



Fire Industry Association

Fire, the Environment and Foams

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1. SCOPE

Although Class A foams, Wetting Agents and Water Additives are all used in firefighting applications this document will focus on Class B foams, as these are currently by far the largest proportion of foams currently in use and being sold within the United Kingdom. Where these other agents are to be used and dispersed it should be remembered that the same rules relating to the dispersion of firefighting run-off into the ground or water environment apply, and the onus is on the operator to ensure that dispersion follows the applicable legislation (as defined in section 9 of this document).

2. FIRE FIGHTING FOAMS - TERMINOLOGY AND DEFINITIONS

a. Fire

- Class A Fire A fire in ordinary combustible materials such as wood, cloth, paper, rubber and many plastics.
- Class B Fire A fire in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents and alcohols.

b. Foam

- Foam Concentrate A concentrated liquid (as received from the manufacturer / supplier).
- Foam Solution A homogenous mixture of water and foam concentrate in the correct proportions.
- Foam (Sometimes referred to as "Finished Foam") A stable aggregation of bubbles of lower density than oil or water.

c. Foam concentrates, Wetting Agents and Water Additives

- Class A Foam Concentrate concentrated liquid suitable for use on Class A fires.
- Class B Foam Concentrates concentrated liquid suitable for use on Class B fires. (Most Class B Foam Concentrates can be used on Class A fires – but may not have been specifically tested on these fires).
- Class B Foam Concentrates suitable for use on water miscible fuels concentrated liquid suitable for use on water miscible fuels such as alcohols, ketones etc. As well as immiscible fuels. These foam concentrates are generally referred to as "Alcohol Resistant".
- Wetting Agent a concentrate that when added to water reduces the surface tension and increases its ability to penetrate and spread. These agents can be used on Class A and Class B fires (Water immiscible fuels ONLY).
- Water Additive an additive that, when added to water in the proper quantities, suppresses, cools, mitigates fire and/or vapours, and/or provides insulating properties for fuels exposed to radiant heat or direct flame impingement. Under NFPA 18A the hazards that water additives can be listed under are defined in Chapter 4 Uses and Limitations, Section 4.2.3 Hazards.

3. BACKGROUND TO THE USE OF FOAMS ON FIRES AND THE ENVIRONMENTAL IMPACT OF LARGE FIRES

The continued global dependency on fossil fuels to provide energy and chemicals for daily life means that flammable liquids will carry on being stored, processed and transported in large quantities.

The attendant risks associated with the use of such flammable liquids inevitably means that fires will occur; at which point some course of action will have to be decided upon.

Historically this would have involved an intervention to control the incident with the ultimate objective of extinguishing all flames. To date Class B fire fighting foams have been used to suppress, extinguish and prevent re-ignition of such fires and safeguard fire fighters/post fire clean-up operations.

The environmental consequences of any action have to be considered, so that deciding to extinguish the fire might prove to be more damaging overall than opting instead for what is known as 'a controlled burn.¹

The main criteria to be considered when deciding whether to attack the fire with foam, are:

- the potential risk to life and property, and
- whether the overall pollution loading on the environment following an intervention, would be more damaging than opting for a controlled burn.

In reality such a decision really will be made by the firefighters on scene in conjunction with the Environment Agency. So, if a controlled burn strategy is considered for a large flammable liquid fire, it amounts to a decision as to whether the air pollution, and property/inventory loss, that will result from doing nothing outweighs the potential aquatic and ground pollution as a consequence of extinguishing the fire.^{2,3}

Set against this is the potential for pollution as fire run-off, a mixture of hydrocarbon residues and foam chemicals, migrates into the soil and water receptors with the risk of tainting potable supplies for years to come. The fire effluent run off from contaminated water used for a controlled burn can be significant, and can far exceed the effluent from an effective foam attack.

Under the COMAH system it is necessary to have an agreed response plan in place that includes containment measures for all run-off, in order to prevent any ground or aquatic pollution taking place.

