.

The REACH restriction on PFAS in firefighting foams [34], requires that **PFAS-containing wastewater originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L** must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**.

Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).

Disposal of PFAS containing water from cleaning of equipment (including PPE)

Cleaning activities for firefighting equipment and personal protective equipment (PPE) used in conjunction with PFAS-containing foam often result in contaminated rinse water. This water can contain various PFAS compounds, including those classified as POPs. Due to its unclear composition, small volume, and diffuse origin, this waste stream presents challenges for proper classification and disposal.

According to paragraph 7 of the REACH restriction on PFAS in firefighting foams[35], developed in line with the conclusion from RAC, users must separately collect and treat **PFAS-containing wastewater**

[34] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

[35] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**.

Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).
Pre-treatment (e.g. using activated carbon or ion exchange) may be used to concentrate PFAS, but residues must be treated using methods that destroy or irreversibly transform PFAS.

Additional considerations include:

- PPE decontamination water can vary in PFAS content depending on use history and cleaning technique.
- On-site containment and batch treatment is preferred over uncontrolled release or discharge.
- Operators should avoid cleaning contaminated PPE or equipment in locations connected to stormwater or untreated drainage systems.
- Emerging technologies: Innovative approaches are emerging in some regions. An example is new evaporation technologies, which allow for the treatment of PFAS-contaminated water such as run-off or rinse water[36,37].

Disposal of PFAS containing system components (different parts of the firefighting system) [16]

Firefighting system components exposed to PFAS-containing foams (e.g. valves, pipes, tanks, nozzles, hoses, and pumps) may retain significant PFAS residues, especially if porous or corroded. If these components can no longer be decontaminated to acceptable levels, they must be disposed of in an environmentally sound manner in line with EU waste legislation.

Before selecting a disposal route, the component must be classified based on its PFAS content and properties. For guidance on waste classification (POPs, hazardous, or non-hazardous), see the Identify and classify waste section.

Some components, especially those made of or containing porous materials (e.g. rubber seals or flexible hoses), are particularly difficult to clean and may retain PFAS even after repeated rinsing. The UBA guidance (2024) [17] notes that such materials are often better replaced and disposed of than reused, due to the technical limitations of decontamination and the potential for ongoing PFAS release.

As some disposal methods may be limited by site location and other factors, a thorough review of available options, along with an assessment of cost-effectiveness, should be conducted. Disposal options depend on the material type, condition, and classification. Typical treatment pathways (for firefighting system components):

- **POPs waste:** Porous or absorbent parts (e.g. rubber seals, flexible hoses) exposed to legacy foams containing PFOS, PFOA, or PFHxS typically exceed POP concentration limits and thus require destruction methods outlined in Annex V of the POPs Regulation (e.g. hazardous waste incinerators or cement kilns).
- **Hazardous waste:** Components such as pipes, valves, or nozzles—particularly if internal surfaces are corroded, porous, or difficult to clean— may contain residual PFAS below POP concentration limits but still above hazardous waste limits (Annex III, WFD). These generally require incineration at authorised hazardous waste facilities.
- **Non-hazardous waste:** Non-porous, metal components (e.g. stainless-steel tanks or thoroughly cleaned metal pipes) that can demonstrably achieve PFAS concentrations below

36 https://www.yasa.ltd/post/how-to-remove-forever-chemicals-pfas-from-water-and-wastewater
37 https://heliosinnovations.se/en/vart-erbjudande/pfas-rening/

regulatory thresholds may be classified as non-hazardous, allowing for recycling or landfilling, depending on national regulations.

Operators should document cleaning methods, PFAS measurements, and consult waste authorities in uncertain cases. Given the ongoing development of disposal technologies, it is advisable to consult with competent authorities to determine the most suitable and up-to-date options.

Disposal of PFAS-containing soil

Proper disposal of PFAS-contaminated soil requires a structured approach. Before applying any disposal actions, please follow the assessment steps outlined above (Identify and classify waste section) to determine the contamination status of the soil.

To assess contamination, operators should follow a stepwise approach:

- **Visual delineation**: As recommended by ITRC Guidance (2023), visibly contaminated areas (e.g. foam residues, wet zones) should be marked immediately after an incident using survey flags or tape.
- **Field screening (optional)**: A preliminary shake test—shaking a small soil or water sample (10–25 mL) and observing for foam—can suggest high PFAS contamination, though it is not reliable for low concentrations or all soil types.
- **Laboratory analysis (mandatory)**: Confirmatory testing in an accredited laboratory is necessary to quantify PFAS levels and identify the specific substances present (e.g. PFOS, PFOA, PFHxS). Results must be compared with the concentration limits set in Annex IV of the POPs Regulation (for POPs waste) or relevant thresholds under the Waste Framework Directive (for hazardous waste).

Once PFAS concentrations in the soil are determined, appropriate remediation or disposal measures can be selected. If contamination levels exceed defined threshold limits[38], excavation may be required to reduce the risk of PFAS leaching. If immediate excavation is not possible, cover area with rain proof cover such as a plastic tarpaulin to prevent PFAS leaching to groundwater.

Contaminated soil remediation pathways may include:

- Excavation and transport to a licensed facility
- Stabilisation (to immobilise PFAS)
- High-temperature incineration (preferred for strongly contaminated or POP-classified soil)

Not all incinerators are certified for PFAS destruction. Operators must verify that facilities meet performance standards under the Industrial Emissions Directive and POPs Regulation Annex V.

Confirmation sampling after remediation is essential to verify success. If residual PFAS remains above regulatory thresholds, further remediation or disposal may be required.

National Guidance: In some Member States, additional rules apply. For instance, Germany's "Leitfaden zur PFAS-Bewertung in Böden" outlines soil screening values, guidance for separating fractions by contamination level, and stepwise instructions for appropriate management. Such national documents should be consulted alongside EU regulations.

Disposal of PFAS containing PPE

Personal protective equipment (PPE), such as firefighting suits, gloves, boots, and hoods, may become contaminated with PFAS during exposure to PFAS-containing firefighting foam (FFF). While PPE is

[38] As PFAS regulations are rapidly evolving, many EU Member States are in the process of developing or updating the PFAS threshold limits in soil. For example, as of August 1st, 2023, Germany introduced in its Federal Soil Protection Ordinance (BBodSchV) binding test values for several PFAS compounds in soil, including PFOA: 0.1 µg/l, PFBA: 10 µg/l and PFOS: 0.1 µg/l.

designed to reduce direct exposure, it can retain residual PFAS and thus pose a risk of cross-contamination or environmental release if not adequately cleaned or disposed of [15].

During use, best practices for decontamination and storage should be followed. ISO 23616:2024 [18] provides procedures for cleaning and maintaining firefighters' PPE, distinguishing between:

- Routine cleaning for non-hazardous contaminants.
- Advanced cleaning for exposure to hazardous substances, including combustion residues and chemicals such as PFAS.

The standard requires advanced cleaning at least annually or after confirmed exposure to hazardous substances, including PFAS-containing foam. Additionally, ITRC Guidance (2023), provides a general procedure which can be followed. As recommended there, contaminated items should be removed and laundered before reuse, and PPE should be placed in secure bags or containers after exposure to prevent cross-contamination. After decontamination, if PPE cannot be adequately cleaned, it may require special treatment, such as high-temperature incineration, and should be disposed of following local, regional and national regulations. Operators should consult with environmental experts or regulatory authorities to ensure compliance with disposal requirements and get guidance on the most appropriate methods for contaminated PPE [15].

At end-of-life, PPE that can no longer be effectively cleaned or reused must be assessed for its waste classification (see previous chapters on the correct classification of waste).

Additionally, according to the REACH restriction on PFAS in firefighting foams[39], **PFAS-containing wastewater originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L** must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**. Water used for cleaning of PPE is expected to contain PFAS and must be collected and treated accordingly. (see Disposal of PFAS containing wastewater from cleaning of equipment (including PPE)).

Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).

4.4.4 Decision Tree

The decision tree provides a structured overview to support the classification and disposal of PFAS-containing waste resulting from firefighting foams. It guides users through the key regulatory checkpoints, and leads to the correct disposal pathway based on the legal status of the waste under the **POPs Regulation** and the **Waste Framework Directive**.

The tree is designed to be used as a **screening tool** to determine:

- Whether the material qualifies as **POPs waste**, **hazardous waste**, or **non-hazardous waste**;
- Whether **wastewater discharge** is legally permissible;
- Which regulatory **thresholds and conditions** must be assessed (e.g. Annex IV POPs concentration limits or WFD Annex III hazardous properties);
- What types of **treatment or disposal options** may be suitable depending on classification.

⚠ **Important**: This decision tree does not replace legal obligations or national interpretation. Users must always verify acceptance criteria with the relevant **national authorities or waste treatment operators**, local thresholds, and permitted treatment options.

