Information Bulletin

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Selection and use of firefighting foams

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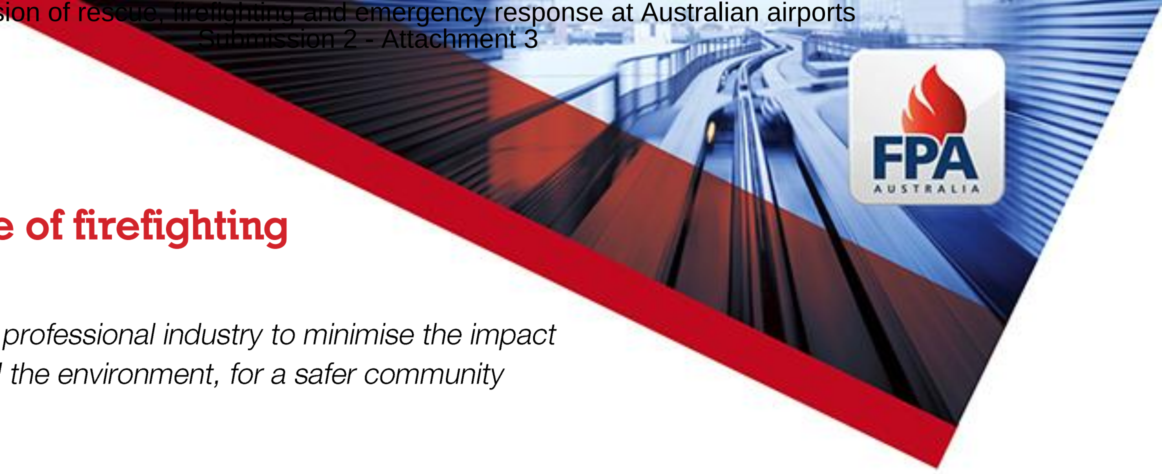
FIRE PROTECTION ASSOCIATION AUSTRALIA

FPA AUSTRALIA



Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

Table of Contents

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

1.0 Purpose statement

The purpose of this document is to increase awareness of the issues surrounding the selection and use of firefighting foams based on their:

- Firefighting performance;
- Environmental impact; and
- System and equipment compatibility.

This Information Bulletin also provides information on the different types of firefighting foams, suggestions for environmental best practice, as well as general recommendations for the selection and use of firefighting foams.

2.0 Audience

This Information Bulletin is intended for:

(i) FPA Australia members;

(ii) Users of firefighting foams, including owners of facilities protected by foam systems and response agencies who use firefighting foam; and

(iii) Other stakeholders involved in the selection and use of firefighting foam, including manufacturers, suppliers, installers and maintainers of fire protection systems and equipment that use firefighting foam.

3.0 Background

Firefighting foam is an effective suppression agent for preventing, extinguishing or controlling fires involving flammable liquids (Class B fuels). Its use can significantly reduce the risk to life, property, environment and business disruption from such fires. Also, in addition to limiting the growth and impacts of a fire, use of these foams also reduces the amount of noxious and harmful breakdown products—including known carcinogens—released by the fires on which they are used.

Firefighting foam is used in fixed and portable fire extinguishing systems as well as fire brigade apparatus. Firefighting foam is produced by mixing foam concentrate with water to produce foam solution. This solution can either be applied:

- Non-aspirated (through water nozzles, sprinklers or deluge nozzles, provided the foam is suitable for application through these devices); or
- Aspirated (when the foam solution is mixed with air through dedicated foam making devices; such as, a foam branch pipe, top pourer, foam cannon, foam sprinkler or high expansion generator).

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

The application of firefighting foam to liquid fuel fires suppresses the release of flammable vapours, separates flames from the fuel, blocks the supply of oxygen to the fuel and cools the fuel surface.

The environmental acceptability of different types of firefighting foam has been a topic of increasing global discussion in recent years, with particular focus on the properties of fluorinated versus fluorine free foams. Whilst a vast amount of environmental information is now available in the public domain, FPA Australia is concerned that much of this information focusses on environmental issues in isolation of other key factors such as firefighting performance, firefighter safety and system compatibility.

