THE CATALYST

Q1 2022

JOIFF

THE INTERNATIONAL ORGANISATION FOR INDUSTRIAL EMERGENCY SERVICES MANAGEMENT

1. Adaptive Learning
   The Future of E- Learning is Here
2. NFPA Fifth U.S. Needs Assessment Report
3. PFAS Deadlines Looming

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Foam Feature includes:
LastFire approach to Fluorine Free Foams
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ABOUT JOIFF

JOIFF, the International Organisation for Industrial Emergency Services Management is a not-for-profit organisation dedicated to developing the knowledge, skills and understanding of personnel who work in and/or who are required to provide emergency response to incidents in Industry, primarily High Hazard Industry, with the aim of ensuring that risks in Industry are mitigated and managed safely.

The 4 pillars of JOIFF aiming to support its Membership in preventing and/or mitigating hazardous incidents in Industry are: Shared Learning – improving risk awareness amongst JOIFF Members; Accredited Training – enhancing operational preparedness in emergency response and crisis management; Technical Advisory Group – raising the quality of safety standards in the working environment of High Hazard Industry and Professional Affiliation - networking and access to professionals who have similar challenges in their work through Conferences and other events and the prestige of being a member of a globally recognised organisation of emergency response.

Full Members of JOIFF are organisations which are high hazard industries and/or have nominated personnel as emergency responders/hazard management team members who provide cover to such organisations. Commercial Members of JOIFF are organisations that provide goods and services to organisations in the High Hazard Industry.

JOIFF welcomes enquiries for Membership - please contact the JOIFF Secretariat for more information.

JOIFF CLG is registered in Ireland. Registration number 362542. Address as secretariat.

JOIFF is the registered Business Name of JOIFF CLG

ABOUT THE CATALYST

The Catalyst is the Official magazine of JOIFF, The International Organisation for Industrial Emergency Services Management. The Catalyst is published Quarterly – in January, April, July & October each year. The JOIFF Catalyst magazine is distributed to all JOIFF members and member organistions worldwide. The Catalyst magazine is published by ENM Media on Behalf of JOIFF.

Publisher & Advertising Sales:
Paul Budgen
Tel: + 44 (0) 203 286 2289
Email: pbudgen@edicogroup.net

Editorial Coordinator:
Lora Lammiman
+ 44 (0) 1305 831771
Email: lora.lammiman@edicogroup.net

Annual Non – Member
Subscription Rates:
UK & Europe £60:00
Rest of World: £ 90:00

MESSAGE FROM THE CHAIRMAN

Dear JOIFF Members and Catalyst friends,

We started with "Covid 19" and managed to outlive "Covid 20" and this past year "Covid 21" (and now Omicron 22?), still there is no end to the challenge to get control over this virus that has changed the world for ever.

In all of this, we, as the emergency response fraternity, are still looked upon by all of mankind to be prepared to handle every emergency incident that occurs – Omicron does not limit the number and severity of emergencies, so let us remain ready, prepared and competent to do what we do best, to the benefit of mankind!

May I take this opportunity, on behalf of the Board of Directors, to wish all our JOIFF members and friends strength and endurance during 2022 to rebuild, to invent, to re-organise and to overcome all the challenges facing you.

When I look back at 2021, I am proud to report that JOIFF went from strength to strength with the number of webinars as well as the first ever virtual conference and exhibition to add to the knowledge base and preparedness of all industrial fire services.

The JOIFF Board in co-operation with ENM, Paul Budgen, are continuously working to keep shared learning alive and 2022 will be the same all over again, but with current and beneficial events to serve you, our members.

During the previous year the JOIFF Board was extended with the appointment of two additional Directors namely Kevin Deveson and Mohanned Awad and I would like to take this opportunity to thank both for their contribution to the success of JOIFF holistically.

I would also like to thank our Board Members, Alec Feldman (CEO and Administration), Gerry Johnston (Training) and Paul Frankland (Finance) for the continuous contribution to JOIFF's success.

Paul Budgen, our Commercial and Marketing partner and ENM as a whole, must also be thanked for "making things happen" efficiently and effectively – there is no challenge too big for Paul and his team and the Board of Directors appreciate his inputs and directives with great admiration.

Finally, to all our JOIFF members, this organisation belongs to you and without your membership, will seize to exist, as the future of JOIFF depends on your continual membership and also your assistance to help expand the membership of JOIFF.

I trust that we can rely on all our members to assist the Board to grow the organisation, to the benefit of all our members, as well as the Industrial Fire Service fraternity.

May 2022 be full of happiness, blessings and may every response to an adverse incident be successful.

I salute all the members of the Industrial Fire Services for your dedication and willingness to be there for others when the need arises!

Regards,

Pine Pienaar FIFireE; FJOIFF; FSAESI
Director: JOIFF
Email: pine.pienaar2@outlook.com

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JOIFF NEWS

JOIFF Guidelines

JOIFF's Shared Learning activities provide information aimed at improving the knowledge of JOIFF Members in emergency services management and to assist its members to work to current levels of Good Industry Practice and to ensure that emergency responders are well informed, competent and correctly equipped to deal with potential accidents/incidents to which they may be required to respond within their Area Emergency Response Plan.

JOIFF Guidelines are an important part of increasing JOIFF's Shared Learning knowledge base in line with new developments requiring different approaches to emergency response and they are developed by JOIFF Working Groups of Subject Matter Experts from JOIFF Member Organisations Worldwide.

The following JOIFF Guidelines have been completed:

JOIFF Guideline on USE and MAINTENANCE of FIRE EXTINGUISHERS containing FOAM.
Published in November 2006.

JOIFF Handbook on PERSONAL PROTECTIVE EQUIPMENT (PPE) to protect against Heat and Flame.
Published in January 2007.
Also available in the Croatian and French languages.

JOIFF Guideline on Confined Space Entry.
Published in July 2011.

JOIFF Guideline on inerting vertical storage tanks.
Published in August 2015

JOIFF Guideline on Foam Concentrate.
Published in October 2018.

This publication replaced the first JOIFF Guideline on Foam which was published in August 2010 as there had been major changes in the foam industry since its publication due to increasing regulatory requirements and changes in the manufacture and use of foam concentrate.

JOIFF Guideline on Emergency Response to incidents involving vehicles powered by Alternative Fuels (including Hybrid vehicles).
Published in November 2020.
Also available in the Croatian language.