So, for well run and well-regulated oil and petrochemical facilities handling large amounts of flammable liquids, the question of whether to intervene should not be in doubt.

- 1 Guidance provided by the Environment Agency (PPG 28 'Using controlled burn during fires: Prevent Pollution) although now officially withdrawn is still available for consultation and can offer suggestions for assessing a situation, to determine whether a controlled burn strategy would be appropriate.
- 2 FPA Australia calculated that a 61m diameter tank of burning crude oil would release 17.5 tonnes of air pollution every hour comprising of NOX, SOX, volatile organic compounds, polycyclic aromatic hydrocarbons and acid aerosols.
- ³ During the course of the UK Buncefield fire in 2005, a fire that was actively fought, it is estimated that prior to extinguishment, 8000 tonnes of fine soot particles were released into the atmosphere. It is reckoned that this could have resulted in an extra 12 premature deaths in the local population. If Buncefield had been allowed to burn, the quantity of air pollution would have been much greater.

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4. BENEFITS OF USING FOAM ON FIGHTING LARGE FIRES AND THE IMPLICATIONS OF NOT USING FOAMS

As stated above the main criteria that must be evaluated prior to the decision to intervene with a firefighting operation are the potential risk to life and property, and whether the overall pollution loading on the environment following such an intervention would be greater than opting for a controlled burn. When we evaluate whether to use Class B firefighting foams the further hazard / risk analysis should take place over whether to use water or another firefighting media.

Class B firefighting foams provide a simple way of decreasing the density of water, and so are effective for preventing, controlling or extinguishing flammable liquid fires. The efficiency of Class B firefighting foams over water alone can significantly reduce the risk to life, property, business disruption and environmental impact. Additionally, the use of Class B firefighting foams reduces the amount of noxious and harmful combustible breakdown products from the fires. Following extinguishment the Class B firefighting foams provide post fire security through the continued suppression of flammable vapours whilst the fuel cools, thus limiting the incident risk through potential re-ignition of the fuel source.

The use of Class B firefighting foams leads to a significant reduction in the firewater run-off from the firefighting, which in turn reduces the containment post fire clean-up / treatment of the firewater run-off.

Since the principle constituents are water and air, both of which are readily available in quantity, foam remains the only practical proposition for dealing with fires of this scale and nature.

Furthermore, there are numerous examples of successful extinguishments of obdurate tank fires around the world testifying to the unique capability of foam in dealing with these types of incident.

5. BEST PRACTICE WHEN FIGHTING FIRES WITH FOAMS

In order for a foam system to be effective – getting 'the best tool for the job' requires selection of:

- The most suitable foam concentrates for the hazard.
- Selection of the most effective means of delivering foam onto the fuel surface thereby determining the type of foam discharge devices to be used.
- Calculation of the quantities of foam concentrate and water; plus, the flows and pressures required. This will include application of foam system codes and standards (such as EN13565-2) and any supplementary requirements for post fire operations and testing.
- Select the form of foam proportioning to be used based upon the specific system and site conditions, availability of water supplies, power, and structural considerations.

Whilst provisions for fire effluent run-off are not within the remit of the fire protection engineer, these need to be factored into the overall project planning.

6. TESTING FOAM SYSTEMS

Once a foam system has been installed various pre-commissioning tests should be carried out.

- Pipework should be pressure tested to verify leak tightness of pipe joints.
- All isolation valves and 'deluge' valves should be functionally tested.
- Foam chamber vapour seals must be intact.
- Nozzles must be correctly positioned, orientated, and free from obstructions.
- Foam storage tanks should be charged.
- Pumps should have their prime movers checked and operational before the pumpsets are tested to verify their performance 'duty' is being met.

This is normally facilitated by means of test lines on both the water pump(s) and foam pump(s) discharge pipework. These lines may feed back into the water/foam storage tanks as appropriate and incorporate a pressure gauge and flow meter. Testing may discharge water to drain but is seen as an unnecessary waste.