FPA Australia recognises that fire protection products and practices must be environmentally responsible. In fact, protecting the environment is a fundamental part of the Association's Vision. However, FPA Australia contends that acceptable life safety, fire protection and environmental outcomes cannot be achieved by consideration of any single performance characteristic. All the characteristics and properties of a product or system must be considered holistically to reach a well-informed view as to which product or system is best suited for a particular application. FPA Australia contends that the decision to select and use a particular type of foam should only be made after careful consideration of a range of factors, including:

- Firefighting performance
- Protection of personnel (both firefighters and the community)
- Potential adverse environmental impacts
- Compatibility with the fixed or portable fire systems in which it is to be used
- Compatibility with existing foam concentrate in storage
- Compatibility with materials (e.g. potential tank/pipework corrosion and seal materials)
- Compatibility with existing proportioning equipment
- Cost.

This document is intended to provide a balanced overview of the key issues which impact on the selection and use of firefighting foam. Only by careful consideration of all these key criteria can foam users make an informed decision as to which type of foam is most suitable for their current and future needs.

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

4.0 Factors impacting on selection and use

Three main factors must be considered when assessing the selection and use of firefighting foam: firefighting performance, environmental impact and system/equipment compatibility.

4.1 Firefighting performance

Firefighting foam is used to prevent, control and extinguish fires. The firefighting effectiveness of a foam must be a prime consideration for its selection and use.

To be effective, a firefighting foam must:

- Rapidly spread over the fuel surface
- Cool the fuel surface
- Resist mixing with the fuel
- In the case of polar solvent (water miscible) fuels, resist attack from or breakdown by the fuel
- Suppress the release of flammable vapours
- Resist breakdown due to radiant heat
- Provide protection from re-ignition and flash-back.

A high level of firefighting performance is essential to protect life, property and environment. High level firefighting performance facilitates:

- Rapid fire extinguishment
- Reduced potential for fire spread
- Reduced release of toxic products of combustion
- Reduced usage of water and foam
- Reduced risk to the life safety of responding firefighters and the community
- Reduced volume of fire water effluent (foam and products of combustion).

It is essential that the firefighting performance of any foam being considered for use—irrespective of whether it is a fluorinated or fluorine free foam—is independently tested and certified to relevant and recognised standards.

Poor firefighting performance will result in fires being more difficult to extinguish and burning longer. This, in turn, will result in an increased release of toxic and carcinogenic products of combustion into the environment. Contaminates in fire water runoff have a direct adverse impact on the environment, so minimising the quantity of water used to extinguish a fire is also essential to minimising environmental impacts. Additionally, use of a foam with inferior firefighting performance can adversely affect the safety of firefighters and the wider community.

There are a range of firefighting performance test standards which, depending upon the intended application, can be used to demonstrate the suitability of a foam for a particular application. Some commonly used test standards are listed in Section 5.2.

Demonstrated evidence of firefighting performance—to the relevant test standard—is essential in selecting the most suitable firefighting foam for a particular application.

4.2 Environmental impact

FPA Australia supports efforts to reduce the adverse impacts that fire and firefighting activities have on the environment. Appropriate selection and use of firefighting foams is important as some firefighting foams do have a greater environmental impact than others by virtue of their chemical composition.

It must be clearly understood, however, that all firefighting foams and firewater runoff have the potential to pollute the environment. Short term (acute) effects can be expressed in terms of acute toxicity and Biochemical Oxygen Demand (BOD). A comparison of foams published in 2006 by the Firefighting Foam Coalition indicated that, in terms of acute effects, fluorine free foam concentrates fell into the 'Slightly Toxic' category while fluorinated foam concentrates were categorised as 'Relatively Harmless'.

Regardless of the type of firefighting foam used, it is also extremely important to consider the environmental impact from the combustion products of the fire itself. Whilst it is difficult to quantify the environmental impact of an individual fire, it is clear that extinguishing a fire as quickly as possible will reduce adverse environmental effects resulting directly from the fire. Using a foam with superior firefighting performance can minimise the amount of foam and water required and will result in less fire water effluent whilst also reducing the quantity of combustion products released.

Failure to adequately consider the firefighting performance of a foam, may result in selection of a foam that is ineffective for the intended application, increasing the adverse environmental impacts from a fire incident whilst also increasing the risk to life safety of both firefighters and the community.

For more information on environmental impact, see Section 5.0.

4.3 System and equipment compatibility

Use of a firefighting foam which has not passed the fire testing protocols applicable to the fire protection system or equipment that it is to be used in may increase the risk to life, property and the environment from a fire incident. Its use may also have serious implications for product/system approvals and insurance cover.