JOIFF Guideline on Emergency Services Management of Airports.
Published in July 2021

All JOIFF Guidelines ae available for free download by JOIFF Members from the JOIFF Members Area of the JOIFF website.

JOIFF Guidelines may be made available to individuals who are not members of JOIFF by applying to the JOIFF Secretariat for a copy. Certain conditions will apply.

JOIFF

JOIFF
INDUSTRIAL EMERGENCY SERVICES MANAGEMENT CONFERENCE 2022

POSTPONED

DUE TO THE ONGOING COVID-19 RESTRICTIONS IN THE NETHERLANDS, JOIFF HAS NO OPTION THAN TO POSTPONE OUR CONFERENCE IN MARCH.

We are working closely with all stakeholders and aim to reschedule the event for October 2022.

POSTPONED

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NEWS FROM JOIFF

ACCREDITED TRAINING PROVIDERS

With the lifting of some COVID travel restrictions during Q4 2021, it was possible for more overdue JOIFF accreditation audits to be carried out.

ARC FIRE TRAINING SERVICES LTD.
United Kingdom

JOIFF accredited Arc Fire Training Services Ltd. recently successfully completed an accreditation audit and received their certificate of JOIFF accreditation.

Eric Dempsey MJOIFF, Director, Arc Fire Training Services Ltd.
with the Certificate of JOIFF Accredited Training Provider.
Director, Rebecca Harby, Quality, Learning & Development Manager and Gerry Johnson FJOIFF, JOIFF Director of Standards of Training and Competence.

H2K
Netherlands

JOIFF accredited Training Provider H2K successfully completed an accreditation audit and received their certificate of JOIFF accreditation.

Presentation of Certificate of JOIFF Accredited Training Provider following the successful audit.
From left to right: Peter De Roos, Manager Research and Development H2K, Kevin Deveson, Director of JOIFF, Gerry Johnson, Director of JOIFF, Paul van Helden, Financial Director H2K and Raph van den Elshout, Operations Manager H2K.

RelyOn Nutec
Netherlands

JOIFF accredited Training Provider RelyOn Nutec successfully completed an accreditation audit and received their certificate of JOIFF accreditation.

Presentation of Certificate of JOIFF Accredited Training Provider following the successful audit.
From left to right: Rita de Klerk, Business Support, Martijn de Ruijter HSEQ, Gerry Johnson Director of JOIFF, Gijsbert van Pinxteren Sales Manager Fire Academy, Peter Van Cauwenberghe, Managing Director Central Europe, Kevin Deveson, Director of JOIFF.

The Fire Training Group
United Kingdom

During Q4 2021, The Fire Training Group, Aberdeen, Scotland, applied for JOIFF Accreditation. They successfully completed an accreditation audit and received their first certificate of JOIFF accreditation.

Presentation of Certificate of JOIFF Accredited Training Provider following the successful audit
From left to right: Lynn Mitchell, Operations Manager, The Fire Training Group, Gerry Johnson, Director of JOIFF, Shona Gall, Administration. The Fire Training Group.

JOIFF

ROLL OF HONOUR

During October, November and September 2021, the following persons were awarded JOIFF qualifications:

JOIFF DIPLOMA

ADNOC Onshore
Abu Dhabi
United Arab Emirates

Ishmile Katehwe Dip.JOIFF
Firefighter

Khaled Salem Mohamed Al Zahmi Dip.JOIFF
Firefighter

JOIFF DIPLOMA

ADNOC Onshore
Abu Dhabi
United Arab Emirates

Fahd Al Shtairy Tech.JOIFF
Firefighter

Astron Energy
Cape Town
South Africa

Ezekiel Mmesi Tech.JOIFF
Fire Officer

ASSOCIATE MEMBER OF JOIFF

Doc. dr. sc. Aleksandar Regent AMJOIFF
Croatia

Aleksandar Regent has been the director of TPI Teh-projekt Inzenjering Ltd., Rijeka, Croatia for 29 years a company specialised in fire protection equipment and PPE manufacturing and procurement.
He has a Dr. Sc. in Environmental Engineering, Dipl. Ing. in Mechanical Engineering, was employed as a Senior Lecturer at the Department of Occupational Safety, Polytechnics of Rijeka where he was teaching courses on Personal Protective Equipment, Environmental Management, Physical Agents (protection from noise, vibration, lighting, ionising radiation, thermal environment factors) and Firefighting Equipment from 2006 till 2016.

From 1986 onwards, he was a member of the research team on 7 research and scientific projects, led by the professors of the Faculty of Engineering Rijeka He has been registered as an active scientist within the national register of scientists under the auspices of the Ministry of Science, Education and Sports and as a scientific assistant. He has published more than 100 professional and scientific papers and 3 textbooks. He has been working as a consultant and principal design engineer and project manager for 16 years, on more than a hundred projects of various water, thermal and fire protection installations in the industry, both at home and abroad.

He has been active in Croatian Standards Institute as the president of the HZN/TC21 Fire Protection and Fire Fighting Equipment for 18 years, the president of the HZN/TC556 Personal Protective Equipment, a member of the HZN/TC557 Protective clothing and a member of the HZN/TC207 – Environmental management. He has been a member of the NFPA since 1983, a member of the SZPV – Slovenian Fire Protection Assn. and of the HUZOP – Croatian Fire Protection Assn. He has more than 47 years of working experience in the industry and 10 years of teaching experience at the Polytechnic of Rijeka and Juraj Dobrila University of Pula.

In his spare time, he has been an active

mountaineer, climber and skier.

Aleksander Regent first became involved with JOIFF over 15 years ago, when he started teaching at the Polytechnics of Rijeka. He was impressed with The JOIFF Standard Handbook on Personal Protective Equipment (PPE) to protect against Heat and Flame so much that he requested permission from JOIFF to translate it. In August 2007 the largest tragedy to the Croatian firefighters happened when 12 of them lost their life in a tragical wildland fire. This tragedy arose interest for firefighter's PPE, and 3000-5000 copies of the translation of JOIFF handbook was published jointly by the Polytechnics of Rijeka and Croatian Firefighters Assn. as the editors. In 2015. He translated JOIFF Guideline on Foam 2010 and in 2021 he translated JOIFF Guideline on Emergency Response to incidents involving vehicles powered by Alternative Fuels which is due to be published by the Croatian Firefighters

In recognition of his work in translation of the JOIFF Guidelines into the Croatian language, the JOIFF Directors have awarded him the status of Associate Member of JOIFF – AMJOIFF. This makes the Guideline avaible to a large number of persons as the Croatian language is fully understood in Serbia, Bosnia & Herzegovina and Montenegro, and partially in Slovenia and Macedonia

On being advised of the award of AMJOIFF, Aleksander said "Why did I like and admire JOIFF from the beginning was because of the professionalism, deep understanding of fire protection and firefighting, genuine commitment to spreading the knowledge worldwide, participation of so many fire brigades, firefighters, experts and manufacturers from all over the world. Spreading of knowledge has always been my goal, my professional obligation if I may say so, so I found in JOIFF just the right partner. This award and recognition of JOIFF to my work will give me new impulse to continue my work in future for the benefit of the firefighters in Croatia and in the neighbouring countries."

