# OIL TECHNICS
# (FIRE FIGHTING PRODUCTS) LTD, UK

## Response to HSE Call for Evidence on UK REACH Restrictions: PFAS in Firefighting Foams

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## Executive Summary

Oil Technics appreciates this opportunity to provide evidence to HSE regarding its call for evidence on proposed UK REACH restrictions for PFAS firefighting foams. This submission provides detailed evidence justifying continued C6-AFFF-LF firefighting foam use for Offshore Installations for at least 10 years with review, since it is at least if not more onerous than fires on Seveso III sites, with additional challenges of -18°C low freeze requirements and seawater use.

Offshore installations represent more hazardous and challenging conditions for life safety because they are:

- congested and confined multi-level hazardous facilities.
- accommodation adjacent to hazardous areas.
- limited personnel escape options with little separation distances from safe and hazardous areas.
- fires spread quickly offshore (aided by wind) requiring the most effective agents to prevent rapid escalation and life loss.
- Fluorine Free Foam (F3) alternatives cannot deliver required fire performance functionality when seawater (only available firewater offshore) and non-aspirated or very low expansion delivery devices should be used (necessary to combat adverse effects of wind).
- Disproportionate shut-down, re-engineering, clean-out costs while compromising designed life safety and infrastructure protections.
- Limited remaining operational life of offshore installations as society increasingly transitions to a fossil-free energy future.

HSE is requested to consider the evidence provided to justify at least a 10-year transition period in line with COMAH sites in UK, as the risks to lives under these challenging operating conditions are at least as severe as COMAH sites, possibly more so, due to the congested and constrained limitations for escape to safe areas and the speed with which fires can escalate in constant wind conditions prevalent offshore. Only seawater is available for firefighting operations in winter temperatures that often drop to -18°C in North Sea, Irish Sea and continental shelf Atlantic Ocean waters and beyond.

There are no known F3s available which are UL162 listed[21] for approval under such onerous operating conditions.

## A. <u>Background</u>

Much work has been done by foam users and the fire industry to control, restrict and prevent legacy C8-PFAS foam use and prevent any foam discharges to the environment. This is focused on collection and containment wherever possible, with firefighter training principally using PFAS-free or Fluorine Free Foams (F3s)[1,2]. Where not possible, only alternative more benign high purity short-chain C6-PFAS foams are used which are collected, contained and disposed of safely according to Jurisdictional requirements. C6-foams are categorised not bioaccumulative nor toxic[3,4], with a short average 32day half-life in humans excreted in urine[5] (compared to 3.8, 5,4 and 8.5 years for PFOA, PFOS and PFHxS respectively[6]). Very different from legacy C8 foams which can break down to

PFOS, PFHxS and PFOA. These legacy C8-foams ceased manufacture by 2002-3[7], are POP listed under the Stockholm Convention, and have already been widely replaced across UK and EU generally, preventing this historic problem from being perpetuated.

Legacy fluorotelomer foams breaking down to small amounts of PFOA also ceased production by leading UK and global manufacturers in 2015 under the US EPA PFOA Stewardship program[8].

Body loadings of legacy C8-PFAS can increase to levels of concern with increasing exposure, hence their earlier tight restrictions on use in most places and banning from use across UK, EU, US etc., which is not the case with short-chain C6-PFAS. The US Centre for Disease Control's (CDC) latest 2017-18 PFAS in blood serum survey[9] of the whole US population confirmed that PFOS and PFOA concentrations had declined by 32% compared to the 2011-12 survey results[9] covering all age groups and demographics across the US population. CDC found the main C6 breakdown product PFHxA was not detected within blood serum from any age group or demographic in the US population[9], despite inevitable exposure from the plethora of consumer items containing them from medicines, cosmetics, furnishings, clothing, electronics, computers, food packaging, glossy magazines, mobile phones, even dental floss[10]. Presumably due to short human half-life before excretion in urine[5].

Since early 2016 all leading fluorinated firefighting foams contain only high purity C6-PFAS fluorochemicals (earlier in some cases - Oil Technics converted all its fluorinated foams to using only high-purity C6-PFAS during 2015), which fully comply with EU regulation 2017/1000[11].

| Component | Amount allowable under EU regulations EU 2017/1000 | 1% AFFF LF-C6 concentrate Performance against EU2017 |
|---|---|---|
| >PFOA or its salts | ≤25ppb | ≤10ppb |
| >PFOA related substances | ≤1000ppb | ≤1000ppb |

This allows their continued use, especially offshore where no known equivalent functionality can be provided by any leading F3s, which as Swedish research shows[21], usually struggle with impaired fire performance using seawater. UL162 listing[12] and our own testing evidence confirms F3s are usually too viscous to be accurately proportioned at 1% under operating conditions of -18ºC, required offshore in both North and Irish Seas plus continental shelf Atlantic Ocean waters, during winter.

The offshore industry relies on these C6-foams continuing to be accepted for use during emergency fire incidents in UK. Any change to this would prevent the rapid fire control relied upon offshore to retain current low rates of fire impacts, including maximizing safety of life on offshore installations.

The European Chemicals Agency's (ECHA) Socio-Economic Assessment Committee (SEAC) has recognised these issues as very valid concerns in its final opinion (p12)[13]
"***Regarding the transitional periods proposed by the Dossier Submitter, SEAC considers that some transitional periods may need to be extended. The relevant transitional periods include the following:***
***• Placing on the market of specific types of new PFAS-containing fire extinguishers dispensing alcohol resistant foam (a 18-months transitional period is proposed by SEAC), and***
***• Use in the marine sector (a 5-year transitional period is proposed by SEAC)***
***• <u>Use at offshore installations belonging to the oil and gas sector (a 10-year transitional period is proposed by SEAC</u>.***"

Table 3 (p14-15) confirm: "*1.* ***Where the concentration of total PFAS is greater than 1 mg/L shall not, as a constituent of a firefighting foam, be****:*

*a.* ***placed on the market*** *[after 6 months from Entry into Force or EIF] or*

*b.* ***formulated*** *[after 10 years from EIF].*

*2.* ***shall not be used as a constituent of firefighting foams where the total PFAS content is greater than 1mg/L****.*

*3 . Paragraph 2 shall apply from:*

h. ***10 years after entry into force for installations belonging to the offshore oil and gas industry and a review of the substitution status shall be implemented before the end of the transitional period to address the uncertainty about the successful implementation of alternatives;***"

***4. a. ensure that they are only used for fires involving flammable liquids (class B fires);"***

**Paraphrase of 4. h**: confirms all collected PFAS waste from emergency use or cleaning firefighting equipment shall be handled for adequate treatment [if incinerated must be above 1,100oC – p11], **where total PFAS exceeds 50mg/L (ppm) for the offshore oil and gas industry** and 1mg/L in all other uses/sectors. The treatment shall minimize releases of PFAS to environmental compartments **as far as technically and practically possible** and shall exclude sewage treatment, irrespective of any pre-treatment.

It follows (p68): "***However, the fluorine-free foams behave differently compared to PFAS-containing foams and show more variability in their performance. Therefore, they seem to be more specific to different types of fuel or water (Dahlbom S.et al., 2022) which complicates the management of fluorine-free foams by firefighting services and their co-operators, also making more uncertain the effectiveness of alternatives on the wide range of fuels and other flammable liquids that can be found.***" … "***SEAC recognizes that PFAS-based surfactants can provide specific valuable properties that are unmatched by fluorine-free alternatives***. … ***Another issue already discussed by the Dossier Submitter and emphasized by some stakeholders is the difficulty with the higher viscosity of alternatives at low temperatures*** *(comments #3543 and #3549)****, the latter comment raising the issue of transportation under extreme winter cold weather as a concern.*** … ***These properties include for example film-forming ability, fuel repellence, and high ambient temperature performance and allow for an ease of operation which is currently not obtained with fluorine-free foams. This means that more precision and meticulousness is needed when fighting fires using fluorine-free foams compared to using PFAS-based foams.***"

Page 86 adds: "***SEAC further underlines, as noted above, that transitional periods should ensure the avoidance of increased risks to human health and the environment related to increased risk of fire damage***."

Page 94 re-inforces: "***SEAC recommends in this context to adopt a no-regret strategy; that is, a restriction option that remains justifiable whether catastrophic fires take place or not. Therefore, SEAC considers that a review of the substitution status based on local information before the end of the transitional periods for Seveso sites and offshore oil and gas installations would strengthen the proportionality of the proposed restriction***."

Also (p96)[13] clearly states ***" Considering the specific challenges affecting the transition to fluorine-free foams in the offshore sector, SEAC finds that a long transition time is required. SEAC notes that it took eight years to by the actor that***

***reported having already carried it out. Overall SEAC concludes that it would be appropriate to apply the same timelines as for the similar onshore activities (i.e., a 10-year transition period with a review)***." The previous SEAC Draft opinion (p49)[35] confirmed…"***Given the potential very high impacts of even a single catastrophic fire on human health and the environment, the proportionality of the proposal is uncertain if risks of such catastrophic fires are not kept as low as they are currently. SEAC recommends in this context to adopt a no-regret strategy; that is, a restriction option that remains justifiable whether catastrophic fires take place or not."***

The accompanying Information Note[14] to SEAC's draft opinion specifically confirmed information requests considered relevant to this proposal's evaluation included:

"*1.* ***SEAC would welcome further information on the availability, technical feasibility and implementability of alternative PFAS-free firefighting foams in the following sectors****/activities:*

- *a.* ***offshore exploration and exploitation****,*
- *b.* ***transport of flammable liquids in pipelines****,*
- *c.* ***(bulk) transport of flammable liquids on rail and road****,*
- *d.* ***Temporary storage directly related to transportation of dangerous substances****,*
- *e.* ***"Neighbouring establishments" as defined by Seveso Directive*** *(an establishment that is located in such proximity to another establishment so as to increase the risk or consequences of a major accident)"* ie equivalent to COMAH sites in UK.

