CL:AIRE

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PFAS Site Profile

PFAS Site Profiles were developed as part of the Environment Agency PFAS Risk Screening Project and represent an understanding of PFAS uses and occurrences from specific industry sectors at the time of writing in March 2024. This profile focuses on Aqueous Film-Forming Foam (AFFF).

Aqueous Film-Forming Foam (AFFF)

1. INTRODUCTION

1.1 Overview

Per- and poly-fluoroalkyl substances (PFAS) are a broad group of more than 12,000 synthetic fluorinated organic chemicals. PFAS have been used in a wide variety of consumer products and industrial applications since the 1940s because of their unique chemical and physical properties, including oil, water and stain repellence, temperature and chemical resistance, and surfactant properties. These properties mean they are also extremely persistent in the environment. Some PFAS are bio-accumulative and toxic, and/or highly mobile.

Increasing awareness of the widespread presence of PFAS has heightened regulatory concerns about their potential risks to human health and the environment. To ensure effective actions are implemented the Environment Agency needs to better understand the potential sources of PFAS, the mechanisms of transport (pathways) and the relative significance of these substances in the environment.

As part of the Environment Agency PFAS risk screening project (Phases 1 to 4 carried out between 2020 to 2025) Jacobs developed individual site profiles for several potential high risk site types. They focus on specific industry sectors, representing potentially important sources of PFAS, whether from use or manufacture, with the potential for release into the environment.

The primary aim of these profiles is to help those parties involved in the regulation, investigation and remediation of sites where these problem chemicals present a risk to health and the wider environment. These are not definitive studies, but they introduce some of the technical considerations that need to be borne in mind when assessing a particular type of facility. Representing an understanding of PFAS at the time of writing (March 2024) and with published literature notably increasing continuously as practitioners and regulators seek to improve their understanding of PFAS, users must make their own appropriate assessments with current knowledge and specific to their site.

The reader is referred to Ross and Hurst (2019) and ITRC (2023) for more detailed information on PFAS chemistry, properties, fate and transport, risk assessment and remediation, to Glüge et al. (2020) for a review of the diversity of uses of PFAS, and to Ross (2023) for an overview of the uses of PFAS to assist with identification of sites of concern.

1.2 Site Profile Selection and Preparation

The site types for which site profiles have been developed in this project have been selected to represent potentially important users and sources of PFAS release to the environment in terms of quantity, frequency and historical records available.

Technical and scientific publications, fact-sheets, regulations, product websites, articles and online newspaper reporting interviews on the PFAS discussions were researched and reviewed to obtain information on the use of PFAS, with particular reference to the United Kingdom.

Each site profile includes site background information focused on PFAS use and identification of specific zones (where applicable), description of the processes involving PFAS, types of PFAS likely to be present, and an indication of the impact to water and soil. Brief examples and case studies from the literature are also provided.

For each site type a number of zones or activities have been identified where PFAS may be used. It should be recognised that not every site of this type will have all the activities identified. For example, a fire station site may be anything from a building where fire tenders containing Aqueous Film-Forming Foam (AFFF) are based (but filling, maintenance and training happen elsewhere) to a hub with a wide range of activities such as fire practice training, concentrate storage etc. in addition to vehicle storage.

Site profiles have been created for the following site types identified as potentially important potential sources of PFAS release to the environment:

- Civil and Military Airfields and Airports;
- Control of Major Accident Hazards (COMAH) Regulated Sites;
- Fire-fighting Grounds and Fire Stations;
- Landfills;
- Metal Manufacturing and Finishing;
- Military Bases (other than Air Transport Sites);
- Oil and Gas Industry (onshore exploration and extraction operations);
- Paper and Cardboard Manufacturing;
- Refineries and Fuel Sites;
- Textiles, Upholstery, Leather, Apparel and Carpets (TULAC) Manufacturing; and
- Waste Water Treatment Works.

Additional site profiles which do not relate directly to a particular site type have been developed for the following subject areas, which have potential applications within many different site types:

- Aqueous Film-Forming Foam (AFFF); and
- Fire Suppression Systems.

