Guidance Note

Fire Industry Association

Leading Excellence in Fire Since 1916

Guidance on Applicable standards for class B foams

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1. Scope

The purpose of this guidance note is to help end users navigate their way through the complexities of national and international standards which govern the specification and application of foam concentrates for Class 'B' flammable liquids.

It is recommended that it be read by systems engineers, procurement staff, responders, specifying bodies and other interested parties. This would include, but is not limited to, those involved in the design, installation and maintenance of foam systems or anyone responsible for specifying and selecting the most appropriate foam concentrate for use in a particular risk sector.

Whilst other waterbased media can be tested to the Class B standards referred in the document this guidance is limited to Class B foam concentrates and makes no comparison with other media types.

2. Introduction

The proliferation of standards relating to Class 'B' foam concentrates over the past fifty years has meant that using them to aid the foam selection process can be a difficult and daunting task. Currently, it calls for a certain level of specialist knowledge in order to be able to compare and contrast the different standards governing the use of foam, which then enables the user to make an informed judgement as to which is most appropriate.

It is the intention that this document should provide an accessible and informative guide to help the reader understand how standards impact on the choice and use of Class 'B' foam concentrates in order for them to be able to specify the product best suited to their situation.

2.1 Class 'B' foam concentrates

To put this guidance note into context, it is firstly necessary to provide a brief overview of the foam types, which are subject to the conditions and requirements imposed by foam standards.

At the most basic level, these foam types can be divided into two broad categories. The first group consist of those which contain perfluorinated surfactants and/or polymers, whereas the second group covers products which do not rely on fluorine for their fire performance.

Of the two, the first group is the most diverse and includes film-forming and non-film-forming concentrates for use on hydrocarbon liquids only; or both hydrocarbons and polar solvents.

Specifically, there are fluoroprotein (FP), film-forming fluoroprotein (FFFP) and aqueous film forming foam (AFFF) types for use solely on hydrocarbons and then alcohol resistant grades of these (AR) for use on any flammable liquid.

The second group, commonly referred to as fluorine free foams (F3 or SFFF), are all based on synthetic surfactants and water-soluble polymers. They too can be formulated for use on hydrocarbons only, or both hydrocarbons and polar solvents (AR-F3).

Please note that training foams are not included since they are generally not recommended for use on 'live' Class 'B' fires, nor subject to regulation.

2.2 A brief history of Class 'B' foam standards

Prior to the development of fluorinated surfactants, foams containing only hydrolysed proteins and other additives were most commonly used for the protection of flammable risks; be they oil and petrochemical, aviation, marine or municipal.

Standards regulating the use of protein foam were originally driven by the UK military as a means of ensuring good quality and continued 'fitness for purpose'. The bulk of this development was done by the Fire Research Station, which resulted in the first Ministry of Defence (MOD) specification for liquid foams being issued in 1964.

This proved adequate until the advent of fluorinated surfactants, which led to the development of AFFFs and fluoroprotein foams. In order to accommodate these new foam types, the MOD specification was extended and revised in the mid-seventies and remained the pre-eminent standard for the next twenty years or more. However, it should be noted that there was no provision for alcohol type foams, as the requirement for these by the MOD was minimal.

Other standards influencing the UK landscape during this period included the Underwriters Laboratories (UL162) and to a lesser degree, the US military specification. In reality, UL162 is actually a system standard since it places certain requirements on both foam liquids and equipment.

Originally, this standard only covered synthetic and protein foams, although the test method did allow for the use of polar solvents where applicable.

The relative simplicity of foam standards at this time was a reflection both of the primitive state of foam technology and the parochial nature of individual countries in mandating the use of standards originating from within.

However, things were set to change. A number of drivers would provide impetus to a dramatic increase in the number and range of foam standards.

The first of these came from a significant increase in resources devoted to improvements in foam technology by manufacturers, oil companies and research centres alike. This resulted in new foam types being developed, or in the fire performance of foam products being improved to the extent that existing standards were not providing a sufficiently demanding test.

The second was a result of increasing specialisation in terms of the particular sector covered by the foam standard in question. The 'one size fits all' approach was no longer deemed to be satisfactory, but rather there was a move towards standards that more closely reflected the application for which they were formulated (aviation, marine etc.)

Finally, greater European and global co-operation saw the introduction of standards where local considerations became subservient to and more aligned with those of international standards organisations.