It is important to remember that firefighting foams form only one part of a system and a decision to change the type of foam used should not be made without considering the impact of that change on the complete system. Before making a decision to change the type of firefighting foam used, consultation with key fire protection stakeholders, especially foam system designers and manufacturers, is essential to ensure the performance of the system will not be adversely affected. Important factors which must be considered include:

- Viscosity of the foam concentrate
- Suitability for use with existing proportioning hardware
- Homogeneous mixing of concentrate with water
- Compatibility with materials in the system (e.g. plastic, rubber seals, metals, etc.)
- Stability of foam concentrate or pre-mix solution (separation, stratification, sedimentation)
- Suitability for use on the flammable liquids in question
- Suitability of application method (aspirated, non-aspirated, forceful, gentle).

5.0 Environmental and firefighting performance indicators

A range of methods exist to assess the environmental impact and firefighting performance of firefighting foams. Some of these are detailed below.

5.1 Environmental performance indicators

Scientific measures used to assess the impact of chemicals include Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Both these factors have an influence on the aquatic toxicity of the chemical. BOD/COD profiling identifies the biodegradability of chemicals in the environment and can be used to quantify the chemicals acute (short term) and/or chronic (long term) environmental impact.

Other factors, as detailed below, are also used to establish whether a chemical has other environmental or health effects which necessitate high levels of concern and/or control. Specifically, the Stockholm Convention on Persistent Organic Pollutants (POPs), an international treaty signed in 2001 and effective from May 2004, aims to eliminate or restrict the production and use of POPs. Australia is one of 179 parties who are signatories to this convention. Australia ratified the Convention on 20 May 2004 and became a party to it on 18 August 2004. PFOS was added as a POP to the Convention in 2009 (see Section 6.1.1).

The POP Review Committee established by the Convention developed a procedure for the consideration of individual substances. To qualify as a POP, a substance must meet all four of the following criteria:

- (P) Persistence in the environment
  - (i) Evidence that the half-life of the chemical in water is greater than two months, that its half-life in soil is greater than six months, or that its half-life in sediment is greater than six months; or
  - (ii) Evidence that the chemical is otherwise sufficiently persistent to justify its consideration within the scope of the Convention.
- (B) Bioaccumulation
  - (i) Evidence that the bioconcentration factor or bioaccumulation factor in aquatic species for the chemical is greater than 5000 or, in the absence of such data, that the octanol-water coefficient (K_{OW}) is greater than 5; or
  - (ii) Evidence that a chemical presents other reasons for concern, such as high bioaccumulation in other species, high toxicity or ecotoxicity; or
  - (iii) Monitoring data in biota indicating that the bioaccumulation potential of the chemical is sufficient to justify its consideration within the scope of the Convention.
- (T) Toxicity
  - (i) Evidence of toxicity or ecotoxicity data that indicates the potential for damage to human health or to the environment.
- (LRET) Potential for Long-Range Environmental Transport
  - (i) Measured levels of the chemical in locations distant from the sources of its release that are of potential concern; or
  - (ii) Monitoring data, modelling or environmental fate properties showing that long-range environmental transport of the chemical, with the potential for transfer to a receiving environment, may have occurred via air, water or a migratory species.

If a substance meets each of the above criteria, risk profiling is used to evaluate whether, as a result of its LRET, a substance is likely to lead to significant adverse human health and/or environmental effects and therefore warrants global action. If global action is warranted, a risk management evaluation is undertaken reflecting socioeconomic considerations associated with possible control measures and the substance is listed under the appropriate annex of the Convention. Annexes include:

- Annex A – Elimination
- Annex B – Restriction
- Annex C – Unintentional production.

5.2 Firefighting performance indicators

As previously highlighted, it is important to consider the firefighting performance and system compatibility of any foam when considering changing to a different foam from that currently used.

There are a number of local and international standards that are used to rate the firefighting performance of foam. These include, but are not limited to:

(i) Australian Standards

- AS/NZS 1850, *Portable fire extinguishers – Classification, rating and performance testing*
- AS 5062, *Fire protection for mobile and transportable equipment*
- DEF(AUST) 5706, *Foam Liquid Fire Extinguishing, 3 percent and 6 percent concentrate*.