[39] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

⚠ **Important:** According to paragraph 7 of the restriction on PFAS[40] in firefighting foams, wastewater resulting from the use of PFAS in firefighting foams above 1 mg/L must be collected and treated in such a way that PFAS content is destroyed or irreversibly transformed.

[40] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

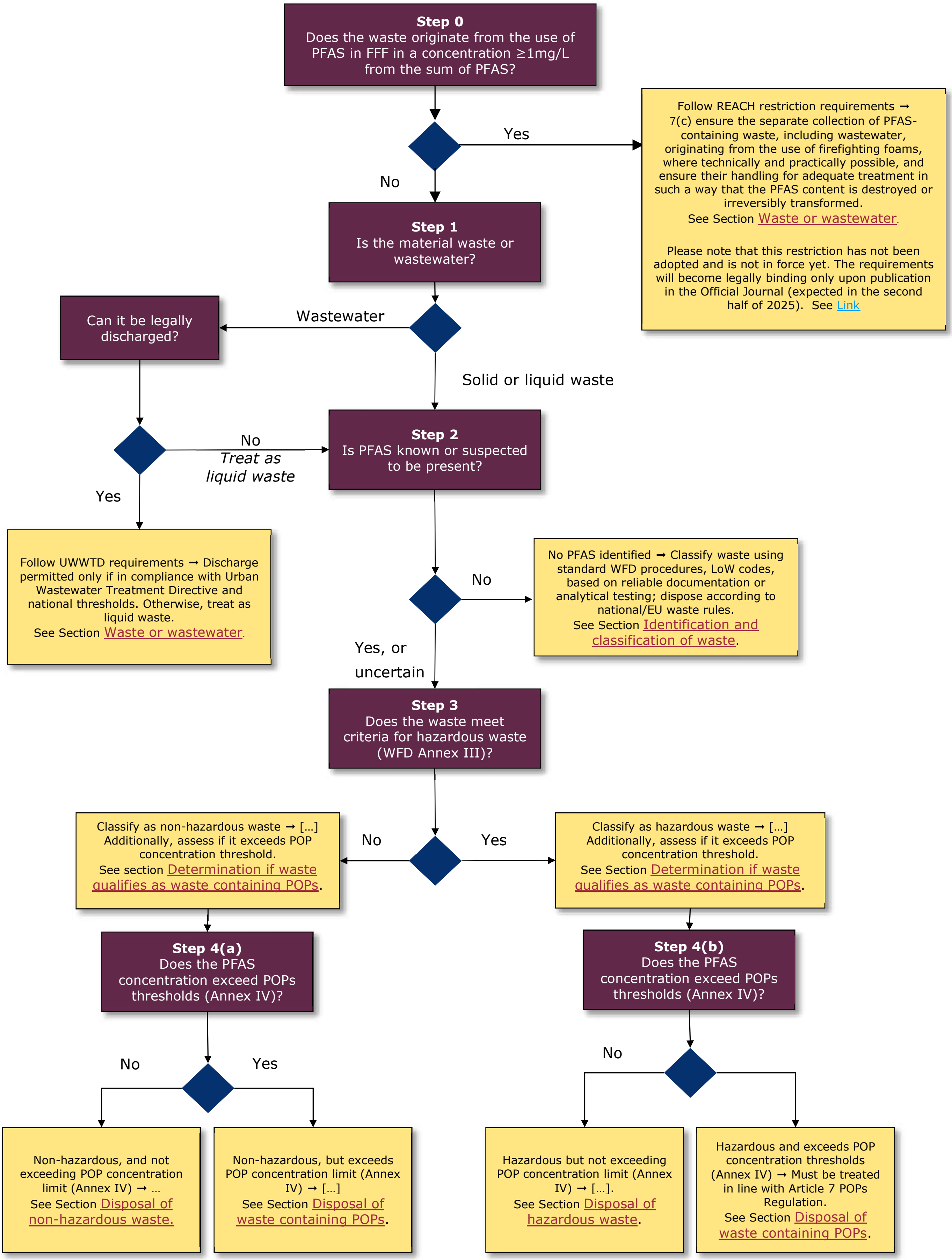

Figure 2. A simplified decision tree for disposal of PFAS-containing waste arising from the use of PFAS-containing FFF.

4.5 Cleaning of firefighting foam infrastructure

Correct decontamination methods should be used when cleaning firefighting foam equipment or infrastructure, especially when switching from one type of foam to another.
The responsibility lies with the owners and operators of the infrastructure to ensure that proper cleaning, removal, retrofitting, or even replacement of the equipment is done when needed.

When transitioning from PFAS-containing FFF to fluorine-free alternatives, it is essential to perform a cleaning of the firefighting foam infrastructure as thoroughly as possible. While there is a possibility to rely on specialised decontamination companies, these can be very expensive. Additionally, challenges arise as PFAS chemicals can form strong bonds with surfaces forming multiple layers and vesicles through various forces that are resistant to clean out and as a result, PFAS residues can rebound into replacement foam contaminating the system. While the rebound process itself takes time, PFAS concentrations in the fluorine-free foam could eventually exceed the legal limits after longer time spans, thus making the foam use illegal.

Firefighting foam infrastructure can consist of several key components, e.g.:

- firefighting foam storage – tanks or containers that store foam concentrate or premix,
- proportioning system – devices such as bladder tanks, balanced pressure systems, or inline inductors that mix foam concentrate with water at the correct ratio
- foam delivery system – includes piping, hoses, pumps, and valves that transport the foam-water mixture to discharge points
- discharge devices – such as sprinkles, nozzles and foam chambers that apply the foam to fires
- control and detection system – fire detection systems, and alarms that trigger foam application when a fire is detected.

This section outlines key considerations for effective cleaning of the FFF infrastructure. However, due to the wide variety of system types and configurations, a one-size-fits-all approach is not feasible. Cleaning procedures should be tailored to the specific system and its history. Owners and operators are responsible for conducting thorough assessments and taking the necessary precautions when cleaning, removing, retrofitting, or replacing any part of the system.

Please keep in mind, when replacing firefighting foam in a fire fighting system, fire safety must be maintained during the replacement phase. This might e.g. include pre-replacement planning (develop a plan, including risk assessments, potential hazards, emergency procedures, etc.) and temporary fire safety measures, communication and ensuring all regulatory standards are met. Such planning and measures are of particular importance in Seveso installations (i.e. those installations underlying Directive 2012/18/EU).

4.5.1 Simplified procedure for cleaning of firefighting component(s)

Due to the wide variety of foam delivery systems, cleaning procedures can differ significantly. Only tailoring the cleaning approach based on system configurations and material response will deliver the best results and ensure a safe and smooth transition to fluorine-free foams.

A simplified cleaning approach is outlined in Figure 3. More detailed flowcharts outlining the decontamination process for many different types of equipment and systems, along with additional implementation guidelines, are available in the Arctic Council's AFFF transition manual - clean out protocols (see also Annex (section 7.7)). There are also certification programs available for cleaning of foam systems in context of PFAS in some EU member states, for example the Netherlands [19]. It should be noted that this cleaning approach might not work in all cases and might need individual adaptation. Experiences showed that flushing with water might not be sufficient in some cases and even if testing of drained material shows acceptable levels the risk of a rebound effect needs to be considered. Consulting with experts in the field is advised.