2. BACKGROUND TO AFFF

Fire-Fighting Foam (FFF), including AFFF, is recognised to be one of the main sources of PFAS loss to the environment impacting ground and groundwater. It is identified as a major potential source at sites such as fire training grounds and fire stations, airfields, oil storage sites, COMAH and other industrial sites with foam fire suppression systems, sites of major fires, as well as potential disposal to landfill and waste effluent. This site profile gives an overview of AFFF to support the site profiles.

2.1 What are Fire-Fighting Foams?

Class B FFF are surfactant solutions used to combat Class B flammable fuel fires, that is, fires involving flammable liquids or flammable gases, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, or alcohols. PFAS fluorosurfactants are added to provide the low surface tension, hydrocarbon repellence and positive spreading co-efficient that enable rapid formation of an aqueous film on the surface of the flammable liquid. The sealing properties of the film prevent the diffusion of flammable vapours and are resistant to burn-back. The chemical stability of PFAS also supports the persistence of the film in fire conditions. While most Class B FFF contain PFAS fluorosurfactants, fluorine-free Class B FFF alternatives are available (Wood Environment and Infrastructure Solutions, 2020). It can be assumed that unless a Class B FFF is specifically described as being fluorine free, it is likely to contain PFAS.

Class B foams have the potential to create an adverse environmental impact if released uncontrolled to the environment, particularly if the foam reaches drinking water sources, groundwater, surface water, or other natural waters. For all Class B foams, including fluorine-free foams, there is a potential for acute aquatic toxicity and excessive biological and chemical oxygen demand, as well as nutrient loading, depending on where the discharge occurs (SWECO, 2020). Wood Environment and Infrastructure Solutions (2020) provide further detail on fluorine-free foam alternatives. Research on fluorine-free foam alternatives continues; for example, one of the novel foam systems produced is derived from polysaccharide copolymers and nanoparticles that are sustainable, non-toxic, and water-soluble (or water-dispersible) (ITRC, 2023a).

Other FFF include Class A foams, which were developed for use on Class A fires, that is, fires involving materials such as wood and paper where the cooling effect of water is of paramount importance in extinguishing the risk. Class A foams are essentially wetting agents that reduce the surface tension of water and allow it to soak into combustible materials more easily. They generally do not contain PFAS chemicals as they are not designed to be film-forming. There is however potential for cross-contamination with PFAS if the same foam forming equipment is used for both Class A and Class B foams. Class A foams are not considered further in this note.

2.2 Types of Class B Fire-Fighting Foams

There are numerous types of foams with different acronyms including those detailed below. These acronyms appear to sometimes be used slightly differently by different manufacturers (e.g. Chemguard and Angus Fire) and authors (Chemguard, 2005; Angus Fire, 2015). Care should be taken with similar acronyms which can mean different things (for example, FFF can be fluorine-free foam but is fire-fighting foam in this document).

The original AFFF started being used in the 1960s. It was a concentrate containing synthetic detergent foaming agent and fluorosurfactants; these are now largely replaced by film-forming fluoroprotein foam (FFFP) but the acronym AFFF continues to be used as a generic term for fluorinated film-forming foam. The various different types of film-forming foams are described below:

- Alcohol resistant aqueous film-forming foam (AR-AFFF) – with additional formulation to make it more suitable for use on polar solvents in addition to hydrocarbons;
- Fluoroprotein foam (FP) – foam concentrate based on hydrolysed natural protein foaming agent, foam stabilisers and preservatives; extensively used in oil and petrochemical industries;
- FFFP – Film-forming foam combining fluoroprotein foam with additional fluorosurfactants developed in the 1980s as a replacement for AFFF; and
- Alcohol resistant film-forming fluoroprotein foam (AR-FFFP) – similar to FFFP but designed for polar solvents.

The acronyms do not relate directly to the type and amount of PFAS in the foam. The specific formulations of FFFs are usually confidential to the companies that produce them, and the formulation of individual manufacturers foams have developed over time (as described further below).