(ii) International Standards

- EN 1568, *Fire Extinguishing Media – Foam Concentrates* (Parts 1, 2, 3 & 4)
- EN 13565, *Fixed Firefighting Systems – Foam Systems* (Parts 1 & 2)
- International Civil Aviation Organisation (ICAO) Fire Test Method, Doc 9137 — *Airport Services Manual*, Part 1 — *Rescue and Fire Fighting*
- NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- UL 162, *Standard for Safety for Foam Equipment and Liquid Concentrates*
- Mil-F-24385F(SH), *Fire Extinguishing Agent, Aqueous Film Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*
- Factory Mutual 5130 (foam enhanced sprinklers).

In addition to these test standards, there are a number of listing or product certification schemes that provide independent evaluation of fire protection products, including firefighting foams. Evidence of suitability from such listing bodies should be sought to confirm the firefighting performance of a foam. When considering the use of product that has been listed or certified, it is important to check the basis for listing or certification and that this includes testing to a standard relevant for the intended application.

The performance parameters identified as a result of testing to these standards will typically include:

- Time to achieve extinguishment;
- Burn-back resistance; and
- Speed of knockdown and vapour control.

6.0 Different types of firefighting foam

Firefighting foams can be broken into two broad categories:

- Foams which contain fluorinated surfactants; and
- Foams which are fluorine free.

However, there are also individual foam types within these two broad categories.

Commonly used firefighting foam types are better known by the following terms:

- Fluorinated Foams
    - AFFF—Aqueous film-forming foam
    - AR-AFFF—Alcohol-resistant aqueous film-forming foam
    - FP—Fluoroprotein foam
    - FFFP—Film forming fluoroprotein foam
    - AR-FFFP—Alcohol-resistant film-forming fluoroprotein foam.
- Fluorine Free Foams
    - F3—Fluorine free foam
    - AR-F3—Alcohol resistant fluorine free foam

> **Note:** High-expansion, protein, Class A and most training foams are, and always have been, fluorine free.

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

6.1 Fluorinated firefighting foams

Historically, fluorinated firefighting foams include small quantities of perfluorinated and polyfluorinated chemicals (PFCs) or PerFluoroAlkyl Substances (PFAS), as they are often called.

Perfluorooctanyl sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are two of the most common PFAS-based products derived from a range of precursors which were contained in older generation fluorinated firefighting foams.

Fluorinated firefighting foams that contain PFOS, PFOA and PFOA precursors (sometimes referred to as long chain, ≥C8 type fluorinated foams) have good firefighting performance. However, they have also been identified as having Persistent (P), Bioaccumulative (B), Toxic (T) and Long-Range Environmental Transport (LRET) characteristics, all of which have a significant negative environmental effect and a potential to harm human health.

Foam fluorosurfactants, which do not contain or breakdown to PFOS or its related substances, are made using a process, known as telomerisation. These foams are known as fluorotelomers or telomer-based foams. While fluorotelomer based foams do not contain PFOS, they do contain trace levels of PFOA which are produced by the manufacturing process and which can be produced by the potential breakdown of precursors with 8 or more carbon atoms (≥C8).

In recent years and in accordance with the US EPA's PFOA Stewardship Program, fluorotelomer manufacturers have achieved a 98-99.9999993% reduction in PFOA content of fluorotelomer surfactants, by transitioning from long chain (≥C8) to environmentally more benign short chain (≤C6) fluorotelomer surfactants. These US EPA PFOA Stewardship Program compliant (≤C6) surfactants are now being used in current generation fluorinated firefighting foam concentrates.

It is important to note that the fluorinated chemicals in these US EPA PFOA Stewardship compliant fluorinated foams behave differently in the environment to PFOS.

> **Note:** For more information on the US EPA PFOAS Stewardship Program see https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/and-polyfluoroalkyl-substances-pfass-under-tsca#tab-3.

6.1.1 PFOS

PFOS is a Perfluorosulphonic acid (PFSA) and derives from the 3M™ developed ElectroChemical Fluorination (ECF) process. The main global manufacturer of PFOS containing foams, 3M™, voluntarily ceased Australian manufacture of its Lightwater™ AFFF and ATC™ AR-AFFF concentrates in 2003.