The Catalyst and the Directors of JOIFF extend congratulations to all those mentioned above.

In light of the COVID-19 pandemic practical training sessions have been limited by travel bans, distancing requirements and other government restrictions, limiting the practical experience firefighters have been able to gather. For that very reason, training providers incl. RelyOn Nutec have invested in alternative methods to ensure that critical competences are kept up-to-date at all times. For years, e-learning has been a go-to tool for companies and organisations that need an efficient way to educate or update competences for their workforce. However, traditional e-learning is in itself not harvesting the true power of learning on a digital platform. It assumes that all learners have the same level of knowledge and understanding and therefore the learner must follow the whole course to be successful, going through tedious time-consuming assessments.

Adaptive learning is a technology-enabled approach to learning. It combines theories of optimal learning with the capabilities of algorithms and computing power. The study material simply adapts to the learner, ensuring that time is spent on the subjects that need the most attention. This significantly boosts the efficiency of the learning process as well as learners' motivation. In essence someone who already has knowledge on the subject will go through the training much quicker compared to a conventional e-learning format. Conversely a learner who has very little knowledge will be taken on a different and longer path to gain competence on that subject. This process ensures that every learner will achieve 100% proficiency on the topic at the end of the course while at the same time, the process reveals blind spots, perhaps unknown for the learner, that can be addressed either on the job or in connection with practical training.

HOW DOES THIS WORK?

RelyOn Nutec has entered into a partnership with Area9 Lyceum to bring adaptive learning technology to the energy sector. Area9 Lyceum's platform RhapsodeTM is considered the most advanced learning platform in the world. Its transformative, personalised, high-impact learning experience is built on 25 years of research and has proven its value particularly across the healthcare and workforce education sectors. It relies on well-established concepts in educational psychology and cognitive science – augmented by usage and data points from real learners using the platform. The aim is to cut training time, increase knowledge, confidence and skills acquisition, and boost learning retention increasing workforce competence with an overall ambition to facilitate further reduction of serious incidents and reduce risk of errors across the energy sector protecting people, assets and the environment.

The platform uses specifically designed probing questions to test the learner's prior knowledge. The way the learner answers the questions determines how the adaptive engine adjusts in real time to take the learner on the most efficient path to ensure mastery of the subject material. This generates a one on one personal experience for the learner, giving a positive, engaging and balanced interaction that is neither too easy or too difficult for the learner, as well as instant feedback.

For example, learners may be asked what is required to create a fire. You can choose up front that you are a novice and new to the subject, an expert with a good knowledge or somewhere in between. The "Fire Triangle" is a basic level of knowledge or for a more expert view point the "Fire Tetrahedron" is more relevant. The system tracks your answers. Once you have selected your answer, you must confirm the answer by indicating your confidence level on your answer such as I "know", "I think I know", "I am unsure" or "I have no idea". The learner can at any time select a full interactive explanation of the lesson material before attempting to answer the question.

The system makes the learner self-aware, creating consciousness of what they do not know rather than being unconscious

ADAPTIVE LEARNING

THE FUTURE OF E-LEARNING IS HERE

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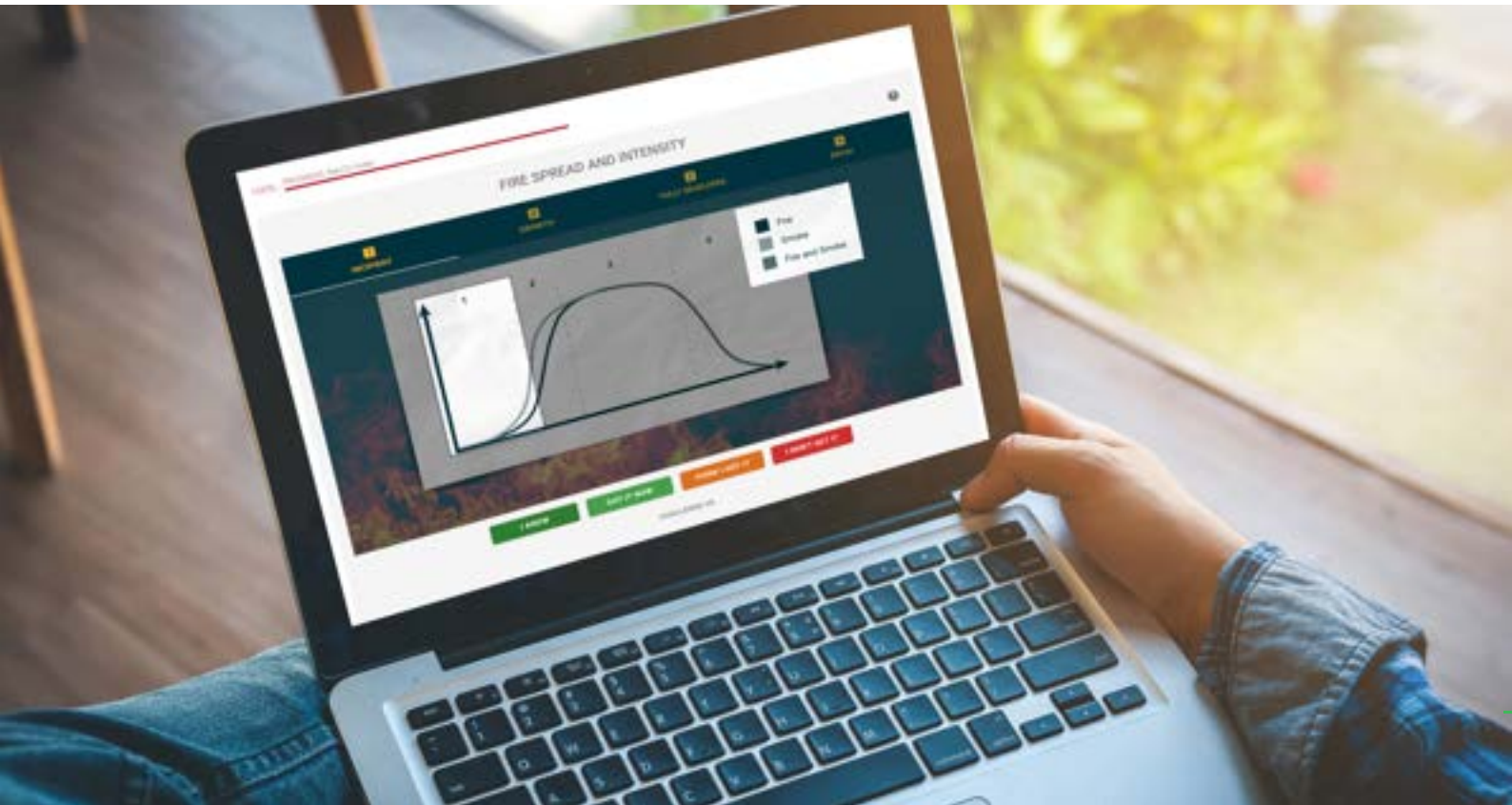