This submission provides the clear evidence to justify a transition period of at least 10 years (with review) as necessary for Offshore oil and gas installations. This would avoid jeopardising existing life safety and critical infrastructure protections, while maintaining the current reduced risk of catastrophic fires occurring.

## B. **Activity:** <u>**Offshore installations**</u>
## **Transitional Period: at least 10-years - as equivalently challenging hazards to COMAH sites.**

We encouraged HSE to adopt SEAC's draft opinion[35] consideration for UK REACH regulations confirming **"*SEAC considers that for some applications in industrial facilities*** [including Offshore installations] *and in the defence sector* ***an appropriate performance level of fluorine-free alternatives at the end of the transition periods proposed by the Dossier Submitter <u>has not been fully demonstrated</u>*."**

SEAC in its final opinion[13] recognizes (p60) that certain costs could be excessive and impractical to achieve in some sectors, notable offshore oil and gas installations:

- ***"The cost of using alternative foams, which considers the difference in prices between PFAS-containing and fluorine-free foams, and additional volumes of fluorine-free foams needed to achieve the same level of fire protection.***
- ***Cost of cleaning equipment to comply with the proposed concentration threshold.***
- ***Cost of additional Risk Management Measures (RMMs) required for training/testing but also real fire incidents during transitional periods."***

Additionally (p69): "***SEAC notes that, specifically with regard to uses in the petrochemical industry the availability of suitable fluorine-free alternatives after the transitional periods proposed by the Dossier Submitter cannot be fully demonstrated at this point in time."***

We welcome this recognition and acceptance, considering that the sector of Offshore Oil and Gas Installations (ie. **including: offshore drilling/jack-up rigs and drilling barges; fixed/semi-submersible offshore oil/gas production and accommodation platforms; spar platforms; associated helidecks; FPSOs [Floating Production, Storage and Offloading vessels]; drill ships; tug boats; offshore supply vessels; associated pipelines; storage etc.**) is a key area of industrial facilities (equivalent to COMAH sites) where an appropriate F3 performance level cannot be demonstrated (particularly during low temperature use in seawater with non-aspirated delivery devices), thereby placing lives under increased risk unless an extended transition is granted. Consideration is also needed for the 90 decommissioning offshore projects which have already been approved by the UK Government between 2020 and 2024[50], with a further 20 decommissioning projects under consideration in April 2024. Therefore an extended transition should be equivalent to COMAH/Seveso III sites (ie.10-year transition with review), as offshore operations are at least equally challenging to COMAH/Seveso III (upper and lower tiers). The evidence justifying this extended transition follows in this submission.

**This offshore sector suffers from the following hazards and obstacles not effectively addressed by F3 alternatives**:

- space and weight limitations.
- inadequacy of approval testing.
- lack of existing relevant approvals.
- lack of verified fire performance during realistic challenging major fires within specific sectors.
- complexity, cost and 'down-time' required during system transition.
- Offshore installations being increasingly decommissioned (90 projects approved for decommissioning by UK Government by April 2024, with a further 20 decommissioning projects under consideration).
- inability of re-design to meet fire protection requirements because of:
  - a. seawater use.
  - b. high winds.
  - c. extreme operating temperatures.
  - d. higher application rates.
  - e. extra concentrate storage exceeding weight restrictions.
  - f. forceful, non-aspirated applications (to combat wind).
  - g. risk of overflowing containments (higher application rates and longer durations).
  - h. excessive costs of clean-out, re-design, retro-fits, off-stream delays, which still do not meet existing life safety protections.
  - i. significant Installation decommissioning by 2030.

## C. 10-year transition justified - for the following reasons:

1. **SEAC opinion[13,35] cautions that "*SEAC has some concerns*** *that other industry/economy sectors than Seveso installations* ***<u>could represent a challenge for fighting fires without PFAS foams (transportation of hazardous chemicals/goods; non-Seveso sites in the vicinity of Seveso sites, etc.).</u>***"*

   Additionally (p85)[13] "***SEAC further underlines, as noted above, that transitional periods should ensure the avoidance of increased risks to human health and the environment related to increased risk of fire damage***"

   **SEAC is correct.** These concerns should include Offshore installations which arguably have at least as challenging an application as COMAH/Seveso III sites, perhaps more so since they are confined spaces with limited opportunity for personnel to move away from fires, which could spread rapidly, given the usually multi-level, highly congested nature of these platforms where escalation occurs rapidly, often driven by high winds, requiring forceful application of non-aspirated foam spray (at typically 3-4:1 expansion) to reach the target areas for protection.

2. **Offshore installations predominantly use C6 AFFF LF (Low Freeze version)** and C6 AR-AFFF LF firefighting foams for the range of hydrocarbons (Crude Oil, Condensate, Jet A1, Diesel, Asphaltine etc.) and polar solvent fuels (Methanol etc.) found on offshore platforms, and proven effective under testing standard UL162[22,12] (Underwriters Laboratories) verifying acceptability, because the foam is tested under critical application rates at low temperatures and using saltwater (representative of operational seawater) with specific non-aspirated/low expansion delivery devices (≤5:1 expansion) representative of conditions and devices used offshore.

   NFPA Research Foundation's 2022 Fire Service Roadmap report[15] confirmed "***The research conducted to date suggests that FFFs tend to lose effectiveness when discharged through non-air-aspirating nozzles that produce lower aspirated/aerated foam with expansion ratios less that 4-5*** *(generally speaking)."* We understand there is no F3 alternative which currently meets the existing C6 AFFF LF capability requirements at 1% (required for space/weight saving) and 3% foam concentrates, nor has passed the existing UL162 seawater accreditation[12] under necessary operating conditions down to -18°C widely experienced in EU, UK and Norway during winter.

3. **The US Department of Defense (DoD) in Jan. 2023 issued a new Fluorine Free Foams (F3s) fire performance test standard MIL-PRF-32725**[16] for, but this is specifically designed for **land-based use using freshwater only**, and is not accepted for Naval use, clearly indicating that F3s meeting this specification are not suitable for application in sea water because they are significantly less effective i.e. UNSUITABLE. Any such MilSpec qualified F3 will also have to carry a warning label "**This product is not authorised for US Navy Ship Board Use.**" This standard also seems considerably weakened by:

   - **Single 50ft$^2$ (4.64m$^2$) fire test uses 3gpm nozzle [50% higher application rate] on Jet A1** and freshwater (*not seawater and 2gpm nozzle on gasoline as AFFF MilSpec– a much harder test*) - ***potentially placing lives at increased risk.***
   - **Allows 2 passes from 3 attempts** (only 66% success) per test - ***eroding safety factor from 100% pass rate currently.***
   - **28ft$^2$ (2.6m$^2$) fire tests use Jet A1 with 10sec preburn - *unrealistically short, avoiding heat build-up*** (*not gasoline with 10sec preburn - tougher*)
   - **Only one 28ft$^2$ (2.6m$^2$) fire test with gasoline**, 2gpm nozzle, 60sec preburn, **60sec extinction**, 240sec burnback – **freshwater only** (***not gasoli****ne, 2gpm nozzle, 10sec preburn,* ***30sec extinction*** *and 360sec burnback with fresh and seawater*). *Probably not tough enough?*
   - **Burnbacks start after 30secs** (*not within 60 secs implying 55-58secs for AFFF spec.*) *– easier to pass.*
   - **Dry Chemical compatibility uses JetA and freshwater (*not gasoline and SEAwater*) -** *also easier to pass*.
   - **ALL fire tests conducted between 5 and 32°C ambient temps**, making it much easier to pass at 5°C - *unrepresentative of year-round conditions!*
   - **Wind speed reduced to 5mph** (not 10mph) - *so less blanket disturbance*.
   - **Viscous concentrates - kinematic viscosity 300cs at 25°C** (*not 2cs for MilSpec AFFFs at 25°C*). **NO requirement at 5°C - *more relevant operationally* , when *AFFF MilSpec is 20cs at 5°C*[18]*)*.**
   - **Corrosion rates now tested with 10% F3, diluted in 90% seawater!** (*not 90% AFFF diluted with 10% seawater*) – so presume seawater is less corrosive than F3s?

- **Aquatic toxicity LC50 requirement now reduced over 16-fold to 30ppm with more tolerant Fathead Minnow specified – *a pollution tolerant species*** (*not LC50 requirement of 500ppm with more sensitive Killifish in AFFF MilSpec*). *How good is that for our environment, when far more F3 is likely used?*
- **F3 PFAS content <1ppb - *potentially unrealistic*** - when five leading F3s each tested 10-87ppm TOF (Total Organic Fluorine – virtually all PFAS) by FAA in Jul.2022 report[24] (using US EPA 537.1 method[29]).
- **NO F3s are currently QPL qualified**[17] (at early May 2023), yet 10 C6-AFFFs are QPL qualified[19] under existing MilSpec 24385F[18].