- Foam proportioning systems should be tested to verify that the correct foam: water ratio is achieved at maximum system demand (within permitted tolerance). There are various ways to meet this requirement:
 - 1. Operate the system and collect samples of discharged foam/water solution once the flow has stabilised. The samples must then be analysed for their foam/water ratio (proportioning percentage). This also enables the foam coverage from the nozzles to be checked.
 - 2. Discharge foam, at the maximum required flow rate, though a suitable test connection upstream of the system control valve, to enable stabilised full flow samples to be taken for analysis.
 - 3. For the test, where practicable, replace the foam with a suitable, environmentally benign, test liquid and record the flow rates of this liquid and water entering the foam proportioner.
- Where appropriate, a quantitative test of the quality of the expanded foam should also be carried out.

7. TRAINING

In order to operate safely and effectively, it is necessary for fire fighters to undergo specific training on the deployment of foam equipment and the application of foam on to burning flammable liquid fires.

8. ENVIRONMENTAL CONSIDERATIONS

Fire fighting foam concentrates are simply a mixture of chemicals and all chemicals, whether man made or natural, have an impact on our environment, some of which are positive but many others can do harm. It can therefore be assumed that all fire fighting foams will have an adverse impact on our environment.

There are three ways whereby foams may pollute the aquatic environment and lower water quality. Namely by their persistence, their propensity to bio-accumulate and their toxicity. Of the latter, toxic effects may result from the inherent toxicity of the foam product being released, or indirectly due to oxygen depletion, as the foam subsequently biodegrades.

For many years a large proportion of the Class B firefighting foams have been formulated using per-fluorinated compounds (PFCs). Fluorosurfactants used in many Class B firefighting foam concentrates reduce surface tension by concentrating at the liquid-air interface and have the physical characteristics of repelling hydrocarbons. Both characteristics positively impact the firefighting performance of Class B firefighting foams.

In the last 20 years investigation into, and legislation to eliminate or minimise the environmental impact of the two per-fluorocarbon chemicals, PFOS (perfluoroctane sulphate) and PFOA (perfluoroctanoic acid) has seen the PFC (perfluorocarbon) based Class B firefighting foams reformulated with so-called shorter chain PFCs with less than 8 carbon atoms. Commonly referred to as "C6" chemistry these reformulated Class B firefighting foam concentrates have been required to be supplied since 2016 in the USA, and under EU regulation after July 2020. Additionally, some manufacturers have developed high performance Class B firefighting foam concentrates contain no PFCs. These Class B firefighting foam concentrates are commonly referred to as "Fluorine Free Foam Concentrates".

9. APPLICABLE LEGISLATION

The regulations that apply to fire fighting foam are listed below:

- The Groundwater Regulations 1998
- Water Resources Act 1991
- Water Industries Act 1991
- Environmental Protection (Duty of Care) Regulations 1991
- Control of pollution (Amendment) Act 1989/ Controlled waste (registration of carriers & seizure of vehicles) Regulations 1991
- The Trade Effluents (Prescribed Processes and Substances) Regulations 1989
- The Environmental Permitting (England and Wales) (Amendment) Regulations 2009 (SI 1799 2009)
- Environmental Permitting (England and Wales) Regulations 2007 (SI 358 2007)
- COMAH
- Commission Regulation (EU) 2017/1000 of 13 June 2017 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards perfluorooctanoic acid (PFOA), its salts and PFOA-related substances

The following websites provide more information on environmental issues and legislation.

- Environment Agency http://www.environment-agency.gov.uk/
- Environment Agency NetRegs http://www.netregs.gov.uk/
- Envirowise http://www.envirowise.gov.uk/
- ECHA https://echa.europa.eu/

DISCLAIMER

The information set out in this document is believed to be correct in the light of information currently available but it is not guaranteed and neither the Fire Industry Association nor its officers can accept any responsibility in respect of the contents or any events arising from use of the information contained within this document.

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