2.3 Application of Fire-Fighting Foams

FFF is applied by mixing foam concentrate with water to make the foam solution, which is then aerated at the nozzle to produce FFF. Foaming systems include aspirators and Compressed Air Foam Systems (CAFS). CAFS may be used for both Class A and Class B foams. FFFs may also be applied via fixed fire suppressions systems (CL:AIRE, 2026m).

2.4 PFAS Formulations in AFFF

The chemistry, history, and production processes for the PFAS that have been used in AFFF are highly complex and there are a large number of potential PFAS present in AFFFs, including both precursors and terminal or arrowhead PFAS. FFF producers consider the ingredients in their products as trade secrets, and Material Safety Data Sheets tend to provide only limited information, for example mentioning PFAS or fluorosurfactants in general, without any specific detail. Most information on the composition of foams comes from researchers testing foams and spills.

Typical AFFF formulations have evolved over time as manufacturers have responded to environmental and health concerns and restrictions, and the description below provides an indication of formulation development over time. AFFF have a long shelf life, and the stocks required to be held in case of emergency are generally substantially larger than the volumes used in operation, maintenance and training, The composition of those held and used in response to incidents may therefore lag behind the composition of those being marketed at the time of the incident.

Further details of PFAS occurrence in FFFs in the EU is provided in the ECHA report of the use of PFAS and fluorine-free alternatives in FFFs (Wood Environment and Infrastructure Solutions, 2020). There is also general information on AFFFs and their use available on the ITRC website (2023b), and in Wood Environment and Infrastructure Solutions (2020). The following sections summarise key information relevant to assessment of AFFF impact in the UK context.

2.4.1 Early Development of AFFF

Fluorosurfactants were first used in FFFs in the 1960s when the United States Navy, supported by 3M, developed AFFF to fight complex liquid fuel fires. The US Navy patented the technology in 1966 (HM Fire Service Inspectorate, 2000).

There were other FFFs in use prior to the development or widespread use of fluorinated foams. For example, in the early 1960s the UK Ministry of Defence installed 'Pyrene' foamers to lay foam blankets on runways at designated sites prior to emergency landings, including as shown, for example, in a 1965 documentary film (Sussex History Forum, 2011). The exact composition of these foams is unknown. The Pyrene company manufactured foam fire extinguishers which used carbon tetrachloride, but it is not known if this technology was also used for foam blankets. Protein foams were also developed and in use prior to the development of fluorinated foams. It seems reasonable to assume that, while the foams visible in the 1965 documentary films that predate the US Navy patent were probably not fluorinated, fluorinated foams are likely to have been adopted by the UK military for use in such runway foaming systems by the late 1960s / early 1970s.

2.4.2 Original AFFF Based on PFOS

The original AFFF were based on PFOS, the C8 PFSA, produced using the electrochemical fluorination (ECF) process. This process results in a complex mixture including around 80% PFOS (linear and branched), plus impurities including PFOA, PFHxS, PFHxA, PFHpA. The use of ECF for producing PFOS was phased out by 3M in the USA in 2002, but may have continued in other countries after this time. In Europe, the use of PFOS in FFFs was restricted under the Marketing & Use Directive (Directive 2006/122/EC, 2006), which required that existing stocks of FFFs containing PFOS should be identified, and their use should be allowed to continue only for a limited time. This allowed FFFs that were placed on the market before 27 December 2006 to be used in England until 27 June 2011.

2.4.3 Replacements for PFOS – Short Chain PFSA

One approach to replacing PFOS in AFFF was to use shorter chain PFSA PFHxS (C6). PFHxS is also produced by the ECF process and is likely to contain similar levels of impurities.

2.4.4 Replacements for PFOS – Fluorotelomer-based AFFF

Another approach has been to use PFAS created using the fluorotelomerisation process. According to ITRC (2023a), fluorotelomer foams have been in use since the 1970s and became the predominant foam after 2001. Fluorotelomerisation cannot be used to produce PFSAs (such as PFOS) but can be used to create PFCAs such as PFOA, and sulfonated fluorotelomers, such as 6:2 FTS. The fluorotelomerisation process creates cleaner products with fewer impurities, however the fluorotelomers can degrade to PFCAs.