Performance cannot be compared to the existing Defense standard MIL-PRF-24385F(SH)v4, 2020[18] which also permits F3 use offshore - providing any such F3 has been qualified by passing ***ALL*** the detailed fire performance tests in fresh and saltwater required by this specification[19], but none has so far. Evidence from US Naval Research Laboratory's (NRL) 2020 report[20] on F3 fire testing over a 28$ft^2$ (2.6$m^2$) pool fire of gasoline confirmed "*Performance of the fluorine-free foams improved when the fuel was switched to heptane and when the solution application rate was increased from 2 gpm to 2.5 gpm with both fluorine-free foams extinguishing the fire in 31 seconds*." Also "*A significant improvement in fire suppression over gasoline was not seen for the fluorine-free foams when the liquid application rate increased from 2.5 to 3 gpm*." NRL concluded[20] **"*The inability of the foams and concentrates to meet critical extinction and property metrics for military qualification testing indicate the difficulties of utilizing these commercial products for Navy operations*** [ie when seawater is used – like Offshore]."

4. **Sweden's Research Institute (RI.SE) conducted extensive fire performance testing on eleven F3s** (Dahlbohm, 2022)[21]. It concluded **"*Testing in seawater generally prolonged*** [F3] ***extinguishment times, or prevented extinguishment."*** It also established that when seawater was used only two F3s extinguished (2min47s and 4min11s), Nine F3s did not extinguish (EN1568-3). Continuing[21] **"*This is assumed to be due to interactions with the fuel causing rapid breakdown of the firefighting foam*."** It also confirmed[21] **"*<u>The more forceful</u>*** <u>[F3]</u> ***<u>application, the greater the fuel pick-up</u>*."** **None of 11x F3s was able to meet the 10min 25% burnback time** (EN1568-3), only one F3 exceeded this 10min requirement when used at an over-rich induction rate of 4.5% admixture (of nominal 3% foam). It concluded[21] **"*<u>All the findings and conclusions point out the importance to perform tests as close to the real fire hazard situation as possible.</u>*"**

5. **Part of the reason F3s have been unable to achieve this UL162 fire test approval**[22] **is because F3s are generally more viscous at room temperature, becoming thicker, even solid or semi-solid as temperatures drop below freezing**. Research by Batelle (US Dept. Energy) in 2020[28] assessed seven commercially available PFAS-free Foams (F3s) finding that F3 viscosities up to 90,000 centistokes(cs) were possible, although significantly reduced in warmer 25°C conditions. The new F3 MilSpec limit[16] is 300cs at 25°C, but no requirement at more important 5°C (AFFF requirement is 20cs at 5°C[18]). This is not representative of most commonly occurring offshore operational conditions. It could cause reduced proportioning or potentially complete blockage at low operational temperatures.

   Therefore, F3 users are increasingly likely to experience viscosity issues causing incomplete mixing and reduced proportioning accuracy, especially at lower operating temperatures. Many F3s are unable to operate effectively even at -5°C. Only one of the 70 or so currently available F3s we know of, has a UL 162 listing[12] at -6°C. None has achieved UL162 approval[12] with seawater at -18°C, necessary to proportion effectively offshore.

6. **F3 foams are incompatible for mixing with any other F3**[16,23], so they cannot be mixed, which prevents mutual aid collaboration amongst platforms nearby during emergencies, even across different operators, which is currently the case. This is an important mutual aid consideration offshore, which would be lacking during any major fire emergency were F3s forced into use.

7. **F3 studies conducted by US Federal Aviation Administration (FAA) in July 2022**[24] confirmed that dry chemical powders (notably potassium bicarbonate widely used throughout aviation including helidecks offshore) reduced performance of all seven leading F3s tested under MilSpec and ICAO Level C protocols against two C6-AFFFs. This testing highlighted "***Overall, none of the tested FFF candidates can be considered a direct replacement for AFFF without compromising the efficacy of fire extinguishment***." *Also "**All the tested FFFs exhibited reduced performance with the application of dry chemical**. … **Since dry chemical is a common auxiliary agent and many ARFF vehicles have dual-agent turret nozzles, this quality may pose significant safety issues in a real-world response.**"…"Additionally, **surface burning was a commonly observed trait of the FFF candidates that is typically not observed with AFFF**."* This testing also confirmed "***extinguishing the fire on the edges of the fire pans and preventing reignition in these areas was generally more difficult with the FFFs than the AFFFs. In the manual application evaluations, this difficulty was more evident and was amplified by the application technique and cohesivity of the foam blanket***." Testing confirmed **F3s did best in over-rich *(15%)* MilSpec tests** *of 3% concentrate***.**
This confirms F3 use would become harder as pool fire sizes increased, and is directly relevant to the need for rapid, effective first aid firefighting offshore to prevent risk of escalation. **Despite 2x F3s being ICAO Level C approved, no F3 passed the ICAO C tests - indoors or outdoors.**

FAA reported[24] that "***A direct discharge into the pan or change in direction of application frequently caused fire reignition in areas of the pan that were previously extinguished or pulled the entire foam blanket away from other areas, causing reignition**."* which could have serious consequences offshore as foam blankets are frequently disturbed and blown around changing their direction by wind. These test findings led to FAA issuing a Cert Alert (Oct.21)[25] of public safety concerns confirming *"…**interim research has already identified safety concerns with candidate fluorine-free products** that must be fully evaluated, mitigated, and/or improved **before FAA can adopt an alternative foam that adequately protects the flying public**. **The safety concerns FAA has documented include:***

- ***Notable increase in extinguishment time;***
- ***Issues with fire reigniting (failure to maintain fire suppression); and***
- ***Possible incompatibility with other firefighting agents, existing firefighting equipment, and aircraft rescue training and firefighting strategy that exists today at Part 139 air carrier airports*."**

These same concerns similarly apply to helidecks offshore.

8. **There is little research data on the effectiveness of F3 foams used within non-aspirated systems** especially against wind, when sea water is used, i.e. Risk of failure increases significantly. NFPA's Research Foundation reported in 2020[26] that **"**[F3] ***Expansion ratios of 3-4:1 required double the density of 7-8:1 expansion applications*."** Existing fire systems equipment is integral to offshore

structures and not easily removed, cleaned or replaced as it is designed specifically to combat the problems of wind while effectively controlling fires fast. Space and weight restrictions apply offshore, so adding concentrate for higher application rates and heavier higher aspirating delivery devices (to be blown away by wind) is not a practical or economic option. This would result in likely unacceptable increases in exposure of lives to loss and increasing risk of catastrophic fires by removing vital existing protections delivering unacceptable risks of increased harm.

NFPA-RF also confirmed[26] that (paraphrasing) '**F3 was not a 'drop-in' replacement for C6 AR-AFFF even using freshwater as individual products varied significantly, making it difficult to develop 'generic' design requirements.'** This research also concluded[26] "*From an application rate perspective,* ***the FFFs typically required between 1.5 to 3 times the application rates to produce comparable performance as the baseline AFFF for the range of parameters included in this assessment***." There is no extra space or weight allocation for 2 or 3 times more foam volume on offshore platforms. There is also very little evidence of F3 effectiveness in major industrial fires and no evidence of F3 effectiveness offshore***. Does ECHA/SEAC have any evidence to the contrary?*** This makes proposed use of F3s largely untenable by the offshore industry, even on Workplace Health and Safety grounds alone.

9. **The new NFPA 460:2024 Standard for Aircraft Rescue and Firefighting Services at Airports**[32] re-inforces NFPA 403:2018, with Annex B.6 explaining… "***There has been limited full-scale testing of ICAO C foams, but tests to date have reflected extinguishments on Jet A within 1 minute at ICAO Application rates of 0.992 gpm/ft² (3.75L/min/m²). The 0.13gpm/ft² (5.5L/min/m²) application rate requirement for AFFF meeting MilSpec in NFPA 403 is 40% higher***."
(NB: NFPA 460 is an amalgamation of NFPA 403, 405 and 412)

**This raises a BIG question: …Are alternative ICAO Level B/C F3s still effective at this low 40% safety factor under challenging operational conditions? …considerably less than existing double or triple safety factors currently used by ICAO Level C/US MilSpec approved C6-AFFFs?**

**NFPA 460 Annex B.6**[32] **continues "*Airports adopting ICAO foam concentrates should evaluate equipment requirements any time a switch to a new manufacturer of foam concentrates is considered.***

***Therefore, starting with 2018 edition of NFPA 403, the following application rates by test standard are used:***

*(1) Mil-F 24385 and ICAO Level C = 0.13gpm/ft² or* ***5.5L/min/m²***
***(2) ICAO Level B = 0.18gpm/ft² or 7.5L/min/m²***
*(3) ICAO Level A = 0.20gpm/ft² or 8.2L/min/m²"*

**This is of particular concern to SEAC, HSE (UK REACH)…and ICAO, CAA** when extensive comparative fire testing confirms F3s deliver inferior fire performance to C6-AFFFs and may require typically 2-3times higher application rates to even extinguish test fires on volatile fuels like gasoline and Jet A1. **Safety factors should therefore be significantly higher than just 40%, at least double - confirming NFPA 460's recommendation**[32] for operational use at 7.5L/min/m² or above for ICAO Level B[46] approved F3s across EU (not 5.5L/min/m2 as currently)? This would add substantial extra foam storage on helidecks offshore where space and response times are at a premium when saving lives. We should also consider that F3s in Dubai 's B777 fire (Aug.2016 – see 17 comparison table below) were probably applied well above this 5.5L/min/m² application rate, after F3 was found not to be working effectively, yet still extinguishment was unachievable and the aircraft effectively burned out after 16 hours[33].