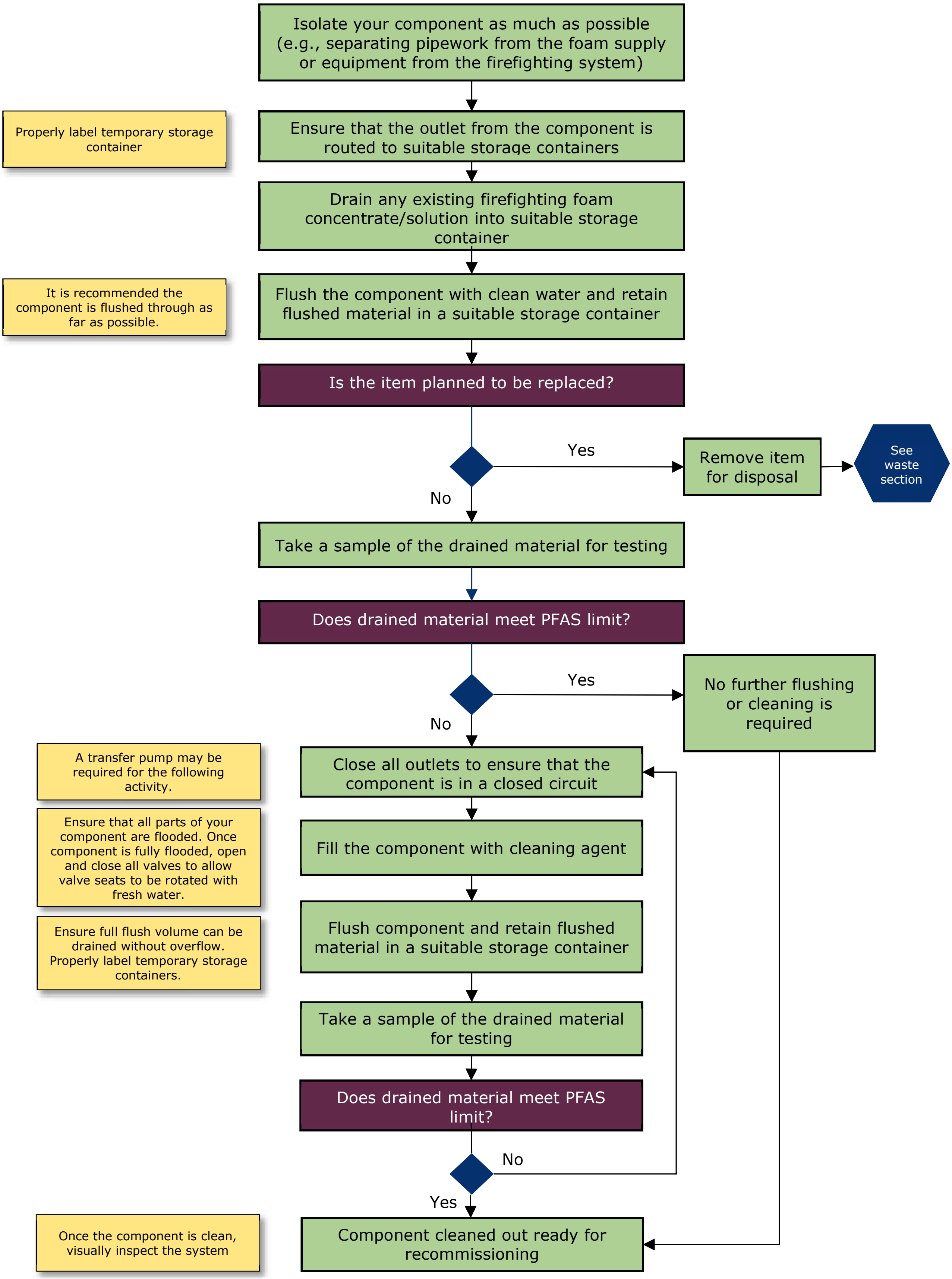

Figure 3. A simplified flowchart (based on the Arctic Council's AFFF transition manual - clean out protocols) for cleaning firefighting components, adaptable for both stationary systems and mobile equipment.

Start the decontamination process by isolating the component from the firefighting foam supply wherever possible. In case of pipework system, isolating sections could help minimise the area that needs to be flushed and cleaned at one time. However, for fixed systems where complete isolation of components is not practical, alternative approaches must be considered.

In cases where isolation is not possible, a full-system flush may be required. This should be planned carefully, as shutting down a large FFF system may have significant operational and regulatory consequences.

To manage this challenge:

- Assess FFF system design: identify whether partial isolation is feasible for specific zones within the system
- Plan to flush in phases: if closing off is not possible, consider phased flushing to maintain partial fire protection
- Implement temporary fire safety measures: ensure alternative fire protection (e.g., mobile FFF units) during the closure of the FFF system

Any removed PFAS-containing FFF must be collected in labelled storage containers. Care should be taken during pumping to avoid excessive foam generation.

As a next step, consider performing an initial rinse with clean water to remove loosely adhered contaminants. It is recommended that the component is flushed as thorough as possible. However, in specific firefighting systems, final elements can be excluded (e.g., the tank) may be excluded unless they have been used in foam service. If the component has had minimal exposure to foam solution, a comprehensive cleaning may not be necessary, and verification of residual PFAS may be sufficient [14].

The outlet from the firefighting system must be routed to a suitable storage location with sufficient capacity to contain the flushed material. All rinsing fluids and waste generated during the cleaning process should be properly contained, labelled, and disposed of following regulations. Avoid direct contact with the PFAS-containing foam and rinsing water and protect yourself using PPE such as gloves. According to the restriction on PFAS in firefighting foams[41], **PFAS-containing wastewater originating from the use of firefighting foams with a PFAS content of ≥ 1mg/L** must be separately collected and treated using methods that destroy or irreversibly transform the PFAS content. As a consequence, **discharge into the municipal sewage system is not permitted**.

Please see section Waste or wastewater for more details. You may consider reusing the same rinsing water several times, to avoid large quantities of rinsing water. There are also innovative approaches like new evaporation technologies, which allow for the treatment of PFAS-contaminated water such as run-off or rinse water[42,43].
Certain components, particularly those made of synthetic rubber, are more difficult to clean, so seals and hose lines should be inspected to determine whether replacement is needed. A sample of the drained material must be taken to determine the residual levels of PFAS. If the PFAS concentration is within acceptable limits, no further cleaning is required. However, if the sample exceeds the PFAS limits, a cleaning process must be initiated. For more information see section Cleaning inspections, monitoring and documentation. In this section also limit values are suggested.

To begin the cleaning process, all outlets must be closed to ensure that the cleaning agent circulates effectively within the system without unintended discharge. A suitable cleaning agent is introduced, ensuring that all internal surfaces are fully exposed to the solution. This allows for thorough decontamination by keeping the cleaning agent within controlled loop. Once the component has been soaked adequately, waste liquids can be flushed from the system and captured for proper disposal.

41 COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

42 URL: https://www.yasa.ltd/post/how-to-remove-forever-chemicals-pfas-from-water-and-wastewater

43 URL: https://heliosinnovations.se/en/vart-erbjudande/pfas-rening/

After cleaning, another sample of the drained material must be tested. If the PFAS levels remain above the acceptable threshold, the cleaning process should be repeated as necessary until the component meets the required standard. Once the system is confirmed to be free of residual PFAS contamination, it is considered ready for recommissioning. A final visual inspection should be conducted to ensure the component is clean and in good condition before being returned to service.

The effectiveness of the cleaning process depends on multiple factors, including:

- selecting appropriate cleaning agent(s)
- applying the correct temperature settings
- repeating the cleaning process as needed
- monitoring the cleaning efficiency.

4.5.2 Selecting an appropriate cleaning agent and adjusting the parameters

The choice of the cleaning agent(s) can have a significant impact on the decontamination effectiveness.

According to the ITRC Guidance (2023), the US Department of Defense (DoD) recommends triple water rinsing method, as the most common approach. Once the system is drained, this method includes a series of rinses to flush out accessible PFAS residues. More specifically, during each rinse cycle, the system is filled with water and allowed to sit for a specified period. For municipal systems like trailers and trucks, the State of Connecticut recommends a sitting time of 30 minutes with hot water or 1–2 hours with cold water (State of Connecticut 2022, as cited in the ITRC Guidance, 2023). However, it should be considered that the rebound effect might be considered as a risk to this approach.

Temperature is one key factor, as higher temperatures generally improve PFAS removal efficiency, particularly for shorter chain PFAS (C4-C6) [20]. Therefore, it is beneficial to conduct decontamination tests at both room temperature (22°C) and elevated temperatures (e.g., 50°C or 70°C). Additionally, maintaining a cleaning agent pH above 12 enhances decontamination by increasing negative charge and electrostatic repulsion.

In addition to water, some studies highlighted better efficiency in removal when using chemical cleaning agents. For example, a study showed that aqueous solutions containing 20% of specific solvent were 2 to 8 times more effective than tap water at 70°C and 10 to 20 times more effective than tap water at 20 °C [21]. More information on specific and commercially available cleaning agents and protocols can be found in the Annex to the restriction dossier - PFAS in firefighting foams, published in 2022 [13].

Nevertheless, as the effectiveness depends on various factors, including the materials of the equipment, the type of foam in the system (both past and present) and how easily high pressure or physical abrasion can be applied throughout the system [22], there is no method that is 100% effective.

It is important to mention that more aggressive clean-out procedures are typically more costly and may generate more additional waste, requiring proper management and disposal. However, insufficient cleaning may leave residual PFAS in the system, potentially contaminating the new fluorine-free foam with PFAS upon refilling [15].

4.5.3 Cleaning inspection, monitoring and documentation

To ensure thorough decontamination, continuously monitor the system (during and after the cleaning) for PFAS residues, adjusting the decontamination strategy as needed. For example, sampling of rinsing water can help confirm that residual contamination has been removed, and/or testing of replacement foams that have passed through the system ensures that PFAS is not reintroduced.

For successful analysis, it is essential to collect a representative sample of the flushed material at the end of the cleaning process to determine residual PFAS levels. The Arctic Council transition manual recommends a simple and quick bubble test to get an indication of the effectiveness of each rinse cycle in a fast way [14]. This involves filling a jar halfway with rinse water and shaking it vigorously. If bubbles persist after five minutes, it may indicate that the cleaning process is incomplete. To further verify the effectiveness of the cleaning process, it is recommended to use surface swabbing to detect residual PFAS contamination on system components. This means wiping cleaned surfaces inside the system with specialized adsorbent swabs, which are then analysed to determine the PFAS load per unit area. Surface swabbing is particularly useful for assessing parts such as pipe interiors, fittings, and storage tanks. Once the system has been thoroughly cleaned and rinse water drained, new fluorine-free foam can be added. A detailed chemical analysis of the new foam in the system should then be performed using accredited methods such as TOPA (see Determination section for further details) to confirm that the cleaning was successful.