The actual chemistry of the fluorotelomers used in AFFF appears to be very variable. Wood Environment and Infrastructure Solutions (2020) lists 22 identified fluorotelomers with varied head groups including betaines and thioamido sulfonates. These range in chain length from 14 carbons (e.g. 12:2 FTAB, with 12 fully fluorinated carbons and 2 nonfluorinated carbons) to 4 carbons (e.g. 4:2 FTS, with 4 fully fluorinated carbons). These precursors appear to transform in the environment into fluorotelomer sulfonic acids including 8:2 FTS and 6:2 FTS. These can transform in turn into PFCAs, for example 8:2 fluorotelomers to PFOA (C8) and shorter, and 6:2 fluorotelomers to PFHxA (C6) and shorter. Environmental monitoring with extended target suites has shown that some of the fluorotelomer precursors can be persistent in soil, waste water, surface water and groundwater; for example the fluorotelomer sulfonamidoalkyl betaine 6:2 FTAB has been found to be locally present in elevated concentrations in various environmental media, with its presence attributed to use in AFFF (Dauchy et al., 2019).

According to ITRC (2023a), legacy 'C8' fluorotelomer AFFFs were manufactured and sold in the USA from the 1970s to 2016. Legacy fluorotelomer-based AFFF foams have historically contained predominantly short-chain (C6) PFAS with formulations ranging from about 50–98% short-chains and the balance as long-chain PFAS (including C8). The long-chain PFAS content of these foams has the potential to break down in the environment to PFOA and other PFCAs, but not to PFOS or other PFSAs.

Over time, manufacturers have developed the fluorotelomer manufacturing process to move away from long chain PFAS (including 'C8'). Modern fluorotelomer foams are based on 'C6' technology which are precursors to 6:2 FTS and short chain PFAS. While they do not contain or breakdown in the environment to PFOS and other long-chained PFAS such as PFHxS and PFOA, foams made with only short-chain (C6) PFAS may still contain trace quantities (parts per billion [ppb] levels) of PFOA and PFOA precursors as by-products of the manufacturing process.

2.5 AFFF Types and Forensic Source Identification

The different manufacturing processes and development of AFFF formulations can be useful for forensic assessment of data and source differentiation, by looking at the relative proportions of PFAS substances present.

ITRC (2023a) suggests that studies show that ECF-based AFFF is the dominant source of PFAS at AFFF-impacted sites in the USA, which is interpreted as being likely to be due to the longer period of ECF-based AFFF use and the relative coincidence of implementation of engineering controls for releases with increased use of telomer-based AFFF. It is not known whether this is also the case in the UK, where there is very limited investigation data, and where testing has been done, it has been focused on PFOS and PFOA. As more data becomes available more evidence is being seen of the presence of locally predominant 6:2 FTS and 6:2FTAB, for example in Environment Agency surveillance monitoring and the UKWIR Chemical Investigation Programme (UKWIR, 2023).

As described above, the ECF process results in a complex mixture of PFCA and PFSA homologues, including both branched and linear isomers. PFOS produced by the ECF process is reported to contain around 70% linear PFOS and 30% branched PFOS (Benskin, et al., 2010). A study by Jiang et al. (2015) reviewed the purity of PFOS and PFOA products believed to have been manufactured by the ECF process in China and found the purity of the PFOS products was between 75–80%, with the major impurity comprising PFOA (more than 10%), also PFHxS, PFHxA and PFHpA. Jiang et al. (2015) found PFOA products were around 95% pure, contained PFOS as the major impurity, and had around 77% linear PFOA to 23% branched PFOA.

In the USA, it is understood that 3M used the ECF process for PFAS manufacture until they phased out its use for the production of C8 PFAS in 2002. The US military specification for AFFF in the 1980s required the use of 3M foams, and there is therefore extensive literature referring to the use of ECF characteristics to differentiate PFAS from military foam usage in the USA from other sources of PFAS or other non-military AFFF which may have been produced by the telomer process. The situation is not so simple in the UK, where there is less clarity on manufacturing processes used for the PFAS products used as the basis of foam formulations by the various national and international foam providers, for military and other uses. It is therefore likely to be more difficult to determine the expected composition of PFAS from different sources in AFFF contaminated sites in the UK.