IF IT AINT BROKE, WHY FIX IT?

In this article, we would like to introduce some curated tips from our 20+ years' experience in the Emergency Response Solutions industry. These tips are based on our experience providing consultation and custom designed/built solutions to companies in all varieties of industry that employ any level of emergency response. Below we're going to share some top nuggets of info we've gathered throughout our years, and in the following Catalyst editions we will be diving deeper into specific topics and key tips, so stay tuned!

WHY REVIEW YOUR EMERGENCY RESPONSE SYSTEMS?

Fire response teams and procedures can vary widely, but all share the necessity to function reliably. Due to the importance of this job, it's understandable why there can be hesitancy to make changes to fire response communications and mobilisation systems. And when change is on the table, the processes involved with re-evaluation, stakeholder buy-in, budget justification, planning, and then implementing and testing the system can be daunting and overwhelming. Additionally, if technology isn't your department, then the glossy brochures can hide a layer of complexity that only adds confusion.

Process complacency and an adverse approach to modernisation can however be more damaging to industry in the long run, sometimes catastrophically so. We've found that on average 15% of companies that reach out to us for advice do so after an incident or major event, usually having discovered that their existing process either didn't work as intended or had stopped doing so. Inappropriate and out-dated equipment, stale procedures and systems that no longer fit a site which has evolved since the procedure was first introduced are the top offenders in cases like these. In addition, we've found that about 50% of companies we re-visited after 5 years since original consultation reported serious near-misses and/or events in cases where no action was taken since.

SO HOW OFTEN SHOULD YOU REVIEW YOUR SITE'S FIRE RESPONSE PROCEDURE?

Depending on your site's hazard profile or response complexity, we would recommend a full review every 5 years as well as carrying out an event review after every 'shout'. This doesn't mean you have to change out your whole response procedure, but rather look at the overall scenario flow during, and after an event. Consider response times, the clarity of information, incident location, severity and preparedness. An example of a common event that is brought to us would be a shout to a small kitchen fire on a site with more than one kitchen where crews later confess, they went to the wrong kitchen first, often passing the correct location on the way! If misdirection is an issue your site has experienced, there are solutions to guarantee that the correct information is sent to team members within seconds of an alarm call.

WHAT SHOULD YOU FOCUS ON WHEN REVIEWING YOUR RESPONSE PROCEDURE?

Communication Channels

"Sirens or Messages?" We think both, if possible, but if using SMS or pagers all members must receive the message and the content should be concise. Generic alerts like "Fire Call, Please Respond" don't prepare a Responder for the tasks ahead, whereas an alert similar to "SD (Smoke Detector) Utilities Building, Room 123, Please Respond" will focus the crew's attention on type and location.

Turn-out

While traditionally the Emergency Response crew start by making their way to the fire station or ERT room, recently with the introduction of smarter communications procedures, the closest members of the team can investigate on route and report their findings without putting themselves at risk.

Sites with double-knock fire alert systems strive to locate and identify the source within minutes and in the hopes of avoiding an expensive partial or full site evacuation. Fire Marshals can aid with the investigation and reporting phase

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while also assisting their colleagues to safety. Using this method, it is very possible to have eyes on the target incident within 10 to 20 seconds of the alarm trigger thus calling it into the incident controller at the earliest possible time. When reviewing your own process, consider if there are ways to improve information flow to better utilise your team's time and resources. If costly false-alarm evacuations are a problem for your site, the double-knock system might be a welcome change.

Time to Scene

If time to scene is excessively long or sporadic, track the time taken from the initial alarm to arriving at the scene, look at each phase to determine where the delays are happening. The recording of Response Time metrics can be included in your alert system and are extremely effective in identifying and tracking challenges.

Mobile Communications

The sharing of critical Information is key, and it should be secure, robust and 100% site-wide. Reliance on mobile phones or IP based devices is not wise as these systems rely on complicated infrastructure that can often be located off-site or out of your control. Consider worst case events, will you have power, phone, IT, cellular connectivity?

We've found that a guaranteed site wide team voice and messaging platform is essential. In a power outage for example, a simple digital radio and paging system with 2 or more days backup-power for example should be a basic requirement for preparing for when all else has failed.

KEY TIP! First-hand Feedback – Seek to see the wood from the trees

Feedback is key, and it is often hard to source authentic feedback in official environments like the likes of Root Cause Analyses and Strategy meetings. If you get a chance to debrief with your teams informally, effective ways to source valuable feedback could be to seek their (ideally painfully) honest opinions on the following:

- Clarity of incident information
- Time taken to turn-out and get to the scene and what (if any) delayed this, for example, was the distance to travel excessive?
- How prepared did they feel, and why?
- Was there any confusing, misleading or incorrect information shared?
- How confident are they in Command and Control effectiveness, Incident Management and the reliability of their communications channels?
- Their improvement suggestions

Have in place a grading system for responses to track progress and changes, and always make sure to smother the team with praise when improvements gain results!