**Is it SAFE for Offshore platforms and European airports to be using ICAO Level B F3s at just 5.5L/min/m$^2$ application rates, when NFPA 460:2024[32] is recommending ALL ICAO Level B approved foams be used operationally at 7.5L/min/m$^2$ minimum, as a requirement to avoid compromising risks to life safety (since 2018)?**
This also justifies a 10-year transition (with review) for Offshore Installations where helidecks are almost universally operated with personnel year-round, often involving ICAO Level B[46] approved foam concentrates. Perhaps Offshore helidecks should require an ICAO Level C approved 1% C6-AFFF-LF in future, to prevent extra weight and storage requirements from higher application rates being required buy NFPA 460:2024[32] for existing ICAO Level B foam usage.

## *Composite materials*

### 10. Composite materials increase smoldering and flashback hazards

Lessons are being learned from the collision and fire of an Airbus A350 aircraft in Japan (2Jan.2024)[36-40]. It reportedly burned for 6 hours, seemingly unable to be extinguished at Japan's Tokyo airport (2Jan.2024), despite expected use of leading AFFF foams.

Miraculously all 379 passengers and crew evacuated safely, although tragically five lives were lost on the smaller Dash-8 plane involved[36-40]. It was almost a catastrophic disaster.

**FAA 2012 research**[41] found composite materials were proving difficult to extinguish and continue smoldering as a source of fuel re-ignition. FAA 2020 studies confirmed composite material use in modern aircraft and helicopters is growing fast, to reduce weight and fuel costs[42,43]. Airbus A350s have 53% composites, A380s 25%, while Boeing B787s contain 50%, and even B777s comprise 12% composites[42,43], yet composite fires are proving harder to control and extinguish[41,45]. This A350 fire reportedly burned for six hours[39], destroying the aircraft, leaving "*…the severely damaged A350's wings as the only identifiable pieces remaining of the plane's charred and broken fuselage*[40]*.*" Composite material experts are already asking "***The fire brigades of the airports actually have to look at why couldn't they stop the fire?***[39]**"** A question equally relevant to regulators like ICAO, NFPA but also HSE and CAA.

This recent Japan A350 fire (2Jan.2024)[36-40] is not isolated. It follows US Airforce loss of a $1.4billion B2 stealth bomber from fire after crashing in Guam (2008)[43,45]. This fire also spread quickly, proved difficult to control, and Defence Analysis data[45] confirms it took 6 hours to extinguish, despite the best high performance AFFF foams being used, confirming "*the full fuel tank likely exacerbated the fire upon crashing*.[45]" A 2009 FAA Presentation[43] identified this B2 fire required huge quantities of agent to finally extinguish this small aircraft fire: **314,155 litres of water and 9,463Litres of AFFF** concentrate.

**11. The new NFPA460:2024[32] requirements for an A350 as a Category 9 aircraft**, requires under AFFF MilSpec[18] **36,200 litres of water and 1,086 litres of foam of** AFFF. ICAO Level C[46] the same quantities but could be AFFF or F3. For ICAO Level B[46] approved foams NFPA 460 requires **46,500 litres of water and 1,395Litres foam** whether AFFF or F3. Presumably this will also apply to the new F3 MilSpec[16], which uses a similar fire test application rate to ICAO Level B[46], using Jet A fuel. This is nearly 7-9 times LESS foam and water than was needed for the small B2 bomber[43]! How would alternative PFAS-free foams (F3s) behave under such challenging composite material situations? Particularly when F3s already exhibit edge flickers preventing extinguishment in 60 seconds or less under existing ICAO[46] level B and C Jet A1 fire tests [1,15,27,43,50]. Current ICAO[46] fire testing uses relatively ideal conditions of 15$^{o}$C and maximum wind speeds of 3m/sec (6.7mph) during fire testing[46]. Certification is also based on a single fire test using new foam accurately pre-mixed to the exact proportioning rate with no account of ageing effects over time, nor the impact of tolerance variations through actual proportioning equipment used on ARFF fire trucks[16,18,42]. Practical firefighting foam efficacy will be severely challenged on most windy airport runways where composite materials are alight under most hot summer conditions. Current ICAO[46] fire tests are therefore probably not representative of current realistic emergency fire conditions being regularly faced daily at most major airports.

*For clarification Jet A and Jet A1 Aviation Fuels are basically interchangeable[47] –Jet A's freezing point is - 40ºC; Jet A1 a bit lower at - 47ºC. Both flashpoints are +38ºC.*

**12. A 2019 US Defense System Information Analysis Center (DSAIC) composites review**[45] highlighted " *But it is how FRPs burn when exposed to fire that presents challenges from the perspectives of force protection and structural durability, when the FRP may structurally fail early in a fire and lead to catastrophic losses*.**"** It also confirmed 2 new composite Naval ships were both complete hull losses - following ferocious fires. One vessel burned for 24hrs before capsizing, breaking apart and then sinking. Reports confirmed the "*fires were so intense, the on-board firefighting measures were not enough to overcome them*."

The second Naval ship fire was caused by an electrical short, while the vessel was docked during fit-out for sea trials. Although the fixed fire protection systems had not yet been installed, reportedly "*the fire was large and **intense**, overcoming the fire protection measures available, so the entire ship was lost*." Uncontrollable fires, with complete loss of both composite aircraft and composite naval ships, again …re-inforces the difficulty of achieving rapid extinguishment.

## 13. Increasing hazards suggest overhaul of fire test Standards

This A350 fire in Japan[36-40] alone sends warning bells about the fire risks and extinguishment challenges of modern composite materials. Potentially highlighting weaknesses in our expectations from existing firefighting foam test standards like ICAO[46], new F3 MilSpec[16]. perhaps even UL162[22]. Current fire testing may no longer be fit for purpose in today's more challenging composite age, not just in aviation (fixed and rotary wing aircraft), but ships, cars and many industrial environments, where composite materials are increasingly used for benefits including rigidity, corrosion resistance, weight saving, longevity, strength and reliability.

Increasing use of alternative PFAS-free foams is a major concern, which are known to behave differently[15,20,21,23,24,26,28]: requiring slower, more gentle, well-aspirated applications, but are prone to sudden flashbacks. This could increase life-safety dangers with smoldering composites[41,42] a trigger for unpredictable and sudden fire re-involvement. It suggests urgent fire test standard overhauls may be essential, with greater focus on firefighter training using liquid fuel fires. Particularly when transitioning to Fluorine Free Foams (F3s) is being considered, to ensure life safety is adequately maintained and help prevent future life-loss tragedies.

**14. FAA's 2020 Strategies for Aircraft Rescue and FireFighting (ARFF)**[42] confirmed extensive small-scale fire testing shows composite materials are strong, resisting fire longer than conventional aluminium skinned aircraft. But it confirmed "*The components of advance composite materials are all affected by fire. Resins and epoxy will burn, particularly in the presence of an aviation fuel fire. …Pooled fuel fires should be controlled first, then burning composites, smoldering composites tend to reflash if not sufficiently cooled*. "

FAA's 2012 'calculating agent quantities' report[41] also found smoldering composite material difficult to extinguish, potentially re-igniting suddenly and unpredictably during passenger evacuations. *"It was concluded that fast response by the fire fighters reduced the chance that smoldering fire will be established.* ***Since fire fighters may have to work in close to the aircraft to control the composite fire, they must be aware of potential re-ignition of fuel under or around the aircraft****."* *Continuing "****To extinguish …fire fighters applied a continuous stream of AFFF directly on the composite material. After applying AFFF for 3 minutes or more, the smoldering composite combustion was extinguished."*** Such re-ignition sources further expose F3 vulnerabilities, without fuel repelling and vapour sealing additives. It also "***noted that quick response and quick knockdown of the fire by airport fire equipment offer the best chance of passenger survivability in an aircraft crash situation."***

**15. Lesson learned by US Navy firefighters (2019)**[44] found "*One of the specific threats of carbon fibers exposed to fire and/or heat can release Methyl Ethyl Ketone Peroxide (MEKP), a liquid catalyst used to accelerate fiberglass curing. It can cause permanent blindness from a single small dose*." Safety Data Sheets confirm MEKP[48] is a flammable polar solvent liquid, requiring alcohol-resistant (AR) foams for fast, effective, reliable extinguishment. Regular aviation foams whether Fluorine Free Foams (F3s) or AFFFs are substantially attacked by polar solvents, significantly reducing effectiveness. Might this help explain long extinguishment delays in composite fires like this A350? Perhaps we should be using low viscosity AR foams for composite fires in future, ensuring rapid control and quick extinguishment are maintained?

