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Position Paper

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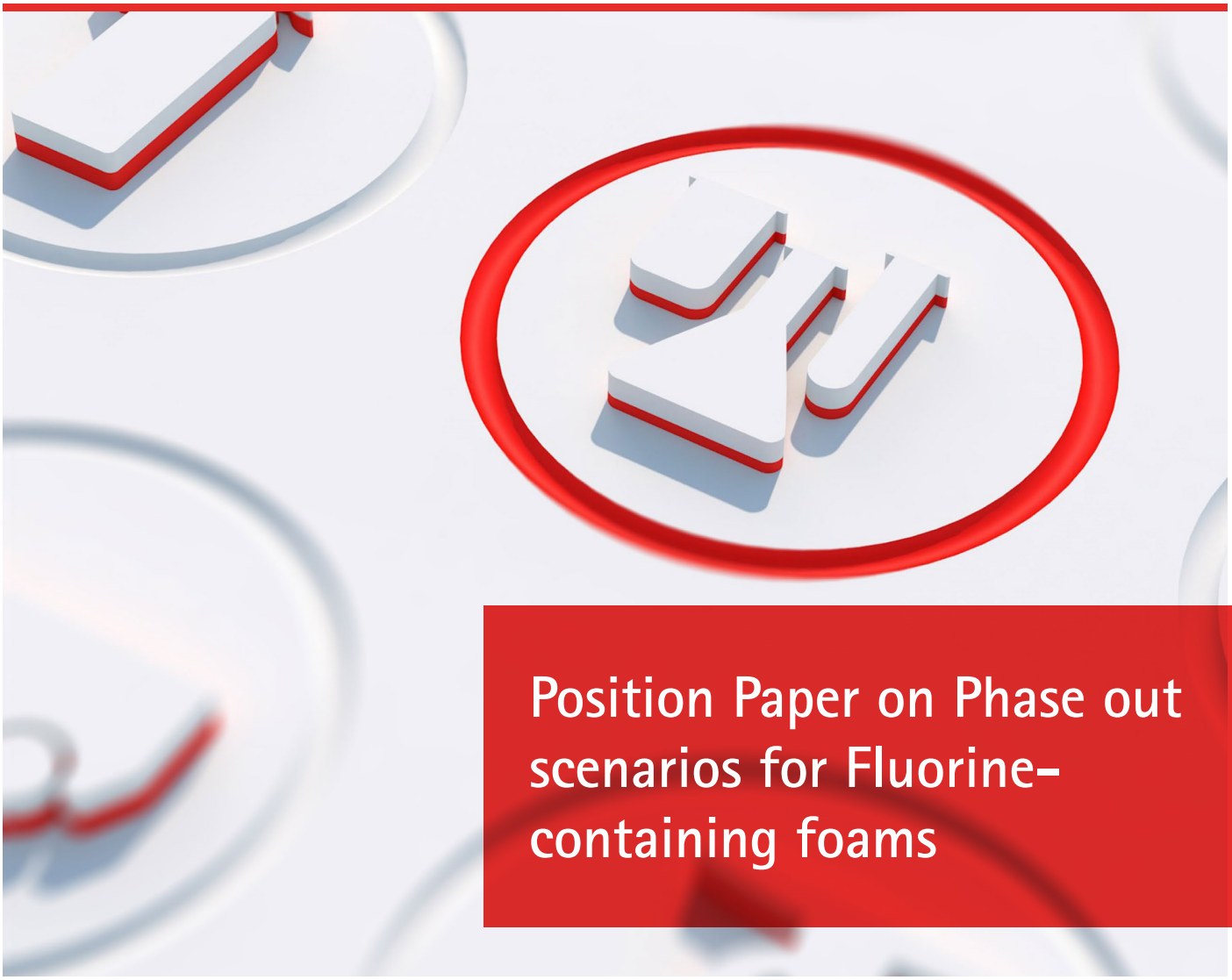
Fire Fighting Agents



Position Paper on Phase out scenarios for Fluorine-containing foams

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Foreword

EUROFEU being involved in the collection of information by the European Commission and its affiliate authorities such as ECHA, executed by the research company Wood plc had participated in 2019 with the socioeconomic study by providing information in writing and participating in a workshop.