IN SUMMARY

The quicker the team get to scene and the clearer the information means a faster resolution. Begin by focusing on response times and try to shave off seconds by tweaking systems and procedures. In the next article, we will delve deeper into how to get your process to work smarter, not harder. We'll be looking into process automation (is it always necessary, and if so, when and how), process breakdowns (how to identify and improve them) and more.

A LITTLE ABOUT US:

At Sigteq have a laser focus on the strategic communication of key information at critical times and have worked with a huge variety of industries including Oil & Gas, Tunnels & ports, Hospitals, Universities, Production, manufacturing, High Hazard Environments, the Military and more. We are passionate about what we do, and we really view ourselves as 'nerds' for technology and innovation. We're really looking forward to sharing more of these key tips with you in the next edition, but if you want to learn a little more about us in the meantime feel free to drop us a message or check us out online!

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NATIONAL FIRE PROTECTION ASSOCIATION

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NFPA releases its Fifth U.S. Needs Assessment report, showing both progress and continued gaps in U.S. fire departments' needs and resources.

Published every five years since 2001, the National Fire Protection Association (NFPA), USA, publishes the U.S. Needs Assessment report which reflects the results of a survey sent to most U.S. fire departments. The goal of the NFPA Fire Service Needs Assessment survey is to identify the major needs of the US fire service by comparing what departments actually have with what existing consensus standards, government regulations, and other nationally recognized guidance documents state they need to have to be safe and effective. The survey includes a broad range of questions that work to identify where U.S. fire departments are experiencing gaps in equipment, staffing, and training, among other needs and resources.

The survey period for the Fifth U.S. Fire Service Needs Assessment was between September 2020 and February 2021 and the report was published in November 2021. The report underscores that the roles and responsibilities of fire departments continue to expand with no sign of stopping. From wildland urban interface (WUI) fires and active shooter incidents to hazardous materials response and traffic control duties, fire departments are being asked to do more and more, but in many cases, without the resources to support those expectations. The expansion of fire department roles and responsibilities shows no sign of stopping despite the ongoing need to address the most basic of resources. Staffing levels across job roles and functions have remained flat and weekday staffing among volunteer fire departments remains a challenge.

"Firefighters are engaged in an ever-expanding scope of activities and are responding to new emergencies on a continual basis," said Ben Evarts, data collection and research manager at NFPA. "The first responder role that firefighters played on the frontlines of the COVID-19 pandemic reflects just one recent example of the myriad ways fire departments are relied upon to protect and serve their communities."

Evarts points out that while some fire department needs are being addressed, challenges remain across the board. Following are some of the key findings from the November 2021 report:

- The COVID-19 pandemic made personal protective equipment (PPE) a part of the global lexicon, but it also uncovered challenges: lack of availability, price scalping, and counterfeit PPE. These issues have put the health of firefighters at risk as communities struggle through a supply chain under immense pressure. Nearly half (47 %) of all departments still had unmet needs for medical PPE at the time they completed the survey.
- Staffing remains a constant need for all fire departments, regardless of career, combination, or volunteer status. Since 2015, most fire departments have seen flat firefighter staffing levels.
- Maintaining fire department infrastructure has proven a daunting task for many departments and is compounded by the need for modern facilities that meet today's fire service missions. Examples of infrastructure challenges include design considerations that minimize exposures for firefighters, private or separate facilities for men and women, and backup power systems.
- Protecting firefighters' own health and safety remains a pressing challenge, with the majority of fire departments (72 %) lacking programs to maintain basic firefighter fitness and health. Nearly three-quarters (73 %) of all fire departments do not have behavioural health programs. Of those that do, 90 % offer post-traumatic stress support; and just one third (34%) have relationships with behavioural specialists.

Fire service needs are extensive across the board, and in nearly every area of need, the smaller the community protected, the greater the need. While some needs have been met in the years between the previous survey and this survey, many have been constant or have increased. Today, many fire departments are unable to fully staff engines, fully train their members for structural and wildland firefighting, or provide all their firefighters with personal protective clothing (PPC) and updated self-contained breathing apparatus (SCBA). Overall, nearly two-thirds (64 percent) of departments have firefighters wearing PPC that is 10 years old or older. Un-met need for PPE can be found in departments serving communities of all sizes, including one-third of the large departments (protecting a population of half a million or more). Among the smallest departments, 75 percent have at least some PPC that is 10 years of age or older. More than half (53%) of all fire departments cannot equip everyone with SCBA. Departments protecting under 9,999 people have the highest rates of unmet need for SCBA equipment. In addition to lacking SCBA, much of the SCBA in use is 10 years of age or older. More than half of the departments use at least some SCBA equipment that is 10 years of age or older.

Across every response type covered in the survey, from structural firefighting to active shooter situations, there are fire department personnel responsible for responding to incidents for which they have not been formally trained or certified.

The survey also uncovered maintenance needs for aging fire department infrastructure, such as facilities and apparatus. Positive trends in the availability and use of personal protective clothing and equipment have been tempered by ongoing challenges with older equipment, unmet needs, and maintenance challenges.

Community risk reduction also remains a challenge. The majority of departments perform many fire prevention activities, but there is unmet need across nearly every aspect of these programs. Assessing need through community risk assessments and by measuring impact remains critical.

The 5th Needs Assessment report can be accessed online at www.nfpa.org/needsassessment.

EMERGENCY RESPONSE AND BUSINESS CONTINUITY

13TH SEPTEMBER 2021.

It was reported in the National Press that one of the largest International Airports in the United Kingdom was temporarily closed down due to a medical emergency. This resulted in airplanes being temporarily prevented from landing at the airport resulting in several aircraft in a holding pattern close to the airport and two flights due to land being diverted to airports elsewhere in the UK. The temporary closure had long term impacts on the airport with long queues in both departures and arrivals the following day.

The Press reported that the closure of the airport was because the Airport Fire Service were called to deal with a medical emergency inside one of the Airport Terminals and airport firefighters who have medical training were dispatched to attend to a man in his 60s who had fallen ill. As a result, airport management decided to close the airfield on "safety grounds" whilst the Ambulance Service were enroute. When the ambulance service arrived, treatment was provided, the patient was transported to hospital and the closure, which began at 9:05pm, was lifted at 9:45pm and planes were then allowed to land as normal and flights started to operate again as scheduled.

Airport management thanked customers for their patience but no mention was made of the cost to the airport, airlines and passengers of this 40 minutes of closure of the airport and the subsequent delays that spread into the following day.