These three factors combined to greatly increase the number and diversity of foam standards in use, although this was offset somewhat, by making obsolete a number of national standards that had been peculiar to a particular geographical area.

However, it is this overall expansion which has brought us to the somewhat complex and potentially confusing position that we find ourselves in today.

3. What have standards ever done for us?

Standards for Class ‘B’ foams are important for a number of reasons.

Firstly, they regulate entry into the market and prevent a ‘free for all’ where any product can be offered for use, irrespective of its suitability. Effectively they set a level playing field where all products may be judged against the same set of criteria. This is particularly important in a safety critical area such as fire protection.

Secondly, they establish a *minimum* acceptable quality, which the foam in question must achieve. Furthermore, they ensure that the assessment of quality is done objectively with reference to an agreed test methodology and defined requirements that the foam has to meet.

Thirdly, they provide ongoing quality assurance to ensure that manufacturing standards are maintained, and changes to process or product are strictly controlled. This limits the scope of value engineering exercises, which could otherwise reduce the quality or performance of the product from that originally certified.

Fourthly, they can ensure that the various components that go to make up a foam system are correctly matched and engineered. The foam concentrate is just one part of a larger system, also comprising of proportioning equipment and delivery device. It is vital that the foam concentrate is compatible with the hardware specified, in order to produce and deploy good quality ‘finished’ foam over a wide range of operating conditions.

Finally, they may be used to determine whether any reduction in foam concentrate quality has occurred with the passage of time. Most foam concentrates are formulated to have an in-service life of 10 years or more. However, incorrect storage or exposure to extreme climatic conditions may significantly shorten their shelf life. Testing against a prescribed standard and then comparing the result with historic data can help determine whether any marked deterioration has taken place over the intervening period.

So, to summarise; invoking a particular standard is not only useful in the original selection of foam concentrates by specifying minimum acceptable levels of performance, but also in maintaining consistent quality of supply to the end user and ensuring that the condition of the foam stocks remains acceptable throughout its lifetime.

3.1 Limitations

Regulating the sale and use of Class ‘B’ fire-fighting foam concentrates through the application of recognised standards helps to ensure that only those that are appropriately specified and of acceptable quality are available for use should the need arise.

However, this in itself, although desirable, is no guarantee that a successful outcome will result, if foam is deployed at a real-life emergency. Why this should be the case is a complex issue; one that is influenced by a number of factors, not least because of limitations within the standards themselves.

Most importantly, it must be recognised that a foam standard, (and particularly when a practical fire test is required), does not accurately replicate an incident where foam is used.

Even when the fire test has been specifically designed to mimic a particular scenario, inevitably it is a compromise when compared with the real-life situation.

The first area where the test often diverges from reality is in the choice of fuel. Most protocols specify a single chemical entity such as heptane or acetone. Such fuels are chosen because they can be specified with controlled properties that can be consistently reproduced, ensuring that any variation from test to test is minimised. Unfortunately, they are rarely encountered in actual fires. Rather, they are more likely to be blended or multi-component materials such as petrol and crude oil, which often pose a more severe risk. Subsequently a successful result obtained using the test fuel specified, cannot necessarily be extrapolated to that being stored and processed by the end user.

Therefore, where possible the foam manufacturer should also be asked to provide data on the flammable liquid in question, so that any concerns arising from the use of an unrepresentative test fuel can be assuaged.

Secondly, it should be realised that the fire test described in most standards is of relatively small size, utilising a foam branchpipe of low flow. Whereas real fires, particularly in the oil and petrochemical sector, are much larger, utilising foam cannons with flow rates that can be 1000 times greater. Work done by the Foamspex research group indicated that the degree to which a foam can become contaminated when forcefully applied to a tank fire is dependent on the square of the flow rate. Consequently, the standard test fire does not adequately replicate the vigorous plunging that takes place when large flow devices deliver foam forcefully onto a tank surface.

Furthermore, a tank fire may have been burning for hours prior to a foam attack being made, by which time the tank walls can heat up to 500^0C, which makes edge sealing extremely challenging. By comparison, a standard fire test only requires a pre-burn period of a few minutes at most, leaving little time for the tank shell to heat up appreciably.

Finally, it is important to remember that fire tests carried out according to a standard method, are done under controlled conditions and often without operator intervention.

It can be seen that because of the many inadequacies of the fire test protocols as they relate to real life, so the extinguishing potential of foam agents cannot be confidently predicted from the small-scale tests; even though the product in question may meet the requirements set out in the standard. Therefore, it is recommended that data from larger scale tests be available to validate the use of a foam concentrate for a particular application. This is especially true when a new type of foam is being introduced to the market for the first time.