It is not clear whether other PFAS producers elsewhere in the world (for example China) also used the ECF process, and also which FFF manufacturers were supplied by PFAS producers using the ECF process. The wide range of AFFF recorded by Wood Environment and Infrastructure Solutions (2020) as containing PFSAs including foams produced in the UK by Angus Fire as late as 2007, indicate that ECF foams are likely to have been in widespread use in the UK, including from suppliers other than 3M.

Legacy fluorotelomer AFFF were manufactured and sold in the USA from the 1970s to 2016. It is likely that they were also manufactured elsewhere in the world and sold in the UK during this period. Although not made with PFOA, they contain long chain polyfluorinated precursors (e.g. 8:2 fluorotelomers) which are shown to degrade to PFOA and other PFCAs in the natural environment. They may contain trace quantities of PFOA as an unavoidable by-product of the manufacturing process. Legacy fluorotelomer-based AFFF foams have historically contained predominantly short-chain (C6) PFAS with formulations ranging from about 50–98% short-chains and the balance as long-chain PFAS. The long-chain PFAS content of these foams has the potential to break down in the environment to PFOA and other PFCAs, but not to PFOS or other PFSAs.

Modern fluorotelomer foams marketed as ‘C6 technology’ are based on short-chain PFAS including 6:2 fluorotelomers with the potential to break down to short chain PCFAs (PFHpA and shorter).

Fingerprints relating to the relative distribution of PFAS may be used to investigate and differentiate multiple sources of PFAS release. The type of AFFF used by the US DoD is controlled by Military Specification (MILSPEC), which means that in the USA it may be possible to differentiate some AFFF from military sources from other sources based on the PFAS signature (Higgins, 2021). The PFAS Source Differentiation Guide for Airports (National Academies of Sciences, Engineering and Medicine, 2023) includes a detailed review of PFAS data related to airports and other sources in the USA and proposes PFAS composition may be used to aid source differentiation between airport derived sources of PFAS and other sources. This provides much useful information and insight into the challenges associated with forensic analysis of PFAS. It should be noted that the airport practice and different regulations and supply chain may mean that some findings may be less applicable in the UK.

2.6 Timing of Use of Different AFFF Types

The nature of usage of FFFs is such that in many circumstances users are required to maintain stocks of foam in case of emergency, but the actual rate of usage may be low if no emergency occurs. The stability of PFAS means that they tend to have a long shelf life and therefore phasing out of specific types of PFAS by the manufacturer does not directly equate to cessation of use of those AFFF by the end operators, except in the case of specific regulatory restrictions.

The chemical nature of PFAS also means that they are difficult to fully remove from equipment when transitioning to a new supply. This can result in ‘crossover’ of legacy PFAS compounds in equipment and washwater. It is not known how much effect this may have for example in transitioning equipment between fluorinated foams, and fluorine-free foams for training exercises or Class A fires.

2.7 Published Data on Fire-Fighting Foam

Wood Environment and Infrastructure Solutions (2020) undertook a desk study to identify PFAS present in FFFs with information sources including literature review and supplier information. Most information on PFAS was found within the scientific literature as they discovered that supplier information and safety data sheets only indicated general terms such as ‘fluorinated surfactant’. They concluded that a large number of highly diverse PFAS substances

were found in the context of use in FFFs. They uncovered very little specific information on testing of specific foams, apart from a study by KEMI (2015). The findings are consistent with the discussion above.

KEMI (2015) published the results of chemical analysis of eight selected FFFs on the Swedish Market in 2014. They included targeted analysis of known PFAS substances, and non-targeted analysis. The targeted analysis found the most common detections were short chain PFCAs, with highest concentrations of PFHxA. The fluorotelomer 6:2 FTS was present at high concentrations in all products. Long chain PFCAs and PFSAs were less frequent and at lower concentrations. The non-targeted analysis found fluorinated telomer products with 6:2 configuration present in the mg/kg range. These results are consistent with the description of modern fluorotelomer AFFF.