20TH JULY 2020

JOIFF published and circulated the "JOIFF Guideline on Emergency Services Management of Airports". This Guideline proposes that it is essential that equal emphasis is put on aircraft and non-aircraft incidents/accidents in airports and training and resources should be made available to cover such incidents/accidents. It suggests that Airport Management should be aware that pre-planning an ethos of "Business Continuity" for the Airport which is made part of the culture of an airport, can result in minimum downtime and loss of business revenue.

It points out that legal requirements and Good Industry Practice requires airports to identify all the hazards and assess all the risks in and to their organisation, to develop plans and procedures to deal with emergencies by their own services and the need to provide the resources and training to allow incidents/accidents to be effectively and decisively dealt with.

BUSINESS CONTINUITY

There is a correlation between the emergency preparedness activities carried out by an organisation and the processes and practices required to formulate and maintain an effective Business Continuity Plan. Business Continuity Management is a holistic management process that identifies potential impacts that threaten an organisation and provides a framework for building resilience and the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value creating activities.

2018 AND 2020 APRIL

In the Q2 April 2018 edition of the JOIFF quarterly eMagazine The Catalyst, JOIFF reported that in 2003, the Chief Fire Officer of Dublin Airport, Ireland, spearheaded an airport defibrillator programme starting with just four defibrillators. Dublin Airport Fire & Rescue Service is responsible for all fire and rescue duties at the airport including dealing with medical emergencies and they have fully trained paramedics as part of the fire crew. They also provide an emergency ambulance service for the airport.

In the Q2 April 2020 edition of The Catalyst JOIFF published a report from Dublin Airport Fire & Rescue Service identifying that Dublin Airport's defibrillator CPR programme has saved 32 lives since it was first introduced in 2003.

20TH OCTOBER 2021

In an unrelated incident, it was reported in the Press of 20th October 2021 that a defibrillator was effectively used to treat a patient in a United Kingdom Premier Soccer League where Newcastle United were playing Tottenham Hotspur at St James' Park Newcastle. During the match, a Tottenham player alerted the match referee when he saw a man in difficulty in the crowd, and another Tottenham player ran to the touchline and urged medical staff to attend with a defibrillator. The referee halted the game, both sets of players walked to the side-lines as emergency crews attended the person in the East Stand and the referee suspended play and took the players off the field.

The doctor of the team's medical staff helped save the Newcastle fan in cardiac arrest and stabilised the person by using a defibrillator. The fan who required medical assistance was reported stable and responsive in hospital.

Some 12 minutes after the game had stopped, the teams returned to complete the first half.

The 2 Tottenham Hotspurs players were named joint men of the match for their part in quickly alerting the match official and medical staff to the severity of the incident.

The doctor, who took control of the compressions and carried on CPR while the St John's Ambulance crew set up the defibrillator, said that the importance of early CPR and early defibrillation is what saved this man's life.

The cost to the 2 football clubs and their tens of thousands of fans of the 12 minutes' stoppage of play to deal with this incident, was minimal.

CONCLUSION:

The above reported incidents highlight the absolute necessity of having a robust and comprehensive system of Business Continuity Planning based on risk management processes and procedures that aim to prevent interruptions to critical services and when interruption occurs, to be able to re-establish full function to the organisation as quickly and smoothly as possible. This system must be dynamic and revised as changing conditions dictate.

The reported incidents also highlight the importance of readily availability of defibrillators in all areas where people gather and in training persons in the effective use of defibrillators and in ensuring that refresher training is provided.

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EMERGENCY RESPONSE

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4 April, 27 June, 5 September and 21 November '22

Hazardous materials first responder
23 May '22

Hazardous materials instructor
12 September '22

Hazardous materials adviser revalidation
7 November '22

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INDUSTRIAL DISASTERS CAN THEY BE PREVENTED?

The primary aim of JOIFF since it was established, continues to be Shared Learning. An important aspect of JOIFF's Shared Learning policy is to ensure that in learning about incidents that have taken place, JOIFF Members can benefit from the misfortunes of some to educate against the same mistakes being repeated by themselves i.e. if such Shared Learning is acted upon, this could prevent many future incidents/accidents and subsequent losses.

Two of the World's worst Industrial disasters took place in the last quarter of the year.

10TH OCTOBER 1957 THE WINDSCALE FIRE, UNITED KINGDOM

Windscale, now known as Sellafield, is located in Cumbria, on the northwest coast of England and is the first nuclear reactor in the United Kingdom. The Windscale reactor was built to produce plutonium for the first UK atomic bomb. This process was achieved by bringing pieces of uranium together in a core to make a chain reaction which converts some of the uranium into plutonium. The chain reaction makes the uranium ferociously hot and left unchecked the reaction can go out of control.
The fire that took place in Windscale in October 1957, is the worst nuclear accident in the UK's history. It is ranked in severity at level 5 out of a possible 7 on the International Nuclear Event Scale, and is considered as one of the worst nuclear accident in the world.

10th October 1957 was a Thursday. On Monday of that week, it was suspected that something unusual was happening in the reactor as the temperature in the core was supposed to gradually fall as stored energy was being released, but one thermocouple in the monitoring equipment indicated that the core temperature was instead, rising. Efforts to cool the temperature in the core took place on Tuesday and Wednesday but the temperature continued to rise. On Wednesday, radiation levels coming out of the massive chimney of the ventilation system were checked and found to be high, high enough for the engineers to assume that a uranium cartridge had burst. This was not a fatal problem and had happened in the past, however, unknown to the operators, the cartridge had not just burst, but it had caught fire, and this was the source of the abnormal heating.

In an effort to cool the core, the cooling fans were turned on and airflow was increased. Speeding up the fans increased the airflow in the channels of the core, fanning the flames of the fire, causing it to spread across hundreds of cartridges in the core. The fire was soon burning out of control and radioactivity was pouring out of the massive chimney into the atmosphere.

Operators arriving for work on Thursday morning suspected a fire when they saw smoke coming out of the chimney. Personnel in the Control Room seeing the temperature gauges continuing to rise began to realise that there was no doubt that the reactor was on fire and had been for almost 48 hours. Inspection of the core area showed that red hot fuel cartridges were glowing in the fuel channels on the discharge face and a fierce conflagration was raging from the discharge face and playing on the back of the reinforced concrete containment, concrete whose specifications required that it be kept below a certain temperature to prevent its collapse.

There was no emergency plan for dealing with a fire and so the operators had no idea how to deal with the incident. No warning of the spread of radiation in the atmosphere was given to the surrounding population who went about their work as normal until workers in the plant called their families and told them to go to their homes and close the doors and windows or to get out of the area.