As the availability of sampling and analysis methods varies by region, check with your local suppliers and laboratories to confirm which options are accessible to you. If you are conducting the sampling yourself, make sure you follow these best practices to ensure accurate results and prevent cross-contamination:

- use appropriate sampling bottles made of PP or HDPE (avoid glass bottles) supplied by the lab,
- wear clean, powder-free nitrile gloves to prevent contamination,
- use new, single-use sampling equipment (e.g., pipettes, syringes, or swabs) for each sample to prevent carryover
- avoid Teflon-coated materials as they can introduce PFAS contamination,
- properly label and store samples as instructed by accredited laboratory.

By adhering to these precautions, you can help ensure reliable sampling and accurate PFAS analysis.

To gain a comprehensive understanding of PFAS contamination post-cleaning, it is crucial to quantify the mass of PFAS remaining in the system. This can be achieved by calculating the residual PFAS load per unit area (e.g. g/m^2) based on swab test results. By multiplying surface concentration data with the total system surface area, it becomes possible to estimate and document the overall PFAS burden retained within the system.

In the EU, there are no harmonized limit values for the cleaning water which enable to assess whether cleaning is successful.
For the new foam installed in the system after the cleaning, the limit of 50 mg/L (as foreseen in paragraph 4 of the REACH restriction[44]) needs to be respected. Please note that this restriction has not been adopted and is **not in force yet**. The requirements will become legally binding only upon publication in the Official Journal (expected in the second half of 2025).
Additionally, compliance with unintentional trace contamination (UTC) limits could be considered. However, these are available only for the substances included in the POPs Regulation and not for the ones included under REACH. These regulatory limits can be found in the Annex 7.4.

There are some limit values for different water compartments. An overview is provided in Annex 7.5. Specifically, drinking water limit values are set on the EU level and some Member States have specific drinking/groundwater/surface water limit values (see table 3 below). Such limit values might be considered as an indication of successful cleaning.

Thorough documentation of the performed analysis and obtained results is essential for ensuring transparency, traceability, and regulatory compliance in PFAS decontamination efforts. Detailed records should include sampling procedures, analytical methods, and results, along with any deviations or uncertainties observed during testing. This documentation not only supports data validation and reproducibility but also provides a critical reference for assessing long-term effectiveness, informing future remediation strategies, and demonstrating compliance with environmental and safety standards. Additionally well-maintained records facilitate communication with stakeholders, including regulatory bodies.

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[44] COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards per- and polyfluoroalkyl substances in firefighting foams Source: https://ec.europa.eu/transparency/comitology-register/core/api/integration/ers/470061/102503/3/attachment

4.6 Substitution of PFAS-containing firefighting foam by fluorine-free alternatives

With the phase-out of PFAS-containing firefighting foams underway, organizations need to adopt fluorine-free alternatives to stay compliant.

Fluorine-free alternatives, also known as “F3” or “fluorine-free foams”, offer effective and environmentally friendly fire suppression solutions, with many already tested and independently certified for various applications.

Transitioning to fluorine-free firefighting foams

PFAS-containing FFF have long been used to combat flammable liquid fires. However, concerns over the environmental and health impacts of PFAS have led to stricter regulations, prompting organizations to seek safer alternatives. This chapter explores the shift toward fluorine-free solutions and outlines key considerations for making the transition.

Fluorine-free foams, often referred to as “F3” or "fluorine-free alternatives," have become the primary substitutes for PFAS-containing FFF. These alternatives do not contain PFAS and have been demonstrated to be effective in fire and vapour suppression and to be compliant with the evolving independent certifications and regulations.

There is a range of fluorine-free FFF currently available on the market, and many have already been tested and certified for use [23]. These foams provide similar performance to PFAS-containing FFF, forming stable foam blankets that are effective against flammable liquid fires [24]. Transitioning to these foams may require some changes to the foam delivery system to be compatible with the replacement foam. A thorough market analysis and direct communication with verified manufacturers and suppliers is essential to ensure a selection of a high-quality, reliable foam that meets specific operational needs. Please refer to the Table for key elements to be considered when transitioning to fluorine-free FFF.

Verifying PFAS-free status

When considering fluorine-free alternatives, it is crucial to confirm they are genuinely PFAS-free, meaning they do not contain regulated PFAS in concentrations other than allowed as unintentional trace contamination. In addition to verifying the absence of PFAS, it may also be helpful to check the overall composition, as some manufacturers have attempted to replace PFAS with other chemicals, such as siloxanes, which may also be subject to regulation. Foams sold as "fluorine-free" or "F3" or “PFAS free” must come with documentation certifying that they do not contain PFAS or fluorinated compounds. Labels or document for a product that only state “PFOS free” and/or “PFOA free” do not guarantee that there are no other PFAS present. This information can typically be found on the product label or in the product documentation provided by the manufacturer. If in doubt, you can contact your supplier or manufacturer to confirm whether the foam is indeed PFAS-free and compatible with your existing firefighting infrastructure.

Key considerations for successful transition

As the phase-out of PFAS-containing FFF progresses, organizations need to plan their transition to fluorine-free alternatives carefully. There are several important elements to be considered for a successful transition as outlined in the Table . However, the elements outlined below should be only considered as a basis and must be supplemented with specific additions and modifications to accommodate local conditions and unique requirements of different sectors.

Table 3. Some of the key elements to be considered for a successful transition to fluorine-free firefighting foams (based on information provided in chapter 5 of the AFFF Phase out in the Arctic - Literature review and complemented with the input from the expert group).

Key consideration	Explanation
Risk based justification for fire hazard management	Not all foam systems are cost effective or necessary. For example, instead of using foam for small pump skids in storage tanks, alternatives such as automatic detection and shutdown could be used. Therefore, always ask if there is a better way to reduce risk than using the foam.
Fluorine-free FFF suitability	When switching to fluorine-free FFF, assess its effectiveness through a site-specific analysis to determine if FFF remains the best option. Even as data on the availability and performance of different FFF improves, application rates and methods must still be verified. Before making a large purchase, it is advisable to test fluorine-free FFF in practice by purchasing a smaller quantity to evaluate their suitability for the intended use, including extinguishing performance, mixing with water, type of application, and composition.
FFF performance specifications	You as a user might lack detailed performance-based procurement specifications, which is now more crucial with new foams. Check LASTFIRE guidelines[45] for fluorine-free FFF procurement.
System decontamination	Existing systems must be thoroughly cleaned to remove PFAS residues and prevent contamination of new foam. This may involve multiple flushes or specialized chemicals. Residual PFAS levels should meet regulatory limits, and all rinse water must be treated as contaminated waste. Check section on decontamination for more details.
System and equipment modifications	Equipment must be checked to ensure proper proportioning and application of the new FFF. Some fluorine-free FFF have higher viscosity than PFAS-containing FFF and may require adjustments to maintain accuracy within standards. Material compatibility should also be assessed for components like pipework and valve seals.
Environmental and hazard considerations	All FFF have environmental and health risks, so their impact must be reviewed to establish proper containment and treatment measures. Substitute products should be checked for any persistent organic compounds, as fluorine-free doesn't always mean pollutant-free.
System testing and ongoing assurance	With any FFF system change, management of change requires updated operating manuals and acceptance testing. Best practices should include annual FFF checks and regular system test, potentially every three years. Procedures should be site-specific.
Storage and shelf life	Fluorine-free FFF may have different storage and shelf-life requirements compared to PFAS-containing FFF. It's important to follow manufacturer guidelines and track expiration dates to maintain fluorine-free FFF effectiveness.
Training and emergency planning	Scenario specific emergency response plans should be reviewed and updated to reflect system changes, along with training for responders.
Managing FFF system transition	During the FFF transition, plans should minimize operational impact that could reduce firefighting capability. This may involve shutting down hazardous operations and coordinating with external fire departments for hazard management.
PFAS contamination management (including legacy contamination and recovery and disposal of existing stocks)	You must identify PFAS contamination and ensure waste disposal as outlined in regulations. Please refer to section on storage and disposal for more information.

It is important to note that there is currently no "one-size-fits-all" solution. The most suitable approach will depend on factors such as your system design, the relevant certification for your application, and

[45] LASTFIRE (2017). Cradle to Grave foam assurance. The Lastfire process. Source: Link

national and local regulatory requirements. You might have to check and confirm which options are applicable to your specific system to ensure a smooth and effective transition.

As outlined in the Determination section 4.1 , the term "fluorine-free" does not necessarily mean a product is completely free of fluorine or without environmental or health risks. Any substance released in large quantities can have harmful effects. Therefore, the best way to protect the environment is by preventing releases through containment whenever possible[46].