As a take-away from that workshop, EUROFEU considered it to be important to provide more detailed information related to the timing and cascading of a potential complete phase-out from fluorine technology in firefighting foam agents as was indicated by ECHA representatives in the workshop.

EUROFEU wants to substantiate its statements regarding a time-line for an exit from Fluorine technology, which were given during the workshop. It has therefore issued this document to outline the complexity of such a project, the major difficulties to overcome and their respective impact on the overall timeline. EUROFEU seeks to support both legislators as well as manufacturers of firefighting foam agents and users thereof to transition successfully without opening gaps in fire safety.

EUROFEU's member organisations regularly liaise with end-users regarding foam change-outs and as such have drawn upon this knowledge to offer some very general observations within this document. As every foam system is custom-made to suit the site and manage the risk, the authors do not have knowledge of individual systems and so offer this guidance 'blind' and in good faith.

1 Application Sectors

A comparison between fluorine-containing and fluorine free foam agents with respect to their performance is of course only possible between foam agents of suitable performance level based upon testing to the same standard.

As usual, there are better and less good products available on either type, which is why general statements cannot be made without the premise to consider agents with an even or very similar performance level.

1.1 Aviation

In aviation the risks at an airport would typically include:

- Airport rescue firefighting vehicles (ARFFV) dealing with shallow spills of fuels, emergency landings and medical incidents
- Hangar protection by either sprinkler systems, monitors or high expansion systems.
- Fuel storage tank farm protection by foam systems

1.1.1 Mobile applications (ARFFV)

ARFFV are considered to be able to immediately transition to fluorine free foams with minimal risk to lower the current overall level of safety.

In addition, use of fluorine free agents may require a more in depth application training for firefighters to be determined by airport fire and rescue services.

1.1.2 Hangar Protection

In terms of hangar protection, high expansion systems are already using exclusively fluorine free foam agents. Systems with monitors require a review of the system for its capability to operate fluorine free foam agents. Factors like throwing distance, foam quality and proportioning of the foam concentrate shall be investigated by operators with any issues resolved.

Considering these aspects technically, monitor based systems may be capable to transition to fluorine free with minimal technical changes. The time-frame for this would be set by the time needed to execute the review and technical change.

The following types of sprinklers are most common for hangar protection:

- Aspirating heads: transition mainly depends on foam quality they produce, depending on this a change to fluorine free foams may be possible immediately or after minor technical changes (i.e. change of sprinkler heads).
- Non-aspirating heads and grate nozzles (floor based pop-up nozzles): since fluorine free foams are only performing as foam these heads likely will have to be replaced by foam generating heads unless individual testing may prove different.

A transition away from fluorine-containing to fully fluorine free foam agents in any case require to consider compatibility of existing hardware (pumps, proportioners, trucks, nozzles, sprinklers etc…) with the fluorine free foam concentrates and their effective application. Provided the correct hardware is in place there is no other obstacle to change.

1.1.3 Fuel storage tank farm protection

The predominant risk being Jet A1 fuel stored in limited volumes (when compared to typical storage tank farms in the oil and gas industry) with much smaller quantities of hydraulic fluids, gasoline and diesel. As these fuels are well defined it is possible to select a fluorine-free foam agent which is effective on those fuels.

Tank farm protection systems are already based around foam protection using foam generating hardware. Where monitors are used, the foam quality generated by them with the selected foam agent needs to be checked.