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

In 2004, the first 12 POPs were listed in annexes to the Stockholm Convention. In 2009, PFOS was one of 9 new substances added as an Annex B Restricted substance in accordance with the Stockholm Convention with the expectation that every four years progress on its elimination is reported. It should be noted that Australia's National Implementation Plan – Stockholm Convention on Persistent Organic Pollutants (dated July 2006) was published by the Commonwealth Department of the Environment prior to the addition of PFOS as a POP.

Australia is yet to ratify this addition of PFOS as an Annex B Restricted substance and update the National Implementation Plan to reflect this. Australia is considering ratification of PFOS as a POP but must go through a domestic treaty process for which the Commonwealth Department of the Environment is responsible. FPA Australia considers that the Australian Government should ratify PFOS as a POP in accordance with the Stockholm Convention urgently to provide clarity for foam users and protection for our environment.

The Stockholm Convention's goal is to reduce and ultimately eliminate production and use of PFOS and encourages:

- Phase out of PFOS use when suitable alternative substances or methods are available;
- Producers or users of PFOS to develop and implement an action plan for elimination; and
- PFOS producers or users, within their capabilities, to promote research on development of safe alternative substances to reduce human health risks and environmental implications.

The European Union (EU) has prohibited the marketing and use of PFOS since 27 June 2008. Subsequently, PFOS was banned from use in 28 European countries in 2011, requiring high temperature incineration (above 1,100°C) to destroy it. Canada followed by banning it in 2013.

As PFOS is listed as a Persistent Organic Pollutant under the United Nations Stockholm Convention, FPA Australia recommends that any fluorinated firefighting foam containing PFOS and/or its related chemicals, including perfluorohexane sulfonate (PFHxS), should be immediately removed from service and sent to an authorised regulated waste facility for disposal.

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

6.1.2 PFOA

PFOA is a Perfluorocarboxylic acid (PFCA) and is under review by the UN's Stockholm Convention Committee.

Concerns about PFOA's persistence, detection in human blood and effects in animal studies has led to further scientific research. This research has shown that long chain (≥C8) fluorochemicals are larger more complex molecules which are more likely to breakdown to substances which become toxic, potentially bioaccumulative and remain in mammalian organisms for long periods of time. Research indicates that long chain (≥C8) fluorochemicals have half-lives in humans typically averaging 5 years for PFOS, 8.5 years for PFHxS, and 3.5 years for PFOA.

PFOA was mainly used as a polymerization aid in the manufacture of several types of fluoropolymers, which were used in a wide variety of industrial and consumer products, including extensive use in cookware and not firefighting applications. The Electrochemical Fluorination Process (ECF) that was used to make PFOS also generated some by-product PFOA in the manufacturing process. Trace amounts of PFOA can also be found from precursors and was also used as a polymerization aid in the manufacture of several types of fluoropolymers. These were used in a wide variety of industrial and consumer products, including domestic cookware. The Electrochemical Fluorination Process (ECF) used to manufacture PFOS generated some by-product PFOA which deposited trace quantities of PFOA into from eight carbon chain (C8) or longer fluorotelomer surfactant precursors and as an unavoidable by-product from the manufacturing process (generally at a ppm level).

In 2006, the US Environmental Protection Agency (EPA) and eight global fluorotelomer and fluoropolymer manufacturers launched a voluntary PFOA Stewardship Program aiming to phase out PFOA and the precursor chemicals from their production processes, waste streams and finished products by the end of 2015.

Fluorotelomer manufacturers who were part of the US EPA program have virtually eliminated PFOA (down to ppb levels) from fluorotelomer surfactants as they transitioned to environmentally more benign short chain (≤C6) alternatives which are now being used in firefighting foam concentrates. The majority of the major foam manufacturers are now producing fluorinated firefighting foams containing typically ≥97% C6 fluorosurfactants (with the remaining percentage consisting predominantly of C4 fluorosurfactants), improving environmental outcomes and complying with the US EPA PFOA Stewardship Program.

In 2013, the Danish Environmental Protection Agency compiled a survey of PFOS, PFOA and other perfluoroalkyl and polyfluoroalkyl substances. It confirmed that the technologically best alternatives to long-chain fluorinated chemicals are short-chain fluorochemicals with a carbon chain length of ≤C6. These short-chain fluorinated alternatives are still persistent but much less bioaccumulative and toxic than the long-chain homologues, as they are excreted more rapidly by humans and other organisms.

The Danish EPA's overall conclusions confirmed that the US EPA PFOA Stewardship Program will result in significantly lower environmental concentrations and human exposure to these chemicals in the future.