There are several documents which provide further suggestions and considerations for the transition to fluorine-free FFF which may be of use when planning a transition to fluorine-free FFF. These include:

- AFFF Phase out in the Arctic - Literature review
- Firefighting foam transition guidance from API

Although no comprehensive European database currently lists all fluorine-free alternatives, several publicly available sources/documents provide valuable information on options currently in use and available across Europe. Key sources include:

- GreenScreen Certified Products List: A database of PFAS-free certified products, including fluorine-free firefighting foams
- ZeroPM: Alternative assessment database to PFAS
- UNEP (2017): *Risk management evaluation on PFOA, its salts and PFOA-related compounds* [25] (sub-section 2.3.2, with additional information in section 4.8.3 of the Addendum [26])
- UNEP (2019): *Risk management evaluation on PFHxS, its salts and PFHxS-related compounds* [27] (sub-section 2.3.1.1)
- ECHA (2022): *PFAS in firefighting foams – Annex to Annex XV restriction report* [28] (section E.2 – provides shortlisted alternatives based on Wood et al. 2020 study [29])
- ChemInfo Public (database for alternatives to AFFF): https://recherche.chemikalieninfo.de/public

[46] Firefighting source coalition: Best Practice Guidance for Fluorinated Firefighting Foams. Source: Link

CASE STUDIES

5. Case studies

A key factor in determining whether alternatives are feasible is considering the process of adopting them, including the systems that need to be updated and the need for additional training for users. Examples from companies that have already made the switch serve as important starting points, offering proof that a transition can (or cannot) work, along with insights into the main costs and benefits. To better understand the options and challenges involved in replacing PFAS-based firefighting foams, several case studies of successful foam replacements are provided in the following examples.

5.1 Case study 1

Transitioning Per- and Polyfluoroalkyl Substance Containing Fire Fighting Foams to New Alternatives: Evolving Methods and Best Practices to Protect the Environment [30]

This case study shares key lessons learned from transitioning to F3 foam in an Australian aircraft hangar, emphasizing enhanced cleaning, structured equipment replacement, and waste minimization.

About 20 months after switching from C8-foam, F3 foam samples still showed PFAS levels up to 1.6 g/L, despite applied water flushes. This indicates that water rinses alone are insufficient for effective PFAS decontamination. In response, specialized chemical cleaning agents were used to improve PFAS removal from infrastructure surfaces, such as tanks, piping, and sewer lines. Testing involved the sequential application of water, caustic, and the cleaning agent to sewer infrastructure. While the final water rinse showed the lowest PFOS concentration, the cleaning agent stood out for its ability to remove significantly more PFOS compared to water and caustic rinses. A biodegradable, low-vapor pressure cleaning solution proved far more effective than water, outperforming caustic solutions in PFAS removal by over an order of magnitude. This cleaning agent was successfully used worldwide in foam transition projects, including hangar sprinkler systems and aircraft rescue firefighting vehicles.

Transitioning foam inevitably generates PFAS-contaminated waste, but effective waste management can reduce costs and risks. Foam fractionation, such as Evocra's Ozofractionative Catalyzed Reagent Addition process, effectively removes PFAS from liquids and enables cleaning agent reuse. However, according to another source[47], the OCRA process primarily breaks down longer-chain PFAS (typically >6 carbon atoms) into shorter-chain forms (<6 carbon atoms). While this reduces some of the PFAS burden, combining this method with other technologies is needed to effectively tackle and remove shorter-chain compounds.

Therefore, for owners considering a foam transition, a well-structured program is essential. This should include a thorough evaluation of foam replacement options, a cost-benefit analysis, a comprehensive decontamination strategy, and detailed plans for safety, environmental protection, and waste management.

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47 Evocra website (date of access: April 2025). Source: Link

5.2 Case study 2

PFAS Decontamination of water from firefighting training facility at Korsør, Denmark [31]

The firefighting training facility in Korsør, Denmark, faced severe PFAS contamination caused by the use of firefighting foam. As part of the study for the Danish authorities, 500 litres of process water was collected from the site's filtration network of groundwater and surface water. Initial contamination levels in water samples were alarmingly high, with PFAS concentrations reaching 36,000 ng/l for a 22-compound list and 28,000 ng/l for a 4-compound list. The goal was to meet Denmark's strict regulatory limits, requiring reductions to below 100 ng/l for the 22-list and 2 ng/l for the 4-list.

To address the challenge, an integrated treatment approach was implemented, combining BAM Ultra technology, nutrient addition, and an active aeration system. Over an 18-week period, the treatment involved water collection, material homogenization, continuous aeration, and bioremediation support. Within just four weeks, the site achieved a 99.99% reduction in PFAS levels, meeting all regulatory standards and setting a precedent as the first successful treatment method in Denmark. Long-term results showed no rebound of contaminants and sustained compliance.

This case study demonstrates that complete PFAS remediation is achievable through enhanced bioremediation techniques, offering a scalable and globally applicable solution for addressing PFAS contamination in firefighting facilities and beyond.

5.3 Case study 3

Minimizing the environmental impact of PFAS by using specialized coagulants for the treatment of PFAS polluted waters and for the decontamination of firefighting equipment [32]

This study underscores the critical need for thorough decontamination of systems exposed to PFAS. Simply replacing PFAS-containing extinguishing agents does not prevent ongoing PFAS emissions, as residual PFAS can remain in the equipment and leach into the environment when fluorine-free agents are used. Specialized precipitants for PFAS adsorption are essential for environmental protection.
The study showed that specialized coagulants used in rinsing solutions for cleaning fire extinguishing systems (such as fire trucks, boats, and sprinkler systems) have been shown to significantly reduce residual contamination. Real-world applications of this method demonstrate its ability to clean PFAS-contaminated surfaces. The evaluation involved analysing PFAS levels in the initial rinse (first flush) after foam concentrate removal and comparing them to the final rinse, providing insight into decontamination efficiency. PFAS analysis was conducted by Fraunhofer UMSICHT.
PFAS concentrations, typically ranging from 10 to 800 µg/L, can be lowered to below 1.0 µg/L, often even under 0.3 µg/L, achieving elimination rates of over 99% and sometimes complete removal when levels fall below detection limits. Additionally, the rinsing wastewater can be treated on-site using the same precipitant, eliminating the need for expensive off-site disposal in high-temperature incinerators.

5.4 Case study 4

Characterization of PFAS residuals: A case study on PFAS content in a firefighting foam delivery system of an aircraft rescue and firefighting vehicle [33]

A study on an Oshkosh T-1500 ARFF vehicle at the Red River Army Depot (RRAD) in Texas focused on PFAS contamination in its fire suppression system, examining residual PFAS in the water, mixed foam, and foam concentrate systems. Three water rinses were conducted to assess PFAS removal, with results showing significant reduction, but some residual PFAS remained on system components. After replacing key fire suppression parts, final rinses revealed only low-level PFAS contamination. Residual PFAS on the parts accounted for less than 1% of the total PFAS flushed from the system (120 mg on parts vs. 19,600 mg flushed during the baseline rinse).

Targeted replacement of components highly contaminated with PFAS, such as hoses and valves, proved highly effective. Replacing just three components (two hoses and one valve) reduced PFAS mass by 50%, and expanding this approach to water and foam tanks could achieve over 90% total PFAS reduction. This strategy offers a cost-effective alternative to full system replacement while optimizing PFAS removal during foam transitions and supporting long-term operational sustainability.

5.5 Case study 5

Demonstration and validation of environmentally sustainable methods to effectively remove PFAS from fire suppression systems report [34]

A case study from NAS Willow Grove and TAFB highlights the effectiveness of cleaning systems to reduce PFAS contamination. At NAS Willow Grove, the fixed system cleaning resulted in a removal of approximately 88 g of PFAS mass, and the final water flush showed a 99% reduction in total PFAS concentrations compared to the baseline. After cleaning, the PFAS concentration in the firefighting formulation rebound samples dropped significantly, from around 1,500 µg/L in the uncleaned tank to 12 µg/L in the cleaned tank, indicating a substantial reduction in PFAS levels. Similarly, at TAFB, the final water flush showed a >99% reduction in both total PFAS and total organic fluorine (TOF) concentrations compared to the baseline. These results demonstrate the effectiveness of the cleaning processes in removing PFAS contamination from firefighting systems.

CONTACTS

In case you need support, contacts are provided on the following pages, for each EU country.

6. Contacts

ECHA's contact for regulatory issues is available at ECHA Regulatory support.