1.2 General Industry

In general industry (i.e. power generation, pharmaceutical, household/cosmetics, coatings and adhesives), foam systems are widely used to protect hazards concerning flammable liquids. Typical hazards are mixing tanks, reactor vessels and filling equipment, but also logistic warehouses. Fire protection can consist of multiple local foam systems, sprinkler system with foam application or High Expansion foam systems (mainly for logistic warehouses).

Local foam systems could technically be converted to fluorine-free foam concentrate, but there may be significant costs and efforts for the engineering, as well as modification of equipment. Each system needs to be considered individually where the suitability of the fluorine free foam agent on very specific flammable liquids will require project-specific testing as long as there is no generally available and validated test data for these non-standard fuels or suitable surrogates.

Sprinkler systems with foam application are widely used when a risk contains both Class A (solids) and Class B (liquid) fuels. Only Aqueous Film Forming Foam (AFFF) type fluorinated foams are proven to be effective on both types of fuels when discharged through non-aspirating nozzles. Fluorine free foams typically require aspiration (air mixing) to create effective foam and users of fluorine free foams must assure the foam to be suitable for the normal non-aspirating nozzles used in sprinkler systems. If for whatever reason the transition of a certain system to a fluorine free foam may require a higher application rate, then that system might not be just need to be modified but require a total rebuild to accommodate higher flow/larger pipes.

High Expansion foam systems which are sometimes used in mixed-risk warehouses and production areas already use aspirating foam generators. The vast majority already uses fluorine free foam agents. The conversion of the very few that are not would not be difficult from a technical point of view. The only challenge there is to have the new fluorine free foam agents certified to a similar level of effectiveness as the existing agent, in combination with the high-expansion foam generators built into the system.

1.3 Municipal

Municipal fire brigades (i.e. local authority fire and rescue services) do not necessarily need fluorine-containing firefighting foams as they mostly deal with either Class A fires or spill fires of Class B fuels. In turn, the application in this area of use is probably the most dispersive one of all where any release will likely be directly into the environment as containment may not be possible or practicable.

The typical fire scenarios for municipal departments include road traffic collisions, house fires, bush fires, burning bins, etc. Incidents are generally limited in size, variety of fuels and frequency of occurrence.

In some areas in Europe so called Regional Fire Brigades are in charge of any fire hazard including also industrial fires (see Oil & Gas Industry below). Those fire brigades today typically hold one agent on stock, which is capable to deal with all fire scenarios the fire brigade might face, with the method of attack and application rate adjusted for each pre-identified risk scenario.

The focus of many municipal fire protection is the preservation of life, second is to prevent the escalation or spread of the fire and third to protect property. Environmental protection is likely a core consideration to all municipal fire brigades, however each incident can present its own unique challenges which means that rapid intervention is necessary before appropriate environmental protection measure can be implemented.

Generally EUROFEU believes that a transition away from fluorine-containing to fully fluorine free foam agents for municipal fire risks would require to consider compatibility of existing hardware (pumps, proportioners, trucks, ...) with the fluorine free foam concentrate. In addition use of fluorine free agents may require a more in depth training.
As far as the foam agents are concerned, there are no technical obstacles for an immediate transition.

1.4 Military

Fire risk in the military sector covers mainly protection of explosives, ammunition, ordnance and fuel stocks. With respect to the foam demand, it is predominantly the Class B fire risk driving the source volumes. The variety of Class B fuels is limited (lubricants, gasoline, diesel and aviation fuels) however storage volumes can be high and complex (i.e. purpose-built storage tanks, temporary pillow tanks as well as mass storage of 20L containers). There is a significant risk of dispersive use of foams into wider environment.

The risk scenarios are similar for land based and aviation deployments but are very different for marine applications: stored volumes of foam agents are limited, emergency re-supply is not possible, limited to no room to escape. These preconditions require a very high level of performance and efficacy of the foam agent used.