Faced with the crisis, the Windscale operators dealing with the growing emergency suggested that they use water to tackle the fire, a risky procedure, as molten metal oxidises in contact with water, stripping oxygen from the water molecules and leaving free hydrogen, which could mix with incoming air and explode, tearing open the weakened containment. Faced with a lack of other

options, the operators decided to go ahead with this plan. Water pressure was initially too high so it was reduced and water was allowed to sink into the channels and into the fire. The initial attack had no effect on the growing fires so they ceased applying water.

As a last resort, the operators decided to remove all personnel from the fire area and shut off the air, which they did. The air was shut off and immediately the flames went out.

Water was kept flowing through the pile for a further 24 hours until it was completely cold. After the water hoses were turned off, the now contaminated water spilled out onto the forecourt.[

The fire, which burned for three days, released to atmosphere radioactive material that spread across the UK and Europe. It is estimated that the radiation leak may have caused additional cancer cases, with 100 to 240 of these being fatal.

The UK Prime Minister, Harold Macmillan, had just completed a meeting with US President General Eisenhower, where they had both signed a nuclear treaty between the UK and the USA, and just 6 days after the incident, the Prime Minister ordered a closed enquiry as he did not want the report made public. Under the Chairmanship of Sir William Penney, the enquiry found that the political demand for a megaton bomb had fuelled the fire. The Prime Minister ordered that all copies of the Penney report be recalled and the report into the fire and information about the incident to be kept largely secret. To satisfy the requirement of reporting to the public, the Prime Minister produced a White Paper with edited detail from the Penney report, inserting his own clause saying that the fire was caused by an "error of judgement" of the Windscale personnel who had dealt with the incident. This caused a very bad and unfair public reflection of the efforts of the brave personnel who managed to control and eventually extinguish the fire despite having no plan of what to do in the event of a fire in the reactor.

The reactor tank itself has remained sealed since the accident and still contains about 15 tons of uranium fuel. It was thought that the remaining fuel could still reignite if disturbed but subsequent research, conducted as part of the decommissioning process, has ruled out this possibility. The pile is not scheduled for final decommissioning until 2037.

Amongst the causes of the Windscale Fire are:

- The overall safety of the reactor had been seriously compromised
  - during construction due to political pressure to complete the building programme and
  - when the process was started, changes to increase output demanded by Government for larger quantities of plutonium to manufacture a hydrogen bomb.
- There was no emergency plan for dealing with a fire.
- No action was taken to learn from previous incidents in the plant:
  - there had been a series of radioactive discharges from the core in the years leading up to the accident;
  - only months before the fire, there was a leak of radioactive material into the environment which, like the later fire, was covered up by the British government.

References: Wikipedia.
"Windscale Britain's Biggest Nuclear Disaster" BBC Report 'YouTube https://www.youtube.com/watch?v=x_pWgRx7lno

3RD DECEMBER 1984, UNION CARBIDE PLANT, BHOPAL, INDIA

Union Carbide chose to locate their plant to produce pesticides in Bhopal, a city of 900,000 people in the state of Madhya Pradesh, India, because of its central location and its proximity to a lake and to the country's vast rail system. The plant opened in 1969 and initially produced the pesticide carbaryl, and ten years later the plant began manufacturing methyl isocyanate (MIC), a cheaper but more toxic substance used in the making of pesticides.

On the night of 2nd December 1984, water leaked into one of the MIC storage tanks. Gas began escaping from the tank around 10:30 p.m. although the main warning siren didn't go off for another two hours. A runaway reaction in a tank containing poisonous MIC caused the pressure relief system to vent large amounts to the atmosphere and on 3rd December tons of a toxic gas spewed from the factory and scorched the throats, eyes, and lives of thousands of people outside the factory walls.

The first effects were felt almost immediately in the vicinity of the plant and as the gas cloud spread into Bhopal proper, residents were awakened to a blinding, vomiting, lung-searing hell. Panic ensued and hundreds of people died in the chaotic stampede that followed.

The Bhopal disaster is one of the largest industrial disasters on record and was the world's deadliest industrial disaster. An exact death toll has never been established but estimates of its death toll range from 4,000 to 20,000 and the disaster caused the region's human and animal populations severe health problems to the present. Thousands have died since and an estimated 50,000 people became invalids or developed chronic respiratory conditions as a result of being poisoned.

In the subsequent investigations and legal proceedings, it was determined, among other things, that:

- Staffing at the plant had been cut to save money. Workers who complained about codified safety violations were reprimanded, and occasionally fired.
- No plan existed for coping with a disaster of this magnitude.
- Tank alarms that would have alerted personnel to the leak hadn't functioned for at least four years.
- Other backup systems were either not functioning or non-existent.
- The plant was equipped with a single back-up system, unlike the four-stage system typically found in American plants.
- Tank 610 held 42 tons of MIC, well above the prescribed capacity. (It is believed that 27 tons escaped in the leak.)
- Water sprays designed to dilute escaping gas were poorly installed and proved ineffective.
- Damage known to exist, such as to piping and valves, had not been repaired or replaced because the cost was considered too high. Warnings from U.S. and Indian experts about other shortcomings at the plant were similarly ignored.

The victims of the disaster, those who live on, continue dealing with various health problems including chronic respiratory problems, vision problems and an increased incidence of cancer and birth defects and an environment that remains contaminated to this day.

Could any these disasters have been prevented ? What do you think ?

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LEADING HAZMAT EVENT RETURNS FOR 13TH YEAR

Hazmat 2022

18 & 19 May 2022, Crowne Plaza, Stratford-upon-Avon, UK

The 'premier hazmat event' is back for 2022 with a packed programme to educate and inform chemical incident response professionals in the high hazard industry.

Now in its 13th year, NCEC's Hazmat 2022 is well established as the event to attend for chemical incident response professionals in the high hazard industry. The two-day conference draws upon the knowledge and experience of a broad range of hazmat professionals and industry leaders, including NCEC's emergency responders and chemical experts.

Attending Hazmat 2022 will help you keep up to date with hazardous materials response, chemical exposure monitoring, emergency planning and developments in legislation and technology. It gives you the best opportunity to deepen your understanding of these issues and, more importantly, provides you practical ways to address them through:

- Learning from hazmat professionals and industry leaders, including internationally recognised speakers.
- Learning from case study examples.
- Participating in practical workshops.
- Networking with like-minded professionals.
- Sharing best practices.