Below is the contact information for some national authorities, as provided by expert group:

Country	
Austria	Federal Ministry of Agriculture and Forestry, Climate and Environmental Protection, Regions and Water Management Department Environment and Circular Economy Division V/5 Chemical Policy and Biocides Street Stubenbastei Street No. 5 Postal code 1010 City Wien/Vienna AUSTRIA Phone +43 1 71162-0 v5@bmluk.gv.at
Belgium	Disposal of firefighting foams containing PFAS: Ms Nathalie Buijs nathalie.buijs@ovam.be Compliance on the further use of derogated firefighting foams containing PFAS, and/or on transitional periods for these derogated uses: Mr Philip Tanghe philip.tanghe@vlaanderen.be Occupational Safety and Healthy (OSH) : Mr Pieter Bolle pieter.bolle@werk.belgie.be and Mr Gunter Kathagen gunter.kathagen@werk.belgie.be
Germany	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) Federal Institute for Occupational Safety and Health (BAuA), Federall Office for Chemicals/Authorisation of Biocides chemg@baua.bund.de
Norway	The Norwegian Environment Agency, P.O. Box 5672 Torgarden, N-7485 Trondheim, Norway. post@miljodir.no
Portugal	Portugal's POP Competent Authority contact: Portuguese Environment Agency (APA) Rua da Murgueira 9 – Zambujal - Alfragide 2610-124 Amadora (+351) 214728200 apambiente.pt Email: geral@apambiente.pt APA's webpage on POP stockpiles:

	https://apambiente.pt/prevencao-e-gestao-de-riscos/gestao-do-material-acumulado APA's webpage on POP containing waste: https://apambiente.pt/prevencao-e-gestao-de-riscos/gestao-de-residuos Portugal's REACH Competent Authority contact: Portuguese Environment Agency (APA) Rua da Murgueira 9 – Zambujal - Alfragide 2610-124 Amadora (+351) 214728200 apambiente.pt Email: geral@apambiente.pt Directorate-General for Health (DGS) Alameda D. Afonso Henriques, no. 45 1049-005 Lisboa (+351) 218430500 www.dgs.pt Email: geral@dgs.min-saude.pt Agency for Competitiveness and Innovation (IAPMEI) Estrada do Paço do Lumiar, Campus do Lumiar, Edifício A 1649-038 Lisboa (+351) 213836000 www.iapmei.pt Email: info@iapmei.pt Portugal's REACH Helpdesk: IAPMEI - REACH & CLP
Slovenia	Chemicals Office of the Republic of Slovenia Ajdovščina 4 1000 Ljubljana +386 1 400 60 51 Email: reach.mz@gov.si

ANNEX

The annexes contain more detailed information on the following aspects:

- Analytical methods suitable for PFAS testing
- Examples of standardized forms for the notification of stockpiles in different European countries
- Typical LoW Codes
- Overview on PFAS in foams and related legislations
- Specific cleaning protocols

7. Annex

7.1 Analytical methods suitable for PFAS testing

There are several methods for PFAS testing in firefighting foam, waste characterization and contamination assessment available. These are listed below. For further information on PFAS sampling and analytical methods, the ITRC Fact Sheets[48] provide good background to currently available techniques.

7.1.1 Single Substance Analysis Using Liquid Chromatography Coupled with a Mass Spectrometer (LC-MS/MS)

This method involves using liquid chromatography to separate the PFAS mixture, followed by mass spectrometry (LC-MS/MS) to determine its content. Among the available methods, single substance analysis has the lowest limit of quantification. For water samples, the limit is approximately 1 to 5 ng/L depending on the sample amount and extraction method used, and for foam concentrate samples, it ranges from approximately 10 to 100 µg/L. However, only substances with available analytical standards can be detected - currently fewer than 100 PFAS compounds, with only 20 to 35 routinely analyzed. Unknown precursor compounds and polymer-like PFAS are not identified. Key PFAS for foaming agents include PFBA, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFPS, PFHxS, PFHpS, PFOS, PFNS, PFDS, 4:2-FTS, 6:2-FTS, 8:2-FTS, 6:2 FOSA, and 6:2 FTAB. Currently, targeted analysis do not cover all the substances that are used in FFF. One way to try to solve this is to accompany the Total Fluorine measurements with pyrolysis GC/MS (or F NMR) to confirm the presence of CF_2 or CF_3 groups and the PFAS nature of the substances.

7.1.2 Total Oxidisable Precursor Assay (TOPA)

Following single substance analysis, samples are treated to convert perfluoroalkyl acid (PFAA) precursors into perfluorinated carboxylic acids (PFCAs). By comparing PFCA concentrations before and after oxidation, the total PFAA precursor concentrations can be derived. Concentrations of individual PFAS are determined using the LC-MS/MS method described above. However, TOPA analysis has limitations, PFAS that do not undergo oxidation or only oxidize into substances that cannot be detected are not recorded. This may include substances used as active ingredients in firefighting foam. It may

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48 ITRC Factsheet: Sampling Precautions and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS), accessible from [PFAS Fact Sheets – PFAS — Per- and Polyfluoroalkyl Substances]

not be sufficient on its own to demonstrate the absence of PFAS. The detection limits for this method range from approximately 5 to 10 ng/l. More information on TOPA can be found in the scientific literature.[49]

7.1.3 Total Organic Fluorine Assay (TOF)

The total organic fluorine assay provides an indication of the overall levels of fluorinated organics present (as fluorine) but does not differentiate based on carbon-chain length. This method is adequate for a simple determination that the sample contains significant levels of organo-fluorine (PFAS) compounds. However, it does not provide detailed information on specific PFAS compounds or their chain lengths.

7.1.4 Adsorbable Organic Fluorine (AOF) or Extractable Organic Fluorine (EOF)

Both methods utilize combustion ion chromatography (CIC) but differ in terms of sample preparation. AOF usually uses activated carbon for adsorption, while EOF often uses solid phase extraction (SPE) for aqueous samples. In principle, only those substances that can be adsorbed on the adsorbent or extracted with the selected method are captured. During combustion, organic-bound fluorine is converted into hydrofluoric acid. After adsorption of the hydrofluoric acid in a sodium hydroxide solution, the fluoride concentration is determined using ion chromatography. CIC measures total fluorine, both organic and inorganic. The selectivity for organically bound fluoride depends on sample preparation. Methods are described in the literature that enable the removal of inorganic fluoride for both AOF and EOF. In addition to PFAS, other organofluorine compounds are detected.

[49] For example, Ateia et al., Total Oxidizable Precursor (TOP) Assay- Best Practices, Capabilities and Limitations for PFAS Site Investigation and Remediation, Environ. Sci. Technol. Lett. 2023, 10, 292−301, https://doi.org/10.1021/acs.estlett.3c00061.

7.2 Examples of standardized forms for the notification of stockpiles in different European countries

7.2.1 Germany

German guidance [17] outlines a standardized form for the notification, which can be downloaded from the website of the Federal Institute for Occupational Safety and Health[50], and in which all necessary information is requested. It can also be reported informally; however, the following information must then be provided:

- Substance or group of substances according to the entries in Annex I and II of the POPs Regulations (in this case PFOA)
- EC number/list number or CAS number
- Type of stockpile (in this case: mixture[51])
- Description of the mixture
- Total quantity of the stockpile (in tonnes)
- POP concentration in the mixture or article (in mg/kg)
- Information from the stockpile holder on how the stockpile is stored and what measures have been taken to prevent the release of POPs into the environment (evidence of safe, efficient and environmentally sound management)
- Description of use (only authorized uses, in this case as a fire extinguishing agent)
- Additional information (in connection with the inventory)

7.2.2 Ireland

In Ireland, guidance [35] outlines the process for reporting stocks of AFFF containing PFOA to the EPA. In case you determine or suspect that any of your fire suppression systems contain AFFF containing PFOA, and intend to continue using these stocks, you need to notify the EPA by emailing pops@epa.ie. Additionally, you are required to ensure these stocks are managed by an appropriately authorised waste management company. If the total amount of AFFF containing PFOA at a location exceeds 50 kg, you must report the stock along with other related information to the EPA and provide an annual update on the material(s). Further details on the required information for notifying competent authorities are provided below:

Continue to use AFFF containing PFOA (or potentially containing PFOA)

To notify the EPA of your intention to continue to use AFFF containing PFOA (or potentially containing PFOA), please email pops@epa.ie with the following information:

[50] https://www.baua.de/DE/Themen/Chemikalien-Biostoffe/Chemikalienrecht/POP
[51] Fire extinguishing agents are categorised as mixtures.

- Name and address of location where foam is installed;
- Quantity or quantities and brand(s) of foams;
- Details of any laboratory analysis carried out and results obtained or any information available on the chemical composition of the foam; and
- Contact details of person(s) making the notification.