There is one foam type which is specified for use by the United States Navy which is colloquially referred to as 'MilSpec' as it is based upon a military specification; MIL-PRF-24385F. Requirements are quite severe and impossible to meet by fluorine free foams as the specification mandates the use of fluorinated surfactants:

- spreading coefficient >3 (only possible using fluorosurfactants)
- request compatibility of all foam concentrates being listed according to MilSpec
- foam agents being effective at half or five times of its recommended proportioning rate (i.e. 3% foam must pass at 1.5%, 3% and 15%, whereas for all other foam types a 3% must work at 3-3.9%).
- toxicity for seawater fish to be below a certain value
- fluorocarbon surfactants had to be above a certain value and maintained at or above that
- as well as many other requirements

For US-Military operations based in Europe using MilSpec listed foam agents and joint operations with those may require also European forces to comply to MilSpec. With the US military's National Defence Authorisation Act 2020 (NDAA 2020) passing, this requires US military to stop using fluorinated products by 2024 with exemptions.

In summary looking at the technical challenges of transitioning away from fluorine-containing foam concentrates military land based and aviation applications can relatively easy change to fluorine free foam agents, for marine applications this will be very challenging and MilSpec applications will be done in-line with US operations.

1.5 Oil & Gas Industry (fuel in depth, large storage volumes)

The fire risks in this sector cover fires of chemical processing units in refineries, loading areas (both truck loading as well as jetties), dikes and bund areas, tank storage or storage of liquefied gasses such as LNG. The predominant type of fires is Class B fires or Class C gas fires, with very few Class A fires.

Typical for this sector is that large volumes of those (mostly liquid) fuels are stored in close adjacency, which basically combines a high individual fire risk with a high risk of rapid escalation. The variation of fuels is lower compared to the chemical industry.

For the above reasons industrial O&G-sites have detailed risk management plans and risk mitigation procedures, including fire water retention for storage areas, independent sewer systems and other measures to reduce/eliminate release of chemicals into environment (situation at jetties is different).

A large proportion of the fire risk mitigation is covered by fixed preinstalled systems. Those systems are individually designed, can be very large by size and can as well be embedded deeply into the overall plant design. Consequently changing these systems due to changing extinguishing performance, hydrodynamic properties or application types can be extremely complicated depending on the degree of change.

Fixed systems are an important piece of the overall risk management plan is subject to sign off by insurance companies and AHJ's[1] and operation permits by local authorities. Changes of the system may require a shutdown of the respective manufacturing unit and a revision of operating permits and insurance conditions.

Apart of that changing the firefighting foam agent may require a screening of the chemical by entitled third parties to verify it is acceptable under the given preconditions of use[2]. These screenings can be quite time consuming and costly.

1.5.1 Training

Use of fluorine free foams requires a more in depth preplanning as well as a higher level of training (by training content and frequency) for those people using it compared to the use of fluorine-containing foams of same or very similar performance level (e.g. AFFF, AFFF-AR, FFFP, FFFP-AR) to make sure the type of application and the application density are correct.

From the perspective of foam agents the oil and gas industry is a very challenging sector because of the existing data gaps regarding applicability of foams on different fuel types and the volumes stored, and finally the age of installed systems[3].

1.6 Marine

Tankers, ferries, tug boats and other commercial vessels are representing the majority of the fire risks in this sector. A typical fire scenario includes a minor hydrocarbon or solvent spill on deck alternatively fire in the engine room or cargo bay.

Class B foam is generally used for deck protection typically together with monitors and sprinklers. In addition to Class-B foam, Hi-Ex concentrate can be used for protection of larger volumes such as engine rooms or cargo bays. In fact may vessels already use so called hot foam systems[4] for engine compartment protection which are operated with fluorine free foams.

Fixed systems are predominately used in addition to portable units. Changes of the system require off-time period at port and revision/ approval of operating permits from approving class.

In general MED/IMO certified products will be required from class[5] which are available today on the market as fluorine-free alternative. The challenge will be to verify that alternative product meets the proportioning requirements and other system requirements. There is already an increased interest from end-users of this segment to change over to fluorine free alternatives.