**16. Europe's AircraftFire Report (2014)**[49] found "*Composites are an efficient fire barrier, but:*

- *The resin warming destroys the cohesion between carbon fibres, which changes the mechanical properties of the composite. A mechanical stress can break the fibres as soon as the first layers of fibres are de-correlated;*
- ***The fast heat penetration in the composite induces an off-gassing of pyrolysis products, potentially toxic (intoxication of the occupants) and flammable (gas ignition) with a potential fire propagation in the cabin after few tens of seconds,… potentially having a fatal effect on passengers and crew survivability***."

Concluding[49] "*This requires a re-evaluation of the hazards, to reduce the fire incident/accident rate and to increase the survivability of the passengers and crew during accident involving fire."* Shouldn't this trigger a review and overhaul of existing firefighting practices and fire test standards? Especially when transitioning to PFAS-free foams which behave very differently from faster, more effective C6-AFFFs?

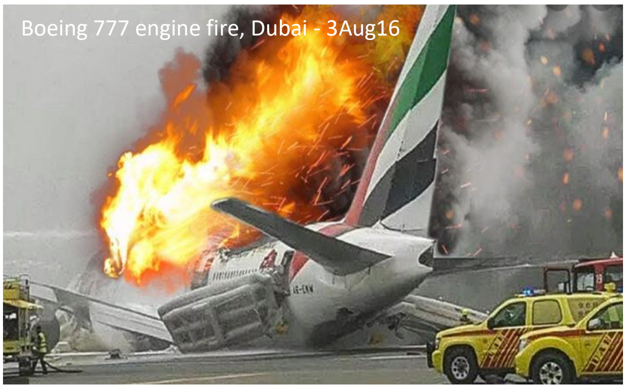
**17. Aviation fire comparison**[33,34]

This 2016 Dubai aircraft fire has direct relevance Offshore, because there are numerous helicopter flights transporting personnel to and from platforms, day and night, year round, in often difficult weather conditions, which were also faced in Dubai. This is placing unacceptably increased risks to life safety, **particularly in storms and winter when F3s may be very viscous, even semi-solid, so unable**

**to be proportioned effectively. This could prevent any rotary aircraft fire from being controlled or extinguished, leading to potentially catastrophic outcomes offshore.**

| **Foam Type Used:** | **Leading Non-Fluorinated Foam (F3)** | **Fluorinated Foam (C8-AFFF)** |
|---|---|---|
| **Aircraft; Location:** | **Boeing 777 - Dubai Int'l airport, UAE** | **Boeing 777 - Changi airport, Singapore** |
| Date: | 3 Aug. 2016 | 27 Jun.2016 |
| Major Fire Summary: | Engine detachment during 'attempted go-around' in 48°C heat with difficult wind shear conditions. The detached engine caused fuselage damage and a subsequent fire. ICAO Level B approved F3 was applied soon after crashing, using non-aspirated jets, causing the foam bubbles ot breakdown on impact (as one would expect AFFF to work effectively). | Engine fire involving much of the wing with leaking fuel caught fire upon landing. Application of thrust reversers intensified the fire through the core of the engine. ICAO Level B approved fluorinated foam (AFFF & FFFP) was applied soon after crashing. |
| Fire Control Time: | **Full fire control not achieved until 16 hours after impact.** | **Fire extinguished within 5 minutes.** |
| Lives Lost; Injuries: | **1 firefighter tragically died 9 mins in during fuel tank explosion. 4 serious injuries (28 minor).** | **No injuries reported.** |
| Life Safety Issues: | **All 300 passengers and crew evacuated in 6 min.40secs after crash, before fire took hold (140 secs before tank explosion).** | **All 241 passengers and crew safely disembarked 15 mins *after* the fire was extinguished.** |
| Aircraft lost; damaged: | **Plane was destroyed.** Estimated value US$340million. | **Plane damage limited to engine and wing (replaceable).** |
| Outcomes: | **Fire and toxic smoke burned for 16 hours.**<br>**Suppose injured, infirm or disabled passengers, perhaps parents with babies and/or young children had inevitably delayed evacuation … catastrophic carnage could have resulted.**<br>***…Suppose passengers were kept on-board for their own safety, away from flames? Was this too close for comfort? …Shouldn't we be learning from this 'spine-chilling' near-disaster?***<br>**Excess foam and discharge of firewater run-off continued for 16 hours, distributing breakdown products of the fire (including PFAS from furnishings, computer screens, electronics, phones, items left on-board by fleeing passengers etc.) causing environmental contamination and on-going site pollution.**<br>**On-going fire would have upset air traffic, reduced airport access for arrivals, caused extended disruption to airport operations and travelling passengers, potentially causing airport closure.**<br>**Part of airport was closed for prolonged period.** | **Fast, effective, efficient, reliable extinguishment.**<br>**Plane damage was limited to engine and wing.**<br>**Runway re-opened with minimal disruption or safety concerns to air traffic, airport operation and travelling passengers.** |

| | | |
|---|---|---|
| Comment: | Q: Why no explanation for failed foam attack in final investigation report? Knowing the answer might help save lives in future.<br>Q: Isn't firefighter's quick arrival and rapid fire control/extinguishment critical in saving lives?<br>Flight attendants evacuated all passengers very quickly ...just 3 minutes before the fuel tank explosion killed a brave firefighter. Did he die needlessly?<br>Q: Might a different foam choice have led to a different outcome?<br>Q: How many passengers may also have died had evacuation been delayed by 140secs? | Firefighters quick arrival and fast, effective, reliable fire control/extinguishment was critical in extinguishing this fire - when all passengers were STILL on-board.<br><br>It is widely recognised occupants are likely to die from toxic smoke inhalation potentially 3-4 minutes after the fuselage is engulfed in flames.<br><u>Seconds count when saving lives.</u><br><br>A quick, safe and well executed response. |
| ***Were Society's expectations met?*** | <u>Desired outcomes were NOT met.</u> | <u>**ALL desired outcomes were met.**</u> |


Boeing 777 engine fire, Dubai - 3Aug16


Engine fire at Singapore, 27Jun2016

18. **Because of the tenacious way that fluorosurfactants can adhere** to storage tanks, pipework and equipment, any transition to F3 is likely to be economically prohibitive offshore[13]. It is not just the cost of clean-outs to 1ppm and lacking performance, but equally importantly the substantial financial loss of offshore platform operation during required shut-downs, realistically for 2-3 weeks during retro-fits and clean-out, on every platform - cleaning, re-designing pressure losses, engineering changes to piping configurations, retro-fitting equipment, changing to larger delivery devices and re-commissioning to provide a system which probably does not deliver existing levels of safety protection. This would leave everyone on the platform exposed, more vulnerable to lives lost in major fire emergencies, which is socially and ethically unacceptable. The Norwegian Oil and Gas Association comments in SEAC's draft opinion[35] confirmed "***<u>these shut-down costs at 2million Euros/day per offshore platform</u>***", a similar figure to that expected for a platform shut down in UK's offshore energy sector. This makes transitioning to F3 across all offshore installations (even a single one) prohibitively expensive, without providing guaranteed equivalent functionality to existing C6-AFFF-LF systems, nor proven effectiveness in major fires. Particularly where seawater, low winter temperatures and non-aspirated delivery devices combine to be essential requirements to control fires, but which F3s are currently demonstrated (Dahlbom, 2022)[21] as being incapable of being effective under such challenging conditions.

19. **The EC's Feb.2022 "Study on Decommissioning of Offshore Oil and Gas Installations"**[27] confirms that "*In the EU, UK and Norway, an increasing number of offshore oil and gas operations are approaching cessation of production and decommissioning as further exploitation of the reservoirs is no more*

*economically viable. Decommissioning is expected to accelerate due to the ongoing shift from fossil fuels to renewable and low-carbon energy sectors and the resulting decreased demand for oil and natural gas."* Also *"**Although decommissioning in the EU will not be completed until at least 2050, the costs are high now and it is estimated that €4.8bn will be spent in the EU-27 on decommissioning of oil and gas infrastructure in 2020-2030**."* The UK Government confirms that in April 2024 there were 90 decommissioning offshore projects approved between 2020 and 2024[50], with a further 20 decommissioning projects under consideration.

It therefore seems unreasonable to expect offshore platforms due for decommissioning by around 2030 to now undergo an F3 transition in 2025-8, involving exceptional unnecessary additional costs to the decommissioning which is uneconomic, disproportionate and unjustifiable. SEAC[13] agreed that a10-year transition would correct this potential oversight, and we encourage HSE to adopt the same approach.

**20.** **<u>FAA Research calculating firefighting agent quantities for aircraft crash fires in 2012</u>[43] <u>found</u> aircraft composite materials behave differently**. It cautioned:

- ***There is also potential for re-ignition of a fuel fire from smoldering fuselage composites***." These are widely used in helicopters as well as fixed wing aircraft, so has relevance for offshore installations.
- It referenced US Military graphite/epoxy/carbon fiber composite testing, finding "***this composite would self-sustain combustion in as little as 2.5 minutes of exposure to an external pool-type fire. …The pool fire was easily extinguished in all tests. However, extinguishment of the composite combustion was not as easy.*** *The surface flames were readily extinguished, but smoldering composite combustion was already established."*
- ***"To extinguish …fire fighters applied a continuous stream of AFFF directly on the composite material. After applying AFFF for 3 minutes or more, the smoldering composite combustion was extinguished."*** Such re-ignition sources further expose F3 vulnerabilities, without vapour sealing additives.