3. PROCESS

AFFF is used in many processes and activities, refer to specific site profiles for further details. Some processes and activities by which AFFF may be released into the environment include:

- Use in training exercises including practicing emergency response;
- Large volume accidental loss through systems failure including foam suppressions systems;
- Low volume accidental release during storage, transfer and maintenance including vehicle washing;
- Incident and emergency response to fires;
- Incident and emergency response to flammable fluid spills for vapour suppression;
- Discharge to drain or ground;
- Controlled or uncontrolled waste disposal; and
- Slow release of AFFF previously adsorbed to concrete and other permeable surfaces during prior release.

Land uses with the potential for AFFF release include (but are not limited to):

- Airports and airfields (military and civilian);
- Fire stations and fire training grounds;
- Large industrial sites including COMAH sites, refineries, steelworks, ports;
- Small industrial sites with fire suppressions systems;
- Fuel storage sites; and
- Sites of major fires where foams have been used.

4. KEY PFAS CONTAMINANTS OF CONCERN

A wide spectrum of PFAS precursors and terminal degradation products may be present associated with AFFF use and loss to the environment.

Wood Environment and Infrastructure Solutions (2020) lists the following PFAS associated with AFFF:

- PFSAs: C2 – C11;
- PFCAs: C4 – C14 and C18;
- Various perfluoroalkane sulfonyl fluoride substances (PASF) including sulfonamides; and
- Fluorotelomers: 22 substances including sulfonates, alcohols, betaines, etc.

The actual PFAS present at any one site will vary dependent on the AFFF formulations used, which will have varied over time. While some generalities may be drawn associated with the dates of operation and use, and the date of phasing out of PFOS-based AFFF and the introduction of fluorotelomer chemistry, actual practice varied. Records of AFFF type and composition are also likely to be poor.

Fingerprints relating to the relative distribution of PFAS may be used to investigate and differentiate multiple sources of PFAS release.

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IMPORTANT NOTES FOR READERS OF THE PFAS SITE PROFILES

The PFAS Site Profiles are based on available online literature and review of readily available technical publications at the time of writing (2020-2024). The authors recognise that additional information may be available that has not been used in this study.

The published literature on PFAS occurrence and distribution is vast and continually expanding. For example, the Interstate Technology and Regulatory Council web resource cited in the PFAS Site Profiles as “ITRC (2023)” was substantially updated in January 2026.

The purpose of the PFAS Site Profiles is to provide regulators and other interested parties with researched advice on how to assess problem sites that may be impacted by legacy use or release of PFAS. The profiles do not seek to address the specific circumstances of each site as these will be unique. As such, the PFAS Site Profiles should be read with the following reservations in mind:

- Practices can vary between different sites and therefore individual sites may not have been exposed to the typical PFAS contaminants of concern as detailed in each site profile;
- Site exposure to PFAS contaminants of concern may vary based on practices and equipment used on site; and
- Given the longevity of PFAS in the environment, site profiles may refer to practices which are no longer followed, and subsequently may omit current practices which avoid contamination.

DISCLAIMER

The information, views and conclusions drawn concerning the PFAS Site Profiles are based, in part, on information supplied to Jacobs by third parties; and from publicly available information. Jacobs has proceeded in good faith on the assumption that this information is accurate and complete. Jacobs accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to Jacobs by third parties or available from public sources.

All users must make their own appropriate assessments specific to their site (or group of sites).

For the avoidance of doubt none of CL:AIRE, Jacobs or the Environment Agency accept liabilities resulting from the use or interpretation of the contents of the PFAS Site Profiles.

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PFAS Site Profile

ACRONYMS AND ABBREVIATIONS

Note: this list of acronyms and abbreviations includes those used across all the site profiles and therefore may include some acronyms and abbreviations not used within this profile.