The engineering challenges associated with a transition away from fluorine-containing foam agents are no more complex compared to other areas of use of fixed installed systems. However the marine sector is unique in that the vessel with the on board fire protection sys-

[1] AHJ = authority having jurisdiction

[2] i.e. HOCNF, REACH, other local juridictions

[3] "Due to the limited variety of fuels there is limited frequency of change in the type of fuels stored in a given tank. This again allows to keep a fixed installed system for a long time and just maintenance for function

[4] Hot foam systems are foam generating systems using the air from inside the compartment on fire = hot fumes and combustion gasses. Foam agents for this application need to be especially designed to give foam under these conditions. Obviously a full function test cannot be run with simulation fluids.

[5] "Class" is a third party approval body assigning an operation permit to a vessel

tem moves daily, down times in harbours are extremely costly. Additionally a reasonable number of vessels may not even accommodate a change of the system to the degree needed since it is embedded into the overall structure so deeply.

1.7 Chemical Industry (complexity of fuels, storage volumes)

The fire risks in this sector cover 3D-fires of chemical processing units, loading areas (both truck loading as well as jetties), dikes and bund areas, tank storage or storage of liquefied gasses such as LNG. The predominant type of fires is class B fires or gas fires, fires of different flammable chemicals and chemical products, very few if any class A fires.
Typical for this sector is

- Very complex risk scenario: wide variety of fuels, risk of highly reactive and/or toxic fuels
- high frequency of product rotation leading to storage vessels being used for different chemicals
- Bulk storage: large volumes, tank storage and similar situations
- Limited segmentation: several products stored in one bund area
- Presence of workers

Similar to the O&G-industry this basically combines a high individual fire risk with a high risk of rapid escalation and a big variation of fuels.

For this very reason chemical sites are very highly regulated with regards to prevention of accidental or unintentional release of hazardous chemicals into the environment.

For the above reasons chemical production sites have detailed risk management plans and risk mitigation procedures, including fire water retention for storage areas, independent sewer systems and other measures to reduce/eliminate release of chemicals into environment (situation at jetties is different).

A big share of the fire risk mitigation is covered by fixed preinstalled systems. Those systems are individually designed, can be very large by size and can as well be embedded deeply into the overall plant design. Consequently changing these systems due to changing extinguishing performance, hydrodynamic properties or application types can be extremely complicated depending on the degree of change. Fixed systems are an important piece of the overall risk management plan which again is subject to sign off by insurance companies and AHJ's[6] and subject to operation permits by local authorities. Changes of the system may require a shutdown of the respective manufacturing unit and a revision of operating permits and insurance conditions.

Apart of that changing the firefighting foam agent may require a screening of the chemical composition of the new foam agent by entitled third parties to verify it is acceptable under the given preconditions of use[7]. These screenings can be quite time consuming and costly.

1.7.1 Training

Use of fluorine free foams in the chemical industry requires the most in depth preplanning as well as a high level of training (by training content and frequency) for those people using it compared to the use of fluorine-containing foams of same or very similar performance level (e.g. AFFF, AFFF-AR, FFFP, FFFP-AR) to make sure the type of application and the application density are correct.

From the perspective of foam agents the chemical industry is the most challenging sector because of the existing data gaps regarding applicability of foams on different fuel types, application techniques, -densities, test scenarios, standards, training demand, testing capacities, etc.

[6] AHJ = authority having jurisdiction

[7] i.e. HOCNF

2 Training and Testing

Training and testing are two areas of activity which do require a closer look in the context of the attempt to transition away from PFAS-containing foam agents to fluorine free foam agents:

"Training" means routine refreshing trainings for fire fighters as well as training for new recruits or trainings for new tactics/application techniques. "Testing" covers testing of foam agents for their effectiveness and suitability on fuels but also testing of installed systems for function ability of the entire system or parts of it (pumps, proportioners, pipes, etc.).