A further limitation of standards is that they can inhibit innovation and prevent the introduction of novel foam products. As a result, advances in foam technology can be slow to be adopted by industry, due to the inertia inherent in getting standards changed to reflect such innovation. Historic examples include the introduction of film forming fluoroprotein foams, which originally were not catered for, and more recently, fluorine free foams and newer media other than traditional foams.

Consequently, standards can prove to be a barrier to the use of the most appropriate Class ‘B’ foam as they struggle to remain relevant to the everchanging demands of a market being driven by technological improvement, legislative imperatives and environmental concerns.

While foam standards are meant to drive product quality up, they can perversely have the effect of encouraging mediocrity in the pursuit of ever more cost effectiveness. Although the world of Class ‘B’ foam standards is well regulated, it can motivate manufacturers to develop products that meet the bare minimum at lowest cost, in order to gain entry to the market. Furthermore, these products may be developed primarily with the intention of passing a particular standard, rather than being optimised for use on real fires. As we have seen previously, those two aims can be mutually exclusive because of the disconnect between test fires as set out in standards and actual incidents.

Foam standards should therefore be seen as the *minimum* entry level for a foam to be judged against and then considered for use. Further to the requirements of the standard, additional supporting fire test data on a range of fuels in different scenarios should be made available by the manufacturer to confirm its suitability for any given application.

In conclusion: *The Class 'B' foam standard is not the 'be all and end all'.*

4. What are "Standards"?

Standards are all around us, even if we are not always aware of them. One example of a widely used standard is the A4 size for sheets of paper (as in this document). This example is used as it is a good illustration that in this case adoption of the standard is *not mandatory* as this size of paper is rarely used in the United States!

The commonly accepted definition of a "STANDARD" is as follows:

- **A standard is a document that sets out requirements for specific item, material, component, system or service, or describes in detail a particular method or procedure.**

Standards are typically developed and defined through a process of sharing knowledge and building consensus among the technical experts nominated by interested parties and stakeholders. This leads to the more formal definition of a standard as follows:

- **A document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.**

4.1 Standard Organisations

These maybe "International" such as:

- ISO International Organisation for Standardisation
- ICAO International Civil Aviation Organisation
- IMO International Maritime Organisation

Or "Regional" such as:

- CEN European Committee of Standardisation
- CENELEC European Committee for Electrotechnical Standardisation
- ARSO African Organisation for Standardisation

Or "National" such as:

- BSI British Standards Institute
- UL Underwriters Laboratories

4.2 Adoption and Use of Standards

A Regional or National body may choose to use an International Standard by direct application or by a process of modifying to suit local conditions.

In the Europe members of CEN, CENELEC, and ETSI are obliged to implement at national level by a EN standard and withdraw any conflicting national standards. In addition, according to Regulation (EU) No 1025/2012 sets out the requirements for standards to meet the requirements of European Union regulations and directives.

It should be noted that Standards are "voluntary" which means that there is no automatic legal obligation to apply them. That said laws and regulations may refer to standards and even make compliance with them compulsory.

4.3 Type Approval

Sometimes referred to as a "certificate of conformity" a Type Approval is granted to a product that meets a minimum set of regulatory technical and safety requirements. Typically, type approval is required before a product is allowed to be sold in a particular country, or industrial sector. As regulatory bodies are rarely truly global this means that the requirements for a given product will vary around the world.

Compliance to a type-approval requirement can be denoted by a third party marking or certificate of conformity supplied with a product, or by a type approval certificate obtained by a manufacturer and kept on record.

As mentioned, these type approvals can have regulatory components, and therefore sale and use of a product can be tied to having these types of approvals.

4.4 Approved Codes of Practice (ACOP)

An approved code of practice can be a document that complements occupational health and safety laws and regulations to provide detailed practical guidance on how to comply with legal obligations and should be followed unless another solution with the same or better health and safety standard is in place or may be a document for the same purpose published by a self-regulating body to be followed by member organisations.

Codes of practice published by governments do not replace the occupational health and safety laws and regulations and are generally issued in terms of those laws and regulations. Organisational codes of practice do not have the same authority under law but serve a similar purpose. Member organisations generally undertake to comply with the codes of practice.

NFPA (National Fire Protection Association) – a US based organisation publishes a comprehensive list of Standards (Codes) which are widely accepted throughout the fire industry globally. They typically relate to design of foam systems.