It is interesting to note that the French Food Safety Agency and Norwegian Institute of Public Health have evaluated the potential human health risks related to the residual presence of PFOA in non-stick coatings for cookware, concluding that the consumer health risk is negligible.

6.1.3 C6 fluorotelomers

Scientific research has shown that short chain (≤C6) fluorotelomer surfactant based firefighting foams are environmentally more benign than those using long chain fluorochemicals, including PFOS and PFOA.

C6 fluorotelomer surfactants used in US EPA PFOA Stewardship Program compliant foams do not have the same adverse environmental profile as PFOS, PFHxS, PFOA or PFOA precursors. Scientific research indicates that they are not bioaccumulative, genotoxic, developmental toxins or mutagenic and they exhibit low toxicity to humans and aquatic environments.

US EPA Stewardship Program compliant C6 fluorotelomer surfactant-based foams:

- Do not break down to PFOS, PFOA or chemicals currently listed or suspected of being POPs or PBT substances.
- Although persistent, are not made with chemicals currently considered to be bioaccumulative nor toxic by environmental authorities.
- Are not listed by the Stockholm Convention or European Chemicals Agency (2016) list of substances of high or very high concern (VHC).

Importantly, short chain ≤C6 fluorotelomer surfactant based firefighting foams retain strong firefighting performance, in most cases equivalent to those containing long chain ≥C8, without increased fluorochemical content.

6.1.4 Summary of fluorinated firefighting foams

Fluorinated firefighting foams should not be grouped as a single class in terms of their environmental properties. US EPA PFOA Stewardship Program compliant foams have distinctly different environmental characteristics to foams that contain PFOS or PFOA (above levels allowable under the US EPA PFOA Stewardship program). As such, US EPA PFOA Stewardship Program compliant foams should not be subject to the same level of environmental controls as those imposed on foams containing PFOS or PFOA.

6.2 Fluorine-free firefighting foams

In response to the environmental concerns with PFOS and PFOA fluorinated foams and as a result of European and US reforms, fluorine-free foam technology has advanced in recent years and fluorine-free foams are available in both the Australian and international markets.

Fluorine free foams do not contain persistent fluorosurfactants and play an important role in fire protection and training. However, as a general rule, they do not provide the same level of firefighting performance as fluorinated foams. Typically fluorine free foams do not provide the same fuel shedding, film forming characteristics or burn back resistance which can be vitally important to rapid extinguishment of fires in some applications. These properties are particularly important in industrial and petrochemical applications as well as incidents where the foam is applied forcefully, as is often inevitable in emergency incidents.

It is worth noting, that in tests carried out in 2008 by Schaefer, Dlugogorski and Kennedy, between a PFOS 3M™ AFFF (FC-206CF) foam and an early 3M™ (RF6) fluorine free foam formulation indicated that it may require up to three times more fluorine free foam agent applied over a longer period to control an equivalent volatile fuel incident. The use of fluorine free foam in actual fire incidents also resulted in increased foam usage similar to this laboratory observation. Additionally, the use of the fluorine free foam agent required re-application every 15min compared to 90min for the fluorinated foam.

However, it must be noted that fluorine free foams are available which have been certified to test standards including UL 162, ULC, FM, ICAO, EN1568, IMO and LASTFIRE. As is the case with all foams, users should verify that the foam being

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

considered for use has been independently tested and certified to a standard relevant to the intended application.

While fluorine free foams are 100% biodegradable and are therefore not persistent in the environment, it should be noted, that the acute (short term) environmental impacts of many fluorine-free foams have been shown to be an order of magnitude higher in acute aquatic toxicity than ≤C6 fluorotelomer-based foams. It is therefore important to remember that all foams pollute (regardless of the type of foam being used) and that their use should be managed to reduce environmental impacts.

FPA Australia supports the use of more environmentally responsible foam formulations, however, firefighting foams must only be used in applications where they provide acceptable levels of life safety and firefighting performance demonstrated through a risk based assessment of realistic worst case incident scenarios.

Historically, there have been a number of important applications for which fluorine-free foams have not been suitable. These have included:

(i) Portable fire extinguishers

(ii) Non-aspirated pre-engineered foam/water spray systems used to protect large mining machines.

(iii) Forceful application onto volatile fuels in depth (e.g. storage tanks and associated bunded areas).