Routine trainings of firefighters on general use of firefighting foam can already be done with fluorine free foams. In fact all manufacturers offer special training foams which are readily and fully bio degradable.

Testing of systems and parts thereof in many cases can also be done using special surrogates which are liquids of the same or similar hydrodynamic properties of the foam agent used in a system but not consisting of any surfactants or fluorinated compounds. Where fully system operational testing is required primary and secondary containment of fire-water runoff should be in place.

2.1.1 Performance testing of foam agents and Firefighter familiarisation

As indicated previously, EUROFEU sees serious data gaps particularly regarding suitability of fluorine free foam agents on various fuels as well as regarding their effective application onto those fuels, which is currently being addressed by the German Industrial Fire Brigades' Union (Werkfeuerwehrverband Deutschland). These data gaps in our view should be narrowed or better closed prior to a significant restriction of Fluorine-containing foam agents to not raise the overall risk level above what it is today.

Closing data gaps is possible by testing. Unfortunately the capacities in Europe for real fire testing in general and particularly testing on large fires (as would be required for the O&G-Industry) or testing on special fuels (as would be required for the chemical industry) are very rare if existing at all. The available and publicly accessible resources are limited beyond the minimum needed to cover the demand for testing of new foam agents on real and larger size fires.

The situation for training of firefighters – namely so called hot trainings on real fires – are evenly limited. In the past decades the majority of training sites have been shut down for environmental and other concerns yet have never been replaced by newer resources. This has led to the situation today that only few sites are available which are limited by fire sizes, capacity and fuel restrictions. Hence access to those remaining resources is limited and costly.

With any foam apart from its general suitability for the fuel it is supposed to extinguish also the way of application has a major impact on the effectiveness of the foam. While fluorine-containing foams are considered to be more forgiving with respect to suboptimal application, fluorine free foams likely seem to require a much higher level of accurateness to actually make them work.

Since the vast majority of current trainings of firefighters are still basing on the application techniques which have been developed and refined for fluorine-containing foam agents over the course of decades these application techniques need a revision for fluorine free foams. Consequently firefighters may also need to be trained on the revised application techniques.

This demand for special training on new tactics/application techniques and specifics of fluorine free foams cannot met today. An increase of training and testing resources is urgently required.

EUROFEU and its members are working individually on closing as many data gaps as possible as well are supporting other organisations such as LastFire or the German Association of Industrial Firefighters by providing funding, expertise and contributing in their attempts to better understand the efficacy of fluorine free foam agents compared to fluorine containing foams.

3 Conclusion

Overall EUROFEU understands that some sectors – for example Municipal and Aviation - would be able to transition away from fluorine containing foam agents more easily hence likely faster than others.

Significant questions remain for other sectors such as Chemical Industry and Oil&Gas where efficacy data gaps require to be closed and application techniques and densities specified by recognized international standards (EN1568, ISO 7203, NFPA, ...) need to be reviewed (NFPA 11 is due to complete their work in 2020 with the new standard published in Jan 2021). The sum of all these activities require the availability of a significant level of resources for training and testing.

The transition from Fluorine containing foam agents to fluorine free ones in fixed installed systems, trucks and storage facilities requires a much more in depth cleaning compared to a like for like foam agent exchange. This factor particularly heavily depends on the thresholds to achieve. However, the cost for cleaning including disposal cost for foam agents and cleaning residues as well as replacement of systems or parts thereof are considered to be very high and have a high potential to grow exponentially depending on the conditions to reach.

It is obvious that the duration of transition is directly linked to the level of available resources (testing, training, labour force, financial resources, etc.) under the premise to not sacrifice the overall level of fire safety in Europe. Help may be needed from legislators as well to establish the required resources.

EUROFEU appreciates to work with and is committed to supporting European legislators in their consideration of reviewing the use of fluorine containing chemicals in fire protection.