4.5 Acceptance Testing

Defined as testing conducted to determine if the requirements of a "specification" or "contract" are met.

In relation to Class B foam agents such testing could cover the physiochemical properties and/or fire performance tests as defined within a "Standard".

As stated, acceptance tests are set and defined by the end user or a body of end users and can strictly follow a standard or can impose their own specific test requirements and pass / fail criteria. An example is the batch testing requirements of the LASTFIRE test protocol.

4.6 Standards applied to Class B Foam Agent

Within the UK the appropriate Regional Standards are:

- EN 1568 – Parts 1, 2, 3 & 4 (Fire Extinguishing Media – Foam Concentrates)
- EN 13565 – 2 (Fixed Firefighting Systems – Foam Systems – Part 2: Design, construction and maintenance

The most appropriate International Standards are:

- ISO 7203 (Fire Extinguishing Media – Foam Concentrates)
- ICAO Document 9137 AN/898 Airport Services Manual Part 1 Rescue & Firefighting
- IMO MSC.1 Circ. 1312, and MSC Circ.670
- UL 162

A specific National Standard to be aware of in the *offshore industry* is:

- CAP 437 (Standard for Offshore helicopter landing areas)

If you are dealing with the US military, then they have their own standard (specification) for AFFF foam agents:

- MIL-F-24385

If you are working with design and supply of *fixed foam systems,* then the appropriate NFPA Standards may apply such as:

- NFPA 11
- NFPA 16
- NFPA 30
- NFPA 409

Within the Oil & Gas / High Risk industries a number of end users require that foam agents have been independently tested according to the LASTFIRE test protocol and some purchasing specifications may require batch testing of product produced for their requirement, prior to acceptance.

5. Assessment of fire performance

At the heart of any standard for class 'B' fire-fighting foams lies a practical test of some sort; the object of which is to quantify fire performance against a series of defined requirements.

These usually include set limits for fire control time, fire extinguishing time and post-fire security (burn-back resistance). There may also be a requirement to visually assess the sealing ability of the foam blanket against hot metal.

The fire test may be part of a wider type test approval, or it may be used to certify a particular production batch prior to use.

It will have originated to set minimum acceptable standards that a foam concentrate might be reasonably expected to meet. The design of the test is such that it can be readily replicated by any interested parties, so that results generated from location to location are reliable and bear comparison. However, as with any test, it is subject to variables which may be outside the control of those performing it. This particularly applies to climatic conditions prevailing at the time when testing is conducted outdoors. Test protocols do prescribe recommended limits for temperature and wind speed.

The fire test may be conceived as a model system, which has little resemblance to a real-life situation, or it may have been designed to replicate an actual fire risk. An example of the former would be the fire test as described in EN1568, whereas the latter is better exemplified by the LASTfire test.

However, as we have seen previously, no practical fire test adequately mirrors the challenges posed by a large-scale incident, and so can only act as a guide to how any foam will perform.

There are certain basic components of any fire test, which are shared between the many different foam standards currently in use. These include:

i. *Foam application rate:* Normally measured in terms of rate of foam solution delivered per unit fire area; it has units of litres per minute per m^2. The application rates stated in the test protocols tend to be significantly lower than those which would be used operationally. The lower the foam application rate that is demanded, the more severe the test.

ii. *Foam application time:* The total time that expanded foam is applied to the fire at the rate specified.

iii. *Foam application method*: Expanded foam may be delivered directly onto the fuel surface (also known as forceful, type III), or indirectly via a pourer or backboard (gentle, type II). Type III application is the norm for tests on hydrocarbon fuels, whereas type II application is usually reserved for tests on polar solvents. Foam can also be applied below the surface (or sub-surface).

iv. *Pre-burn*: This is the time elapsed from when the fuel is ignited and allowed to burn freely, until when foam is first applied. It can range from as little as 15s to as long as 10 minutes.

v. *90% control time:* This is the time it takes for the foam to reduce the fire to 10% of its original intensity. It is of particular relevance when testing those products that are to be used in life critical situations, such as aviation fires.

vi. *Extinguishing time:* How quickly the foam can completely extinguish all flames. Most importance is usually applied to this requirement.

vii. *Waiting time:* From the cessation of foam application until the start of the burn-back test (see below), there is usually a prescribed waiting period. The reason for this is to determine how the established foam blanket resists disruption by hot metal, fuel vapours and the elements, if tested outdoors.

viii. *Torch test:* During the waiting period one or more seal tests may be carried out. This involves testing the integrity of the foam seal against the test pan with a torch.

ix. *Burn-back test*: After the waiting time, a small area of fuel is exposed and deliberately re-ignited. The foam blanket must either re-seal the exposed area or resist further encroachment of the flames for a prescribed period.