In Australia, the use of foam in applications (i) and (ii) above, requires the extinguisher/system to pass the specific fire test protocols detailed in Australian Standards AS/NZS 1850, *Portable fire extinguishers – Classification, rating and performance testing* and AS 5062, *Fire protection for mobile and transportable equipment*, respectively.

Recently at least one fluorine free foam extinguisher with approvals to AS 1850 has been released and is now commercially available. There is also at least one supplier of pre-engineered foam/water spray systems that uses a fluorine free foam certified to AS 5062:2006.

It is important to note, however, that a new edition of AS 5062 (AS 5062:2016) has recently been published. It includes a number of new test requirements. These include, a 90 day agent (pre-mix) stability test and fire testing using cylinders filled at least 30 days prior to testing. All systems will need to be tested to these new requirements in the future, whether fluorinated or fluorine free, to claim compliance to AS 5062:2016. At the time of publication of this information bulletin, FPA Australia is unaware of any system using US EPA PFOA Stewardship compliant foam or fluorine free foam that has been tested to these latest requirements.

6.2.1 Summary of fluorine free foams

As with fluorinated firefighting foams, fluorine free firefighting foams should not be grouped as a single class in terms of their environmental properties or performance. Some fluorine free foams have better firefighting and environmental performance than others, and just like fluorinated foams, evidence of suitability for the application in question must be sought.

7.0 Environmental Best Practice

The following outlines FPA Australia's recommended environmental best practice for use of firefighting foam.

7.1 Training and system testing and commissioning

Training of personnel in the use, testing and commissioning of fire protection systems is essential to ensure the fire preparedness of a facility. However, such activities should be undertaken in an environmentally responsible manner.

To minimise the potential for firefighting foam to enter the environment, FPA Australia recommends the following measures be implemented to facilitate training and system testing and commissioning:

- Use training foams or other surrogate liquids that do not contain fluorosurfactants for training, system testing and commissioning purposes, wherever possible.
- Develop test and commissioning methods for foam proportioning systems which do not discharge foam to the environment.
- Where the discharge of foam cannot be eliminated, ensure it is contained for appropriate collection/treatment/disposal in accordance with the requirements of the local regulatory authorities.

  If containment is not possible, then training, testing and commissioning should only be carried out with a surrogate liquid that is neither persistent, nor bio-accumulative, nor toxic.
- New system designs or system upgrades should incorporate the facilities to allow testing and commissioning of the proportioning system without the need to discharge foam. This may be achieved by incorporating a test return line to the bulk foam storage tank or alternatively diverting foam or a surrogate liquid to a dedicated test tank from which it can be recovered for re-use, or disposal in accordance with the requirements of the environmental regulatory authorities.

7.2 Fire water effluent

Fire water effluent or runoff contains many chemicals and will potentially include: unburnt hydrocarbon or polar solvent fuels; products of combustion (potentially including VOC's (Volatile Organic Compounds) and PAH's (Polycyclic Aromatic Hydrocarbons) – some of which are known carcinogens, particulates, surfactants, water-soluble polymers, hydrolysed proteins, co-solvents, anti-freezing agents, biocides and fluorinated compounds.

It may also be contaminated with perfluorinated chemicals (PFC's) from a wide range of sources, including pre-existing contamination of soil, water and other infrastructure. Pre-existing PFC contamination is highly likely to exist on many industrial sites.

For these reasons, all fire water effluent is potentially hazardous and it is therefore vitally important that it be contained as far as possible, regardless of whether fluorinated or fluorine free foam has been used or not. This contained fire water effluent/runoff should then be tested for contamination and treated or disposed of in accordance with the requirements of local environmental regulatory authorities.

7.3 Remediation of PFC contaminated soil and water

Considerable research work has been undertaken recently into remediation options for soil and water contaminated with PFOS and PFOA. An increasing number of viable technologies are becoming available. Some of these technologies include:

- Granular Activated Carbon (GAC)
- Membrane filtration including Reverse Osmosis (RO) and Nano-Filtration (NF)
- Electrocoagulation
- Anion Exchange
- Catalytic Advanced Oxidation
- Oxofractionative Catalysed Reagent Addition
- Activated persulphate
- Reed bed filtration
- Fungal degradation
- Ultrasonic and mega-sonic destruction
- Adsorption onto modified clays.