**21.** **<u>The current NFPA 460: 2024 Standard for Aircraft Rescue and Firefighting Services at Airports</u>[32] Annex B.6 explains…**

- "***There has been limited full-scale testing of ICAO C foams, but tests to date have reflected <u>extinguishments on Jet A within 1 minute at ICAO Application rates of 0.992 gpm/ft2 (3.75L/min/m2).</u> The 0.13gpm/ft2 (5.5L/min/m2) application rate <u>requirement for AFFF meeting MilSpec in NFPA 403 is 40% higher</u>***."
- **This raises a BIG question: …<u>Are alternative ICAO Level B/C F3s still effective at this low 40% safety factor operationally?</u> when considerably less than existing double or triple safety factors currently used by ICAO Level C/US MilSpec approved C6-AFFFs?**
- **Annex B.6 continues "*Airports adopting ICAO foam concentrates should evaluate equipment requirements any time a switch to a new manufacturer of foam concentrates is considered.***
- ***Therefore, starting with 2018 edition of NFPA 403, the following application rates by test standard are used:***

*(1) Mil-F 24385 and ICAO Level C = 0.13gpm/ft$^2$ or 5.5L/min/m$^2$*
***<u>(2) ICAO Level B = 0.18gpm/ft$^2$ or 7.5L/min/m$^2$</u>***
*(3) ICAO Level A = 0.20gpm/ft$^2$ or 8.2L/min/m$^2$"*

*For clarification NFPA 460:2024[32] incorporates former NFPA 403, 405 and 412 Standards.*

**This is of particular concern to SEAC…and ICAO, but also potentially HSE and CAA** when extensive comparative fire testing confirms F3s deliver inferior fire performance to C6-AFFFs[15,20,21,23,24,26,28] and may require typically 2-3times higher application rates to even extinguish test fires on volatile fuels like gasoline and Jet A1. Safety factors should therefore be significantly higher than just 40%, at least double confirming operational use at 7.5L/min/m2 (or above potentially) for ICAO Level B[46] approved F3s (not 5.5L/min/m2 as currently) – not only for helicopters on offshore installations, but also civil aviation fixed wing aircraft operations across UK and Europe.

**Is it SAFE for UK and European airports plus heliports to be using ICAO Level B[46] F3s at just 5.5L/min/$m^2$ application rate, when NFPA 460[32] is recommending ALL ICAO Level B approved foam be used operationally at 7.5L/min/$m^2$ to avoid increasing risks to life safety?** *Who is liable should a tragedy happen?*

This justifies a 10-year transition period (with review) for offshore installations where helidecks are almost universally operated, but also marine shipping with helicopters stationed or visiting (eg. cruise ships, research vessels, supply ships and others), plus civil aviation and defence.

22. **Offshore sole sourcing of specific F3 alternatives will be a likely enduring problem**, as quick AFFF replenishment is currently critical (which can involve other AFFF brands, providing they are listed to the same seawater at -18ºC approval under UL162[12,22]). FAA's Cert Alert in Jan 2023[23] confirms the New F3 MilSpec 32725 warning label[16] that '*each F3 agent should not be mixed with others*' (even from the same manufacturer - (supported by manufacturers own recommendations[30]), which cannot be changed to avoid unexpected reactions, separation or premature performance issues in storage. Each system therefore has to be designed for a specific F3 agent, and disposed of similarly to AFFFs. Manufacturers also recommend[31] "*preventing entry of F3 to sewers and public waters*." NFPA Research Foundation's 2022 Fire Service Roadmap[15] endorses this, stating: "*Although these new foams are being developed and implemented as environmentally friendly AFFF alternatives, the* ***industry trends will require collection and disposal of these products in the same manner as AFFF is being handled today. So unfortunately, the ability to train with these foams will have the same cost burden as the legacy AFFFs requiring special facilities and waste containment/collection."*** This could be a major issue even during or following smaller fires (as well as major fires), adding potentially severe delays and shut-down costs, before platforms could again become operational. F3s are widely regarded as also incompatible with other F3s, seawater and existing AFFFs.

23. **Re-training ALL Offshore personnel (as everyone has to undergo basic fire training) to un-learn currently 'instinctive', semi-automatic emergency responses, adds huge cost**
Re-training firefighters to do the opposite of what many have found instinctive over a life-time will be very challenging, time consuming and expensive as NFPA-RF's Roadmap[15] advises "***As a result, innovative training approaches (e.g immersive reality approaches) should be considered/developed to more effectively and efficiently address the increased challenges of transitioning to these new products. Additional training resources will be required to address new foam alternatives (e.g., model procedures, model strategies or tactics with new foams, training facilities, equipment transition, etc.). Special education and training are needed for foam stewardship (e.g., why the transition is needed, why environmental contamination is important***," Particularly when 90 decommissioning offshore projects have been approved by the UK Government between 2020 and 2024[50], with a further 20 decommissioning projects under consideration. This training intensity, foam disposal, clean-out and significant costs per firefighter had not been adequately considered in the original proposal. SEAC's draft opinion[35] recognised "***Some stakeholders (comment #3546, 3548, 3596, 3614) claimed that, further to technical costs, they will also incur***

***organisational costs (adapting firefighting related procedures) and re-training costs (since alternative foams can require new firefighting tactics and tools), and these have not been accounted for by the Dossier Submitter****. According to one comment (#3548),* ***<u>these costs could represent 25% of substitution cost for big industrial installations</u>****”*

To use F3s effectively requires gentle (not forceful) applications, well aspirated (not non-aspirated), slower (not rapid attack), requiring closer engagement with the fire, meticulously addressing every area of flames, and re-visiting to check for any re-ignition before moving onwards in a painstaking, methodically focused manner, which is unfamiliar because of C6-foam’s flexibility and capability to quickly spread and vapour seal the volatile flammable liquid fuel’s surface (not possible with current F3s). This takes more courage, exposes firefighters to more risk, more heat stress, goes against natural instincts to stay further back. It requires a very different mind-set from their current training for fast, sweeping foam delivery onto pool fires, applied from as far back, in as safe an area as possible, to achieve rapid knockdown and extinguishment to deliver a rapid rescue of casualties, prevent spread and escalation, and get back to safety – ‘job done’! …But it may not be ‘job done’ using F3s, despite every effort being made and no fault of the firefighters involved, the evidence confirms F3s lack necessary resilience offshore[21], so it could be ‘*job undone*’…leading to more damage, more danger and potentially more catastrophic outcomes.

NFPA-RF’s 2022 Fire Service Road Map[15] on ‘lessons learnt and tactics’ confirms “*Specifically, one pass of a stream of AFFF typically extinguished all the fire in application, including on the far side of smaller obstructions.* ***<u>Conversely, the FFFs tended to leave small holes in the foam blanket and needed more agent to extinguish all of the obstructed fires. In short, the FFFs typically took two passes of foam application to match the single pass of AFFF explaining the 1.5-2 times longer extinguishment times</u>****. …As a result, these conditions could have been even more pronounced if the tests had been conducted with a flammable liquid like gasoline. …* ***<u>pre-fire planning and training will be key to successful implementation/deployment of these products going forward</u>***.” Such re-training will be time-consuming and expensive, because it has to be very realistic. To achieve the best from F3s is counter-intuitive to conventional firefighter training and is not instinctive for any individual wanting to get the ‘job done’ and get back to a safer place. It will take many attempts on real fires for every firefighter, before the required technique is mastered and confidence slowly grows with application success. This will also require frequent on-going ‘refresher’ training to ensure firefighters do not lapse back into ‘old ingrained ways’ which could put theirs, and others, lives on the line, with increasing risk of catastrophic fires occurring more frequently.

Such comprehensive training should only be embarked upon, once independent comparative fire test data confirms a high degree of functional fire performance equivalency is possible using F3 alternatives, to adequately protect firefighter lives operationally. This is demonstrably far from the case currently and seems likely to continue for the foreseeable future. **It also seems not to have been adequately considered, or costed in the Socio-Economic Assessment, by the Document Submitters of this PFAS foam restriction proposal. Yet it is a substantial extra cost burden which will be disproportionate to any perceived benefit in several sectors, including offshore installations.**

**24. In the case of F3 transitioning offshore, at least 10 years Is necessary**. Because the consequences of reduced fire safety when using F3 could be disastrous. SEAC’ final opinion[13] considered that review of the substitutional status should occur after 10 years (with review) for Seveso III (COMAH) establishments[13] (mostly using freshwater). SEAC also suggested a review to clearly identify whether F3 alternatives are capable (after 10 years) of delivering equivalent functionality, or not. The severity of challenges offshore outlined in this submission (including seawater, non-aspirated delivery devices, extreme winter temperatures) and **the**

**catastrophic consequences of inadequate functionality justify the same Seveso III (COMAH) transitional 10-year period (with review) should also be applied to HSE regulations under UK REACH for the similarly high risk UK offshore sector. This would seem to be essential to adequately protect lives on these confined high risk hazardous installations offshore in UK as well as across EU**.