General Acronym / Abbreviation	Definition	General Acronym / Abbreviation	Definition
AFFF	Aqueous Film-Forming Foam	HSE	Health and Safety Executive
ALARP	As Low As Reasonably Practicable	ITRC	Interstate Technology and Regulatory Council
AR-FFFP	Alcohol resistant film-forming fluoroprotein foam	LCMS	Liquid Chromatography Mass Spectrometry
BOW	Bilge and oily waste water	LPG	Liquified Petroleum Gas
CA	Competent Authority	MAPP	Major accident prevention policy
CAS	Chemical Abstracts Service	MILSPEC	Military Specification
CAFS	Compressed Air Foam System	MSDS	Material Safety Data Sheets
CDOIF	Chemical and Downstream Oil Industries Forum	NAPL	Non Aqueous Phase Liquid
CIMAH	Control of Industrial Major Accident Hazards	NCM	Nordic Council of Ministers
CIP	Chemicals Investigations Programme	NIHHS	Notification of Installations Handling Hazardous Substances Regulations
CLP	Classification Labelling and Packaging	NORM	Naturally occurring radioactive material
CO_2	Carbon dioxide	OECD	Organization for Economic Cooperation and Development
COMAH	Control Of Major Accident Hazards	ONR	Office for Nuclear Regulation
CPI	Confederation of Paper Industries	PCM	Paper and Cardboard Manufacturing
DoD	Department of Defence (Australia)/Defense (USA)	PNEC	Predicted No-Effect Concentrations
DoE	Department of Environment	PPB	Parts Per Billion
DWS	Drinking Water Standards	PPE	Personal protective equipment
ECF	Electrochemical fluorination	RAAF	Royal Australian Air Force
EOF	Extractable Organic Fluorine	REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
EPA	Environmental Protection Agency (for Denmark)	STM	Surface treatment of metals
EPR	Environmental Permitting Regulations	TOP	Total Oxidisable Precursor
EQS	Environmental Quality Standard	TULAC	Textiles, Upholstery, Leather, Apparel and Carpets
EU	European Union	UBA	Umwelt Bundesamt (German Environment Agency)
FCM	Food Contact Material	UK WIR	United Kingdom Water Industry Research
FFF	Fire-Fighting Foam	UMD	University of Maryland
FFFP	Film-Forming Fluoroprotein	US EPA	United States Environmental Protection Agency
FP	Fluoroprotein	WWTP	Waste Water Treatment Plant
FPP	Fire Prevention Plans	WWTW	Waste Water Treatment Works
FRS	Fire and Rescue Service		

PFAS Site Profile

ACRONYMS AND ABBREVIATIONS

Note: this list of acronyms and abbreviations includes those used across all the site profiles and therefore may include some acronyms and abbreviations not used within this profile.