Notification of stockpiles exceeding 50 kg of firefighting foam containing (or potentially containing) PFOA above the concentration thresholds

Notification of stockpiles of more than 50 kg of firefighting foam containing PFOA (including materials contained in hand-held extinguishers and/or foam concentrate) at a concentration above 0.025 mg/kg and/or a combination of PFOA-related compounds >1 mg/kg, at a given location, you are required to report annually to the EPA before 04 July via EDEN. This can be done as follows:

- Sign up or log on to the EPA's EDEN PORTAL;
- Request access to the 'POPs Application' in EDEN. You will need to wait for your application request to be approved by the EPA;
- When EPA EDEN application approval is granted, launch the EDEN POPs application
- Provide the requested information which will include the following:
    - Stockpile nature/use – installed within fire suppression systems (including fire extinguishers), medical device production etc., please note – may be a combination of uses;
    - Concentration of PFOA and/or PFOA-related substance(s) within each stockpile component (the 50kg limit refers to an aggregate weight and so may be made up of "sub-stockpiles")
    - Location & quantity of stockpile
    - Contact details of person(s) making the notification
    - How the stockpile is managed and stored; and
    - Disposal details in case sent off-site for disposal

Further information on notifying and reporting can be found on the EPA website at www.pops.ie.

7.2.3 Scotland

Similarly to Ireland, Scotland's SEPA Guidance [36] outlines the process for reporting stocks of firefighting foam containing PFOA to SEPA. In case you determine or suspect that any of your fire suppression systems contain AFFF containing PFOA, and intend to continue storing or using these stocks, you need to notify the SEPA by emailing nationalwaste@sepa.org.uk (using "PFOA containing FFF stockpile" as the subject to your email). Additionally, where you have a stockpile of more than 50 kg at a given location of firefighting foam containing (or potentially containing) PFOA above the concentration thresholds you are required to report to SEPA using the same email address and the same subject to your email.
Information that needs to be submitted to SEPA is detailed below:

Continuing to store or use firefighting foam containing (or potentially containing) PFOA

To notify SEPA of your intention to continue to store or use firefighting foam containing (or potentially containing) PFOA, please email nationalwaste@sepa.org.uk (using "PFOA containing FFF stockpile" as the subject to your email) with the following information:

- name and address of location where the firefighting foam containing PFOA is installed;
- quantity or quantities and brand(s) of the firefighting foams;
- any information available on the chemical composition of the foam (e.g., a Material Safety Data Sheet (MSDS) for the foam), or if such information is not available, details of any laboratory analysis carried out and results obtained to identify the chemical composition;
- contact details of person(s) making the notification.

Notification of stockpiles exceeding 50 kg of firefighting foam containing (or potentially containing) PFOA above the concentration thresholds

Where you have a stockpile of more than 50 kg at a given location of firefighting foam containing (or potentially containing) PFOA above the concentration thresholds (including materials contained in hand-held extinguishers and/or foam concentrate), you are required to report by 4 July annually to SEPA at nationalwaste@sepa.org.uk, (using "PFOA containing FFF stockpile" as the subject to your email) providing the following information:

- stockpile nature and use (e.g., installed within fire suppression systems, including fire extinguishers, medical device production etc., noting there may be a combination of uses);
- concentration of PFOA and/or PFOA-related substance(s) within each stockpile component (the 50kg limit refers to an aggregate weight and so may be made up of "sub-stockpiles");
- the location(s) of and quantity in the stockpile;
- how the stockpile is managed and stored; and
- disposal details (quantity and disposal site) for any such foam in the stockpile sent off-site for disposal;
- disposal details (quantity and disposal site) for any such spent foam (that is, used to extinguish a fire) sent off-site for disposal;
- disposal details (quantity and disposal site) for wash waters resulting from cleaning equipment previously used to store or contain any such foam sent off-site for disposal;
- contact details of person(s) making the notification.

7.3 Typical LoW Codes for firefighting foam-related PFAS wastes

Table 3 summarises typical European LoW codes for the different wastes analysed in section 4.4.

Table 3. Typical LoW Codes for firefighting foam-Related PFAS Wastes

Waste Stream	Example Sources/Description	Likely LoW Code(s) (Hazardous vs Non-hazardous)	Notes on Classification
Firefighting foam concentrate (unused)	Drums or totes of PFAS foam concentrate (e.g. PFOS-based AFFF stockpile being disposed).	**16 03 05*** – *Organic wastes containing hazardous substances* 16 03 06 – *Organic wastes not containing hazardous substances*	Mirror entry. Virtually all legacy AFFF concentrates with PFAS will be 16 03 05*. Non-haz 16 03 06 would require no hazardous PFAS or below thresholds (rare). Alternatively, 16 05 08*/09 can be used (similar meaning)
Fire-water runoff / firefighting foam solution	Mixed foam and water from firefighting or training and rinsing water from foam system cleaning.	**16 10 01*** – *Aqueous liquid wastes containing hazardous substances*. 16 10 02 – *Aqueous liquid wastes other than those mentioned in 16 10 01*.	Mirror entry. Use 16 10 01* if PFAS or other hazards present at significant levels (almost always the case for PFAS foam water). Only use 16 10 02 if confirmed no hazardous properties.
Cleaning water from equipment	Rinse water from cleaning firefighting equipment, foam proportioning systems, storage tanks, and piping.	**16 10 03* or 13 05 07* (oily water)**	Mirror entry. If contaminated with PFAS, use 16 10 03*. If mixed with hydrocarbons (e.g., from oil-contaminated firefighting foam or runoff), 13 05 07* may apply.

Waste Stream	Example Sources/Description	Likely LoW Code(s) (Hazardous vs Non-hazardous)	Notes on Classification
PFAS-contaminated soil	Soil, gravel, or sludge contaminated by firefighting foam (e.g. at crash sites, training areas, airport fire pits).	**17 05 03*** – *Soil and stones containing hazardous substances*. 17 05 04 – *Soil and stones other than those mentioned in 17 05 03*.	Mirror entry. Use 17 05 03* if PFAS levels cause any hazard (which they typically do if above tens of ppb). Slightly PFAS-tainted soil could be 17 05 04 only if truly below all hazard thresholds (and POP limits). If soil is processed off-site, use 19 13 01* (hazardous solid waste from remediation) or 19 13 02 (non-haz) for the treated output.
Absorbents, PPE, filters	Absorbent pads, firefighting foam, booms, protective clothing (gloves, suits), filter media used to clean up or which contacted PFAS foam.	**15 02 02*** – *Absorbents, filter materials (including oil filters), wiping cloths, and protective clothing contaminated by hazardous substances*. 15 02 03 – *…other than those mentioned in 15 02 02*.	Mirror entry. Any significant PFAS contamination -> 15 02 02*. E.g. turnout gear with PFOS, or carbon filter from PFAS water treatment, should be 15 02 02*. Only completely "clean" materials would be 15 02 03. These wastes are typically incinerated as haz waste.
Equipment and hardware	Contaminated devices: e.g. old foam fire extinguishers, foam injection system, piping, valves, or even vehicles that cannot be decontaminated.	**16 02 13*** – *Discarded equipment containing hazardous components (hazardous substances)* 16 02 14 – *Discarded equipment other than those mentioned in 16 02 09 to 16 02 13*.	Mirror entry. Use 16 02 13* if equipment is contaminated with PFAS to a degree that it has hazardous components (e.g. PFAS-laden residuals). E.g. a foam trailer with PFOS residue is 16 02 13*. If thoroughly decontaminated, it might be scrapped as 16 02 14. Removed internal components that are hazardous (like a PFAS foam

Waste Stream	Example Sources/Description	Likely LoW Code(s) (Hazardous vs Non-hazardous)	Notes on Classification
			bladder) could be 16 02 15*. End-of-life vehicles with foam systems would generally be treated as hazardous ELVs (16 01 04*).
PFAS-contaminated pipes from built-in systems (construction/demolition context)	Pipes from stationary fire suppression systems removed during demolition or renovation	**17 09 03*** – Other construction and demolition waste containing hazardous substances	Mirror entry. Use 17 09 03* if PFAS residues make the pipes hazardous (e.g., foam piping with PFAS-laden deposits). If cleaned and proven non-hazardous, 17 09 04 could apply.