The most effective of these claim to be able to remove >99% of PFC content in water and soil, achieving reductions below 5 ppb levels. Many are still at a trial stage, but

Granulated Activated Carbon and modified clays have been used effectively in large scale remediation trials.

Such processes can greatly reduce the volume of PFC contaminated material that may need to be sent for destruction by incineration.

Further information on some of the above technologies listed above can be found at:

- CRC Care, http://www.crccare.com/products-and-services/technologies/matcare
- Evocra, www.evocra.com.au
- University of Arizona, Materials Science and Engineering, http://mse.arizona.edu/sound-destruction.

7.4 Cleaning/change out of existing foams

FPA Australia recommends the following process when cleaning foam tanks or changing out existing foams:

1. Decant existing foam into suitable storage containers and consideration should be made to bund the containers.
2. Thoroughly flush system with water and collect effluent in suitable storage containers. The use of hot water or steam may facilitate quicker cleaning.

> Note: Changing from foam containing PFOS or PFOA to either USA EPA PFOA Stewardship compliant foam or a fluorine free foam will require thorough washing of the tank and collection of all effluent until no frothing is visible. It is also recommended a sample of the "clean" effluent be laboratory tested for traces of PFOS/PFOA to determine a baseline level of contamination for future reference and to confirm the storage is essentially "PFOS and PFOA free". To avoid the possibility of contamination, the tank should not be filled with the replacement foam until the results of this testing are available.

3. Treat decommissioned foam and flush effluent to reduce volume of PFC containing material, using suitable remediation technology.
4. Send concentrated PFC containing materials for disposal/destruction in accordance with local regulatory authority requirements.

7.4.1 PFC Disposal Options

Two processes are currently available for the destruction of PFC contaminated waste in Australia. These are:

- High temperature incineration

- Cement kiln destruction.

For information on destruction options in your local region, FPA Australia recommends you contact the local environmental regulatory authority.

8.0 Recommendations

FPA Australia's recommendations on the selection and use of firefighting foam are as follows:

1. The use of foams containing PFOS should be banned.
2. Existing stocks of foams containing PFOS should be removed from service and sent for high temperature incineration or equivalent destruction at an approved facility.
3. Foam manufacturers should reduce and eliminate the production of foams containing PFOA in accordance with the US EPA PFOA Stewardship Program.
4. Foam users should transition from foams which contain PFOS or PFOA to US EPA PFOA Stewardship Program compliant foams or fluorine free foams using a holistic risk based approach to select the foam most appropriate for the intended application.
5. Regardless of whether the foam under consideration is a fluorinated or fluorine free foam, evidence of suitability must be sought to demonstrate its ability to achieve the required firefighting performance for the fuel and application in question.

   Evidence must also be sought to confirm that the foam is compatible with the systems and equipment with which it is to be used.
6. Whilst important, the environmental performance of a foam should not be used as the sole selection criteria, nor considered in isolation. Choosing the most responsible firefighting foam—the best one to protect life, property and the environment—involves selecting one that provides a combination of firefighting performance, reliability and life safety, balanced with minimal toxicological and adverse environmental impacts. Therefore, the following key selection criteria must all be considered:

   (a) Firefighting performance

   (b) Life safety

   (c) Physical properties and suitability for use on known hazards (including forceful application)

   (d) Compatibility with fuels, system design, application method, existing delivery equipment and approvals

   (e) Environmental impact.
7. Any proposal to change the type of foam used in a system requires careful consideration and must take fire safety and engineering factors into account. The type of foam used

should not be changed without completing a detailed review of the design, performance and operation of the system as a whole. Such design reviews should include consultation with fire system designers, foam and foam hardware suppliers, and the relevant authority having jurisdiction.

8. Where possible, eliminate the discharge of foam during training and system testing and commissioning. Where this is not possible, use surrogate liquids or training foams. Where the discharge of foams containing fluorosurfactants during training, testing or commissioning cannot be avoided, ensure that the discharge is contained, collected, treated and disposed of in accordance with the requirements of the relevant environmental regulatory authority.
9. All fire water effluent, irrespective of the type of foam used, should be contained and tested for regulated contaminants. It should then be treated and disposed of according to the requirements of the relevant environmental regulatory authority.

Selection and use of firefighting foams

Leading and supporting a professional industry to minimise the impact of fire on life, property and the environment, for a safer community

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