It is important to note this comprehensively includes all parts of offshore operations, including types of drilling rigs, jack-ups, production, exploration and accommodation platforms, associated helidecks, FPSO (Floating Production, Storage and Offloading) vessels and all other vessel types used offshore for tug, supply and operational duties.

**25. SEAC's final opinion**[13] **makes clear** (p86) that *"SEAC further underlines, as noted above, that **transitional periods should ensure the avoidance of increased risks to human health and the environment related to increased risk of fire damage**."* The evidence is clear that this objective cannot be achieved by existing leading PFAS-free (F3) foams, as extensive comparative fire performance data contained in this submission, confirms. There are no 1% F3s listed or approved for seawater use at the low operating temperatures often experienced in UK and European offshore waters down to -18ºC during winter, particularly when non-aspirated delivery devices are necessary for use to combat wind effects.

26. **In summary: Advantages of transitioning to F3s offshore are currently ZERO.** Any anticipated environmental benefit from preventing small amounts of C6-PFAS discharging into the sea are likely to be offset by increased smoke from extended fire durations and likely increased spread/incident escalation; increased fire breakdown products released including toxic, carcinogenic substances and PFAS from other uses; more foam used during higher F3 application rates delivering slower fire control; increased risk of catastrophic fires occurring; greater risk of lives lost; greater resulting offshore and environmental damage, and repair/remediation costs.

**Disadvantages of transitioning to F3s offshore are numerous, including**:

- **Increased risk of fire escalating** out of control.
- **Very high impacts of single catastrophic event** to human lives and our environment.
- **Demonstrated impaired functionality from poor F3 fire performance**, **particularly using seawater** and forceful, non-aspirated delivery devices required offshore to overcome wind.
- **Increased composites smoldering risks** increased risk of sudden unpredictable re-ignition, for which F3s edge flickering is unlikely to reliably and quickly control or extinguish composite material fires.
- **Reduced proportioning accuracy/reliability** due to viscosity issues, particularly at low winter operating temperatures of -18ºC.
- **Most F3s suffer attack and premature collapse from Dry Chemical** powder applications, regularly used offshore, particularly on helidecks for engine fires.
- **Disproportionate shut-down costs to allow transition**, including system clean-out, re-engineering, retro-fitting equipment for an F3 transition, re-commissioning, re-training, when existing protections are compromised - placing lives under increased risk of harm. – including firefighters.
- **Disproportionate when increasing decommissioning** of UK and EU offshore installations are scheduled around 2030.
- **Current evidence confirms F3s are not capable of effective operation using seawater** with non-aspirated devices at winter operating temperatures experienced of -18ºC in North and Irish Seas, nor Atlantic Ocean's continental shelf or beyond.

## D. Conclusions

This fundamental gulf in current F3 fire performance compared with existing C6-AFFF-LF on widely used flammable fuels offshore, is unacceptable, particularly when seawater and non-aspirated applications (to combat wind) are integral to most offshore platforms. This explains why it is imperative that high performing C6-AFFF-LFs (Low Freeze protected to -18ºC) approved under UL162[12,22] are allowed to remain available for all offshore applications for at least 10 years with review, as a crucial step towards a successful F3 regulatory transition in the UK. This enables avoidance of compromised life safety and inferior critical infrastructure protections for this very challenging sector, because of added congestion, constraints, complexities, challenges and criticality of tight time restrictions on foam's fire control effectiveness. This matches or even goes beyond those challenging but realistic fire scenarios already recognised by SEAC at Seveso III (COMAH) sites[13].

This is particularly due to the confined and congested spaces, seawater use, high winds requiring non-aspirated applications, low operating temperatures, proximity of fuels and helicopters to workstations and accommodation areas, all factors demanding rapid extinction and reduced risk of spreading any fire that may develop. This critically requires current fast, flexible, effective and reliable action from the existing firefighting foam systems under wide-ranging, often extreme incident and temperature conditions to gain rapid control and extinguishment. This is particularly relevant because accommodation areas and helidecks are usually adjacent to high risk oil/gas exploration and oil/gas production areas on these tightly congested platforms and installations.

Disproportionate F3 transition costs for platforms facing de-commissioning by 2030 (4.8billion Euros have been allocated by EC for offshore installation decommissioning in EU before 2030[27]) should also be avoided, particularly when this seems neither economically viable nor socially responsible ,if existing fire and life safety protections are likely to be compromised and downgraded by such an F3 transition, as the current evidence suggests.

Continued use of C6-AFFF-LF for UK offshore installations for at least a 10-year transition period (with review) is critical to saving lives. It also allows foam manufacturers more time to develop improvements in F3 capability, potentially uncovering important new ingredients that could address these currently unachievable fire performance targets for F3s of the future.

As a result of the evidence provided above, ie. use of more varied and volatile fuels (than common test fuel heptane), unavoidable use of seawater, necessity of forceful and non-aspirated applications to combat wind, preventing more gentle application of higher aspirated foam expansion systems from being effective in offshore firefighting systems, plus imminent decommissioning of many offshore installations, so the number will be much smaller in 10 years. **This combined evidence confirms that Offshore installations require to be provided the same 10 yr transition period (with review) as Seveso III (COMAH) sites (possibly longer) since major incidents could more easily become catastrophic with serious loss of life because F3s are not shown equally effective under commonly challenging, realistic and credible major fire events offshore.**

**References:**

1. Fire Industry Association (FIA) UK, 2018 – Factfile 87 – Fire, the Environment and Foams (under revision) https://www.fia.uk.com/uploads/assets/uploaded/5f0028b0-1f7c-4c34-85dd734bbf186a05.pdf
2. Fire Protection Association Australia's Information Bulletin "Selection and Use of Firefighting Foams" – IB-06 v4, Sep.2023 https://fsequip.au/filesx/standards/fpaa_selection_and_use_of_foams.v4.pdf
3. AICIS, 2015 – Inventory Multi-tiered Assessment and Prioritisation (IMAP) Environmental Tier II Assessment for Short Chain PerfluoroCarboxylic Acids and their direct precursors, https://www.industrialchemicals.gov.au/sites/default/files/Short-chain%20perfluorocarboxylic%20acids%20and%20their%20direct%20precursors_%20Environment%20tier%20II%20assessment.pdf
4. AICIS, 2016 - Inventory Multi-tiered Assessment and Prioritisation (IMAP) Human health Tier II Assessment for short-chain Perfluorocarboxylic Acids and their direct precursors https://www.industrialchemicals.gov.au/sites/default/files/Short%20chain%20perfluorocarboxylic%20acids%20and%20their%20direct%20precursors_Human%20health%20tier%20II%20assessment.pdf
5. Russell, Nilsson, Buck, 2013 – Elimination Kinetics of PerFlouroHexanoic Acid in Humans and comparison with mouse, rat and monkey, Chemosphere 2013 Nov;93(10):2419-25, PMID: **24050716** http://www.biomedsearch.com/nih/Elimination-kinetics-perfluorohexanoic-acid-in/24050716.html
6. Olsen G et al, 2007 - Evaluation of the Half-life (T1/2) of Elimination of Perfluorooctanesulfonate (PFOS), Perfluorohexanesulfonate (PFHxS) and Perfluorooctanoate (PFOA) from Human Serum, 2007. http://www.chem.utoronto.ca/symposium/fluoros/pdfs/TOX017Olsen.pdf
7. 3M (Santoro), 2008 – Brief History of PFC production, products and Environmental Presence http://www.astswmo.org/Files/Meetings/2008/2008-Mid-Year_Meeting/Santoro.pdf
8. US EPA, 2016 – PFOA Stewardship Program final report of 2015 goals met, https://www.epa.gov/sites/production/files/2017-02/documents/2016_pfoa_stewardship_summary_table_0.pdf
9. US Center for Disease Control and Prevention (CDC), Feb.2021 – Early release: Per- and PolyFluorAlkyl Substances (PFAS) Tables, 2011-2018 (Specifically 2017-2018 PFHxA Data set) https://www.cdc.gov/exposurereport/pfas_early_release.html
10. Gaines LGT (US EPA) 2022 – Historical and current usage of PFAS: A literature Review https://onlinelibrary.wiley.com/doi/pdf/10.1002/ajim.23362
11. European Commission (EU), 2017 - 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. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1000&from=EN
12. Underwriters Laboratories (UL) 2022 – Online UL162 Fire Protection Certification Directory (Oil Technics Ltd, searchable for other manufacturers products) https://iq.ulprospector.com/en/profile?e=40186
13. European Chemicals Agency (ECHA), 2023 – SEAC Final Opinion on Annex XV dossier PFAS restrictions in firefighting foams., 7 June 2023 https://echa.europa.eu/documents/10162/897b2ca5-e15b-e6c5-a2ef-c7af4f1110a1
14. European Chemicals Agency (ECHA), 2023 – **Information Note** : SEAC Draft Opinion on Annex XV dossier proposing restrictions on PFAS in firefighting foams https://echa.europa.eu/documents/10162/edd33af5-3469-435e-c93f-e78313eddf1c
15. NFPA-Research Foundation (Back et al.), May2022 - Firefighting Foams: Fire Service Roadmap (assistance when transitioning to F3) https://www.nfpa.org/News-and-Research/Data-research-and-tools/Emergency-Responders/Firefighting-Foams
16. US Military Specification MIL-PRF-32725, 2023 – Performance Specification, Fire Extinguishing Agent – Fluorine Free Foam (F3) Liquid Concentrate for Land-Based, Freshwater applications, 6Jan.2023 https://media.defense.gov/2023/Jan/12/2003144157/-1/-1/1/MILITARY-SPECIFICATION-FOR-FIRE-EXTINGUISHING-AGENT-FLUORINE-FREE-FOAM-F3-LIQUID-CONCENTRATE-FOR-LAND-BASED-FRESH-WATER-APPLICATIONS.PDF
17. US Department of Defense, 2023 – Qualified Products (QPD) Database for Mil-PRF-32725 F3 approved firefighting foams. **Use QPL number: 32725 in search window** at https://qpldocs.dla.mil/search/default.aspx **NONE QPL listed** when *viewed 26Apr.23*
18. US AFFF Military Specification MiL-PRF-24385F(SH) Amendment 4, 2020 – Fire Extinguishing Agent, Aqueous Film Forming Foam (AFFF) Liquid Concentrate, for fresh and Seawater, 7April 2020 https://quicksearch.dla.mil/Transient/D1698E19636543EABB1FB936AB3D69FB.pdf
19. US Department of Defense, 2017- Qualified Products (QPD) Database for Mil-F24385F approved firefighting foams http://qpldocs.dla.mil/search/parts.aspx?qpl=1910&param=QPL-24385&type=256