7.4 Overview on PFAS in firefighting foams and relevant regulations

Substance group	Relevant Regulation	Regulatory restrictions for firefighting foams	Validity
Current regulations			
PFOS and its derivatives	POPs Regulation (see Regulation - 2019/1021)	• Placing on the market and use only if PFOS present as an unintentional trace contaminant (currently: < 10 mg/kg (10 ppm))	since 27.06.2011
PFOS, its salts and PFOS-related compounds	POPs Regulation (see Amendment Persistent organic pollutants – PFOS limits and exemptions)	• Placing on the market and use only if PFOS or any of its salts is present as an unintentional trace contaminant (≤ 0.025 mg/kg (25 ppb))	Not in force yet (expected in July 2025).
PFOA its salts and PFOA-related compounds	POPs Regulation (see Delegated regulation - 2020/784)	• Further use of firefighting foams already filled into the system, provided that the release can be captured (regardless of the concentration)	until 04.07.2025
		• Testing, given that all releases are contained	Until 04.07.2025
		• General ban on manufacturing, placing on the market and use	since 04.07.2020
		• Prohibition of use for training purposes	since 04.07.2020
		• Placing on the market and use only if PFOA is present as an unintentional trace impurity (≤ 0.025 mg/kg (25 ppb) or 1 mg/kg (1000 ppb))[52]	since 04.07.2020 with exceptions
	POPs Regulation (see Chemical pollutants – limits and exemptions for perfluorooctanoic acid (PFOA))	• PFOA, its salts and PFOA-related compounds in fluorine-free fire-fighting foams installed after cleaning of the firefighting system to replace foams containing PFOA, its salts and PFOA-related compounds (10 mg/kg for the sum of PFOA, its salts and PFOA-related compounds)	Not in force yet (expected in July 2025). Will extend the exemption for firefighting foams in use until 3 December 2025
	REACH Regulation (see	• Further use of firefighting foams already filled into the system, provided the	until 04.07.2025

[52] ≤ 0.025 mg/kg (25 ppb) for PFOA and its salts or 1 mg/kg (1000 ppb) for PFOA-related compounds

Substance group	Relevant Regulation	Regulatory restrictions for firefighting foams	Validity
Current regulations			
C_9-C_{14} PFCAs, their salts and C9-C14 PFCA-related substances	Regulation - 2021/1297)	release can be contained (regardless of the concentration)	
		• Prohibition of use for training purposes	since 25.02.2023
		• Placing on the market and use only if concentration limits are complied with (< 0.025 mg/kg (25 ppb) or < 0.26 mg/kg (260 ppb))[53]	since 25.02.2023 with exceptions
PFHxS, its salts and PFHxS-related compounds	POPs Regulation (see Delegated regulation - 2023/1608)	• Prohibition of manufacture, placing on the market and use	since 28.08.2023
		• Placing on the market and use only if PFHxS is present as an unintentional trace contaminant in foam concentrates (0.1 mg/kg (100 ppb) for a product used in production of other foam concentrates; 0.025 mg/kg for PFHxS; 1 mg/kg for PFHxS- related compounds)[54]	since 28.08.2023
PFHxA, its salts and PFHxA-related substances	REACH Regulation (see Regulation - EU - 2024/2462)	• Prohibition of the placing on the market/use of firefighting foams and firefighting foam concentrates for training and testing purposes and for public fire brigades	from 10.04.2026
		• Further use for functional tests of the fire extinguishing systems (training and testing purposes), provided that all releases can be captured	unlimited exception
		• Further use for public fire brigades working on fires in Seveso III establishments, provided that the foam and equipment are used exclusively for this purpose.	unlimited exception
		• Further placing on the market and use for civil aviation (including civil airports)	until 10.10.2029
		• Placing on the market and use for public fire brigades or in civil aviation only if PFHxA concentration limits are complied with (0.025 mg/kg (25 ppb) or 1 mg/kg (1000 ppb))[55]	After expiry of the respective exception
Upcoming regulations			
C_9-C_{21} PFCAs	Potential inclusion in the POPs Regulation	• Ban planned for intended use in firefighting foams	Agreed at the 12th Conference of the Parties to the Stockholm Convention (May 2025)
Restriction on PFAS in firefighting foams	Potential inclusion under the REACH Regulation	• Ban planned for the placing on the market and use of PFAS-containing firefighting foams above a total PFAS concentration of 1 mg/L • Use should be linked to certain conditions (e.g. management plan, documentation of storage or disposal of stock containing PFAS, labelling of products with a total PFAS concentration > 1 mg/L,)	To be adopted and enter into force by the end of 2025 (time limits between 18 months and 10 years, depending on sector and use)

53 <0.025 mg/kg (25 ppb) for C9-C14 PFCAs and their salts or < 0.26 mg/kg (260 ppb) for C9-C14 PFCA-related compounds
54 For PFHxS, its salts and PFHxS-related compounds
55 0.025 mg/kg (25 ppb) for PFHxA and its salts or 1 mg/kg (1000 ppb) for PFHxA-related compounds

7.5 Overview of the current limit values (as of April 2025) for different water compartments

Type of sample	Limit value	Regulation	Applicable level and type of value
European level			
Drinking water	PFAS Total: 0.50 µg/L Sum of PFAS: 0.10 µg/L	Directive (EU) 2020/2184 on the quality of water intended for human consumption (recast)	EU level. Legally binding in all MS.
Inland surface water	PFOS AA: 0.65 ng/L PFOS MAC: 36 µg/L	Directive 2008/105/EC on EQS in the field of water policy	EU level. Legally binding in all MS.
Other surface water	PFOS AA: 0.13 ng/L PFOS MAC: 7.2 ng/L	Directive 2008/105/EC on EQS in the field of water policy	EU level. Legally binding in all MS.
Member State specific			
Drinking water	PFAS 4: 4 ng/l PFAS 21: 100 ng/l	The Swedish Food Agency's regulations on drinking water (LIVSFS 2022:12)	Sweden. Legally binding starting from January 1st, 2026.
Groundwater	PFOS: 45 ng/L	Swedish Geotechnical Institute	Sweden. Non-legally binding. Preliminary guideline.
Inland surface water	PFOS AA: 0.65 ng/L PFOS MAC: 36 µg/L	The Swedish Agency for Marine and Water Management's Regulations (HVMFS) on classification and Environmental Quality Standards for Surface Water 2019:25	Sweden. Legally binding. In line with EU regulation.
Inland surface waters that are drinking water body	MAC of 11 PFAS: 90 ng/L	The Swedish Agency for Marine and Water Management's Regulations (HVMFS) on classification and Environmental Quality Standards for Surface Water 2019:25	Sweden. Legally binding.
Coastal waters and waters in the transition zone that are drinking water body	MAC of 11 PFAS: 90 ng/L	The Swedish Agency for Marine and Water Management's Regulations (HVMFS) on classification and Environmental Quality Standards for Surface Water 2019:25	Sweden. Legally binding.

Note: AA – annual average; MAC – maximum allowable concentration; PFAS Total – encompasses all PFAS, regardless of their structure and size; sum of PFAS – includes only a subset of PFAS compounds as defined in the Directive (EU) 2020/2184 – Part B of the Annex III; 11 PFAS - Perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), fluorotelomersulfonate (6:2 FTS), perfluorobutanoate (PFBA), perfluoropentanoate (PFPeA), perfluorohexanoate (PFHxA), perfluorobheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorinonanoate (PFNA) and perfluorodecanoate (PFDA)
The Commission has established technical guidelines to measure PFAS in drinking water[56].

[56] Commission Notice – Technical guidelines regarding methods of analysis for monitoring of per- and polyfluoroalkyl substances (PFAS) in water intended for human consumption

7.6 Identifiers related to specific PFAS

Substance	Identifiers	
PFOA	IUPAC name	○ Pentadecafluorooctanoic acid ○ Perfluorooctanoic acid
	Common name	○ PFOA ○ C8 ○ Perfluorooctanoate (anion form) ○ Pentadecafluoro-1-octanoic acid ○ Perfluorocaprylic acid
	CAS no.	335-67-1 (PFOA - Acid Form)
	EC no.	206-397-9
	Molecular formula	$C_8HF_{15}O_2$

Substance	Identifiers	
PFOS	IUPAC name	○ Perfluorooctanesulfonic acid ○ Heptadecafluorooctane-1-sulphonic acid
	Common name	○ PFOS ○ Perfluorooctane sulfonate
	CAS no.	1763-23-1 (PFOS - Acid Form)
	EC no.	217-179-8
	Molecular formula	$C_8HF_{17}O_3S$

Substance	Identifiers	
PFHxA	IUPAC name	○ Undecafluorohexanoic acid ○ Perfluorohexanoic acid
	Common name	○ PFHxA ○ Perfluorocaproic acid
	CAS no.	307-24-4
	EC no.	206-196-6
	Molecular formula	$C_6HF_{11}O_2$

Substance	Identifiers		
PFHxS	IUPAC name	○	Perfluorohexane-1-sulphonic acid
	Common name	○	PFHxS
		○	Perfluorohexane sulphonic acid
	CAS no.	355-46-4	
	EC no.	206-587-1	
	Molecular formula	$C_6HF_{13}O_3S$	

7.7 Available more specific cleaning protocols from other sources

Table 4. Flow charts for different types of firefighting components as available in the Arctic council's transition manual - Clean out protocols and the relevant section.

Firefighting component	Section in Arctic Council's Manual
Atmospheric Storage Container	P2.1
Original Containers	P2.2
Firewater system	P3.1
Foam solution pipework	P3.2
Foam concentrate pipework	P3.3
Flexible hoses	P3.4
Diaphragm foam bladder tanks	P4.1
Inline inductors	P4.2
Balanced Pressure Proportioning System	P4.3
Pressure Proportioner	P4.4
Foam concentrate pumps	P4.5
Foam chamber/pourer system	P5.1
Subsurface firefighting system	P5.2
Foam spray system	P5.3
Foam sprinkler system	P5.4
Vehicle	P6.1
Portable and mobile firefighting equipment	P7.1

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