The completion of a generic test, as described above, will result in either a simple pass/fail decision, or it will produce a more comprehensive fire performance rating. Examples of the fire ratings possible within the EN1568 (part 3) standard are given in table 1 below.

Table 1 — Maximum extinction times and minimum burn-back times

Times in minutes

Extinguishing performance class	Burn-back resistance level	Gentle application test (see H.3)		Forceful application test (see H.4)	
		Extinction time not more than	25 % burn-back time not less than	Extinction time not more than	25 % burn-back time not less than
I+	A			1,5	10
	B		15	1,5	
	C		10	1,5	
	D		5	1,5	
I	A			3	10
	B		15	3	
	C		10	3	
	D		5	3	
II	A			4	10
	B		15	4	
	C		10	4	
	D		5	4	
III	B	5	15		
	C	5	10		
	D	5	5		

NOTE 1 There is no burn-back resistance level A for class III.

NOTE 2 Typical extinguishing performance classes and burn-back resistance levels for different types of foam concentrate are given in Annex A.

At its most basic, meeting the requirements of a particular foam standard results only in the qualification of the product for use operationally, but makes no recommendation as to how much agent is needed for a particular risk. This is the case for the US military specification 24385F.

Alternatively, qualification may be allied to specific recommendations for foam application rates, an example being that of Underwriters Laboratories standard UL162. In this instance, the foam application rate at which the successful fire test was carried out, is multiplied by a safety factor of 1.67, which takes account for any operational losses that may occur, when subsequently being used in less-than-ideal circumstances. It is this *listed application rate* which informs the end user as to how much foam should actually be applied.

Similarly, the rating system described earlier in EN1568, is used to prescribe application rates for foam systems specified according to the system standard EN13565 (part 2). A base rate is subject to certain multipliers according to the type of risk and type of foam concentrate being used. The multiplier is inversely related to the fire performance rating ascribed by EN 1568. So, for example, an EN 1568 (part 3) 1A rated product would attract a multiplier of one, whereas a 3B rated product would attract a multiplier of 1.5 for spill fires only. In other words, the inferior product would need to be applied at a rate that is 50% higher. Thus, a more sophisticated rating system of this sort allows for direct comparison between foam concentrates and enables the true cost of stocking a particular product to be accounted for.

As well as an assessment of fire performance, other physical and chemical properties of the foam concentrate are evaluated. These might include pH, freezing point and fluorine content, if appropriate. Longer term testing of concentrate stability, corrosion potential and environmental impact may also be undertaken.

Consequently, depending on the suite of tests employed, it is possible to get not just an indication of the firefighting effectiveness of a particular product, but also to determine what this will entail in terms of storage and deployment during its operational lifetime.

6. Summary

Standards written for Class ‘B’ concentrates, by their nature, have to be detailed, technical documents, which can make them a challenge to understand, particularly for those with only a limited knowledge of the subject.

Furthermore, the complex nature of the global processing, transport and consumption of flammable liquids, means a plethora of standards exists to address the different situations where Class ‘B’ foams may be used. Some may be mandated by the local authority and others may be industry specific, but it is of critical importance that any standard(s) chosen is relevant to the risk being protected and adequately covers as many aspects of the users’ requirements as possible.

Therefore, for the end user they are a way of ensuring that basic requirements for foam concentrates are maintained and adhered to. That is; physical and chemical properties, fire performance, storage stability and environmental consequences.

It is taken as read that any foam agent being considered for use should meet these minimum expectations, but thereafter it may be necessary to consider any complicating factors, which are not properly addressed within the text of the standard. These might include multiple fuel hazards, extreme climatic conditions, prolonged pre-burns or the method of foam deployment.

Should this be the case then it is beholden on the end-user to ensure that additional data and information is available to support the choice of a particular product for the intended application. Where such supporting information is absent, it may be necessary, in conjunction with the foam provider, to instigate a programme of additional testing in order to generate the data needed to fill any gaps.

Although time consuming, employing such a diligent approach to the foam selection process, should help promote confidence that ultimately the correct choice of class ‘B’ foam concentrate has been made.