20. US Naval Research Laboratory (NRL – Hinnant, Ananth, Farley, Snow et al) – May 2020 – Extinction Performance Summary of Commercial Fluorine Free Firefighting Foams over a 28ft2 Pool Fire Detailed by MIL-PRF-24385, Report NRL/MR/6185-20-10, 031 https://apps.dtic.mil/sti/pdfs/AD1100426.pdf
21. Dahlbom S, Mallin T and Bobert M (RI.SE) Feb.2022 – Fire Test Performance of Eleven PFAS-free Class B Firefighting Foams Varying Fuels, Admixture, Water types and Foam Generation Techniques, Research Institute of Sweden https://link.springer.com/article/10.1007/s10694-022-01213-6
22. Underwriters Laboratories (UL) 2018 - UL 162 Standard for Foam Equipment and Liquid Concentrates, 8th Edition (includes updates to 10 Jun.2022) https://standardscatalog.ul.com/standards/en/standard_162
23. US FAA, Jan.2023 – Cert Alert 23-01, New Military Specification for Performance-Based Standards for Fluorine –Free Aircraft Fire Fighting Foam https://www.faa.gov/airports/airport_safety/certalerts/part_139_certalert_23_01
24. US FAA (Federal Aviation Administration), Jul. 2022 – Fluorine Free Foam Testing TC-22-23 Final Report https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/fluorine-free-foam-testing
25. US Federal Aviation Administration 2021 – Cert Alert 21-05, Part 139 Extinguishing Agent Requirements, 4 Oct.2021, https://www.faa.gov/sites/faa.gov/files/part-139-cert-alert-21-05-Extinguishing-Agent-Requirements.pdf
26. National Fire Protection Association (NFPA) of America, Research Foundation, 2020 - "Evaluation of the fire protection effectiveness of fluorine free firefighting foams", https://www.iafc.org/docs/default-source/1safehealthshs/effectivenessofflourinefreefoam.pdf
27. European Commission 2021 – Study on Decommissioning of offshore oil and gas installations: a technical, legal and political analysis **https://data.europa.eu/doi/10.2833/580313**
28. US Department of Energy Battelle Research (Chauhan S), 2020 – Assessment of Commercially Available PFAS-Free Foams, SERDP webinar #120,p40-65 https://www.serdp-estcp.org/content/search?cqp=Standard&SearchText=webinar+%23120&x=0&y=0
29. US EPA, Apr.2020 – Method 537.1: Determination of selected PFAS in Drinking Water by solid phase extraction and liquid chromatography/Tandem Mass Spectrometery (LC/MS/MS) https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=343042&Lab=NERL
30. Perimeter Solutions, 2020 – Solberg RF-3 3% Foam concentrate Data sheet – Compatibility https://www.perimeter-solutions.com/wp-content/uploads/2021/04/PERI_Rehealing_RF3_3_FoamConcentrate_Datasheet_v1_A4.pdf
31. Angus Fire, Apr.2021 – Section 6.2 Safety Data Sheet Respondol ATF 3/3 v2.2 https://angusfire.co.uk/wp-content/uploads/Respondol-ATF-33-1.pdf
32. NFPA 460:2024 Standard for Aircraft Rescue and Firefighting Services at Airports https://www.nfpa.org/codes-and-standards/nfpa-460-standard-development/460
33. General Civil Aviation Authority – Air Accident Investigation Sector Final Report dated 20Jan.2020 – AAIS Case No:AIFN/0008/2016 https://www.gcaa.gov.ae/en/ePublication/admin/iradmin/Lists/Incidents%20Investigation%20Reports/Attachments/125/2016-Published%20Final%20Report%20AIFN-0008-2016-UAE521%20on%206-Feb-2020.pdf
34. Transport Safety Investigation Bureau, Singapore Report AIB/AAI/CAS.122 dated 27Feb.2017 https://reports.aviation-safety.net/2016/20160627-0_B77W_9V-SWB.pdf
35. European Chemicals Agency (ECHA), 2023 – SEAC Draft Opinion on Annex XV dossier proposing restrictions on PFAS in firefighting foams. https://echa.europa.eu/documents/10162/e81126e5-1ea1-0118-b27c-86e8df4ff7b7
36. The Guardian, 3Jan.2024 – 'Miracle' escape for passengers after horrific runway crash at Tokyo airport https://www.theguardian.com/world/2024/jan/02/japan-airlines-plane-fire-tokyo-haneda-airport?CMP=share_btn_link
37. BBC News ,3Jan.2024 – Japan jet crash: Passengers describe chaos inside flight 516 https://www.bbc.com/news/world-asia-67865132
38. Financial Times, 4Jan.2024 – Japan Airlines fire to give insights into latest manufacturing materials https://www.ft.com/content/f0903192-dc12-4c13-a04c-2136833b773b
39. Japan Today, 5Jan.2024 – Japan crash marks test of how new carbon jets cope in disaster https://japantoday.com/category/national/analysis-japan-crash-marks-test-of-how-new-carbon-jets-cope-in-a-disaster1
40. The Independent, 7Jan.2024 – Japan Airlines Crash: How the Airbus' new fireproofing helped all 379 passengers survive https://www.independent.co.uk/travel/news-and-advice/japan-airlines-crash-flight-123-airbus-a350-b2474222.html
41. FAA (Scheffey, Darwin and Hunt), 2012 – Methodologies for Calculating Firefighting Agent Quantities Needed to Combat Aircraft Crash Fires Report DOT/FAA/A11/29 http://www.tc.faa.gov/its/worldpac/techrpt/ar11-29.pdf
42. US Federal Aviation Administration (FAA), Sep.2020 – TC20/19 Aircraft Rescue and Firefighting Strategies and Tactical Considerations for New Larger Aircraft: Update https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-

Detail/ArtMID/3682/ArticleID/2843/Aircraft-Rescue-and-Firefighting-Strategies-and-Tactical-Considerations-for-New-Large-Aircraft-Update
43. US FAA, Jun.2009 – Composite Material Fire Fighting https://www.fire.tc.faa.gov/pdf/materials/June09Meeting/hode-0609-CompositeFuselageFirefightingWork.pdf
44. US Naval Safety Center, 2019 – Lesson Learned: Firefighting – Hazards of Aircraft Composite Materials 19-04, https://navalsafetycommand.navy.mil/Portals/29/Documents/LL%2019-04%20Firefighting%20-%20Hazards%20of%20Aircraft%20Composite%20Materials.pdf?ver=Qwf16DbuXwXLAO5dPQJnlQ%3D%3D
45. US Defence Systems Information Analysis Center (DSIAC), Nov.2019 – Fire risks with Fiber-Reinforced Polymer (FRP) composites https://dsiac.org/articles/fire-risks-with-fiber-reinforced-polymer-frp-composites/
46. ICAO (international Civil Aviation Organization), 2015 – Airport Service Manual Doc 9137-AN/898 Part 1, Rescue and Fire Fighting 4th Edition , relevant Chapters 8 , 10,12, https://ufuav.asn.au/wp/wp-content/uploads/2016/11/operations-manual.pdf
47. Air BP, 2022 -Jet Fuel clarification https://www.bp.com/en/global/air-bp/aviation-fuel/jet-fuel.html
48. Sigma-Aldrich 2022 - Methyl Ethyl Ketone Peroxide (MEKP) Safety Data sheet https://www.sigmaaldrich.com/AU/en/sds/aldrich/743003?sdslanguage=EN
49. European Commission (EC) Cordis Sep.2014 – Fire risks assessment and increase of passenger survivability AIRCRAFTFIRE Report ID:265612 https://cordis.europa.eu/project/id/265612/reporting
50. UK Government, Apr.2024 – Oil and Gas: Decommissioning of Offshore Installations and pipelines https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines

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