PFAS Acronym / Abbreviation	PFAS Definition	PFAS Acronym / Abbreviation	PFAS Definition
10:2 FTOH	10:2 Fluorotelomer alcohol	HFPO-DA	Hexafluoropropylene oxide-dimer acid
10:2 FTS	10:2 Fluorotelomer sulfonate or sulfonic acid	HFPO-TA	Hexafluoropropylene oxide-trimer acid
10:2 FTUCA	10:2 Fluorotelomer unsaturated carboxylic acids	MeFOSAA	Methylperfluorooctanesulfonamidoacetic acid
11Cl-PF3OUdS	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	PAP	Polyfluorinated alkyl phosphates
12:2 FTS	12:2 Fluorotelomer sulfonate or sulfonic acid	PASF	Perfluoroalkane sulfonyl fluoride substances
14:2 FTS	14:2 Fluorotelomer sulfonate or sulfonic acid	PFA	Perfluoralkoxy polymer
12:2 FTAB	12:2 Fluorotelomer sulfonamido betaine	PFAA	Perfluoroalkyl acid
4:2 FTS	4:2 Fluorotelomer sulfonate or sulfonic acid	PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
5:3 FTCA	5:3 Fluorotelomer carboxylic acid	PFBA	Perfluorobutanoate or Perfluorobutanoic acid
6:2 FTAB	6:2 Fluorotelomer sulfonamidoalkyl betaine (see also CMDFPAH)	PFBS	Perfluorobutyl sulfonate or Perfluorobutyl sulfonic acid
6:2 FTCA	6:2 Fluorotelomer carboxylic acid	PFC	Perfluorinated Compound
6:2 FTOH	6:2 Fluorotelomer alcohol	PFCA	Perfluoroalkyl carboxylic acid
6:2 FTS	6:2 Fluorotelomer sulfonate or sulfonic acid (see also TDFOSA)	PFDA	Perfluorodecanoate or Perfluorodecanoic acid
6:2 FTUCA	6:2 Fluorotelomer unsaturated carboxylic acids	PFDoA	Perfluorododecanoate or Perfluorododecanoic acid
6:2 diPAP	6:2 Fluorotelomer phosphate diester	PFECA	Perfluoroalkyl ether carboxylic acid
8:2 Cl-PFESA	8:2 Chlorinated perfluoroalkyl ether sulfonic acid	PFECHS	Perfluoroethylcyclohexane sulfonate
8:2 FTOH	8:2 Fluorotelomer alcohol	PFESA	Perfluoroalkyl ether sulfonic acid
8:2 FTS	8:2 Fluorotelomer sulfonate or sulfonic acid	PFHpA	Perfluoroheptanoate or Perfluoroheptanoic acid
8:2 FTUCA	8:2 Fluorotelomer unsaturated carboxylic acids	PFHpS	Perfluoroheptane sulfonate or Perfluoroheptane sulfonic acid
9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	PFHxA	Perfluorohexanoate or Perfluorohexanoic acid
ADONA	4,8-Dioxa-3H-perfluorononanoic acid	PFHxS	Perfluorohexane sulfonate or Perfluorohexane sulfonic acid
CMDFPAH	Carboxymethyldimethyl-3-[[(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)sulphonyl]amino]propylammonium hydroxide; a synonym of 6:2 FTAB used in UKWIR reports	PFNA	Perfluorononanoate or Perfluorononanoic acid
EtFOSA	N-ethyl-perfluorooctane sulfonamide	PFOA	Perfluorooctanoate or Perfluorooctanoic acid
EtFOSAA	N-ethyl-perfluorooctane sulfonamido acetic acid	PFOS	Perfluorooctane sulfonate or Perfluorooctane sulfonic acid
EtFOSE	N-ethyl-N-(2-hydroxyethyl) perfluorooctane sulfonamide	PFOSA	Perfluorooctane sulfonamide (FOSA)
F-53B	Trade name for chlorinated polyfluoroalkyl ether sulfonic acids (9Cl-PF3ONS and 11Cl-PF3OUdS)	PFOSE	Perfluorooctane sulfonamido ethanol
FASA	Perfluoroalkane sulfonamide	PFPA	Perfluoropentanoate or Perfluoropentanoic acid
FBSA	Perfluorobutane sulfonamide	PFPE	Phosphate ester salts
FOSA	Perfluorooctane sulfonamide	PFPeA	Perfluoropentanoic acid
FOSAA	Perfluorooctane sulfonamidoacetic acid	PFPeS	Perfluoropentane sulfonate or Perfluoropentane sulfonic acid
FOSE	Fluorooctane sulfonamido ethanol	PFPS	Perfluoropentane sulfonate
FTCA	Fluorotelomer carboxylic acid	PFSA	Perfluoralkane sulfonic acid
FTMAC	Fluorotelomer methacrylate	PFUnDA	Perfluoroundecanoate or Perfluoroundecanoic acid
FTOH	Fluorotelomer alcohol	POSF	Perfluorooctane sulfonyl fluoride
FTS	Fluorotelomer sulfonate	PTFE	Polytetrafluoroethylene
FTSA	Fluorotelomer sulfonic acid	TDFOSA	3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctane-1-sulfonic acid; a synonym for 6:2 FTS used in UKWIR reports
Gen-X	Trade name for HFPO-DA		