Maria Stearn, NCEC's Project Manager for Hazmat, said: "After a two-year break, we are delighted to be able to once again present the Hazmat conference. We are really looking forward to seeing everyone in person. We have an exciting and varied programme to make this a must-attend event for everyone in the hazmat industry."

CONFIRMED FOR HAZMAT 2022

- Explosives workshop

Presented by Warren Melia, Managing Director, Wildcat IS Ltd

- The police DIM upscaling programme

Presented by Tony Coombes, CSI Operations Manager, Derbyshire Constabulary CBRN Team

- Field expedient decontamination and best practice in disaster response

Presented by Jeremy R Urekew, Hazmat Specialist, Ohio Task Force 1

- Environmental protection

Presented by Andrew Barnes, Incident Management Specialist, Environment Agency

- Alternatively powered vehicles

Presented by Peter Gustafson, Hazmat Lead, London Fire Brigade

- Large scale HCl incident case study and workshop

Presented by Essex Fire & Rescue Service, Environment Agency and Ricardo Energy & Environment

ATTEND, NETWORK, EXHIBIT, LEARN

Delegates at Hazmat 2022 will receive a delegate pack, lunch, and refreshments on both days of the conference, an invitation to the conference dinner on 18 May, and accommodation at the venue hotel for that night.

The conference is also an excellent opportunity to introduce the latest products and services to the key opinion leaders, early adopters and senior decision makers within the chemical incident community and emergency services, raising your company's profile amongst key customer groups. We offer a range of exhibitor and sponsorship packages that will help you generate quality new leads and achieve maximum coverage for your products.

To purchase tickets for the event or find out more about exhibiting, visit www.hazmatevent.com.

HERE'S WHAT DELEGATES HAVE SAID IN PREVIOUS YEARS:

'The subject is high on all national risk assessments and is vital to responder and public safety. Well done to all that have found time in busy diaries to contribute and participate.'

Resilience Advisors Network

'The premier hazmat event, focusing on relevant and current topics.'

London Fire Brigade

'Excellent 2 days updating us on the latest equipment and techniques as well as a great opportunity to network and share learning.'

Hereford & Worcester Fire and Rescue Service

'Thank you for the last couple of days. I walk away motivated to improve my organisation in Hazmat.'

County Durham and Darlington Fire and Rescue Service

ABOUT NCEC

NCEC, part of Ricardo, comprises chemical risk and regulatory experts. They provide support to emergency services, governments and organisations across the globe to help reduce the local and national impact that chemical incidents have on people and the environment. The services offered by NCEC's team include hazardous material training, level 1 telephone emergency response services and Chemdata® – a multilingual, interactive chemical hazard database. For more information, please visit www.the-ncec.com

TRANSITIONING TO F3 FOAMS:
HOW TO DECONTAMINATE FIRE SUPPRESSION SYSTEMS

By Ian Ross Ph.D. PFAS Global Lead Tetra Tech

INTRODUCTION

As regulations continue to be enacted restricting use of firefighting foams containing fluorosurfactants termed per- and polyfluoroalkyl substances (PFAS) all foams containing both 'C8' and 'C6' PFAS such as aqueous film forming foam AFFF, film forming fluoroprotein foam (FFFP) and fluoroprotein foam (FP) will be become defunct in the near future [1].

There are several differing fluorine free firefighting (F3) foams that are widely available and have demonstrated comparable extinguishment performance to PFAS-containing foams. So for the vast majority of Class B fire protection systems there should be no delay to implementing the transition to F3 foams. The performance of F3 foams having been proven in multiple large scale LASTFIRE tests, with some tests demonstrated that F3 foams performed better than some C6 AFFFs [2].

The promulgation and enactment of regulations to address PFAS in North America, Europe and Australia is leading towards phase out of all firefighting foams containing fluorosurfactants. The detection of PFAS in surface waters, soils, biosolids beer, cider, milk, eggs, game and livestock provides examples of their permanence and mobility in the environment [3-6]. The presence of PFAS in drinking water above safe levels in multiple countries is causing spiralling regulatory concern. Exposure to a wide array of differing PFAS still used in firefighting foams via ingestion of food and water continues whilst an understanding of their toxicology evolves. As levels of the legacy C8 PFAS diminish in human blood, some studies reveal that replacement unknown PFAS are taking their place [7].

There are a growing number of lawsuits are being filed against polluters by communities and businesses impacted by PFAS contamination [8]. For instance, some $212M was recently paid to a PFAS-impacted community in Australia, located along a 9-mile PFAS groundwater plume, caused by use of firefighting foams, which impacted the drinking water supply to the town of Katherine [9, 10].

This article aims to describe key considerations and the questions that should be asked when planning a transition to F3 foams. Ensuring replacement F3 foams do not contain any persistent compounds is important. Some fire suppression system decontamination challenges and solutions are described as a guide to implementing a successful foam transition.

F3 FOAM ENVIRONMENTAL PROFILING

Foam suppliers make many claims about the "environmental friendliness" of replacement foams but it is important these claims are independently verified. Some foams have achieved third party certification from GreenScreen CertifiedTM which reviews all relevant environmental and human health data and provides three levels of certification: Bronze, Silver and Gold. However, most replacement foams have not been independently certified.

To assist with ensuring that all brands of F3 foams do not pose a future environmental hazard it is suggested that foam suppliers confirm that all components of the foams, irrespective of concentration, are confirmed to be readily biodegradable as per Organization for Economic Cooperation and Development (OECD) guidelines. They should also confirm that there are no carcinogenic, mutagenic and reprotoxic substances (CMR) in the F3 foam formulations to help ensure the safety of the foams for firefighters. To verify that F3 foams are fluorine free and do not contain PFAS it is recommended that tests are performed with total oxidiseable precursor (TOP) Assay and Total Organic Fluorine (TOF) by Combustion Ion Chromatography (CIC) as both methods are now commercially available.

DECONTAMINATION

A significant mass of PFAS adheres to the interior of fire suppression systems there is a need for system decontamination before transitioning to F3 foams. Rinsing a fire suppression system multiple times with water has been shown to leave a significant PFAS residue within the fire suppression system, that then dissolves into the F3 foam. For example, a double water rinse of a fire suppression system in Australia between a PFAS-foam and F3

foam resulted in 1.6 g/L PFAS subsequently being detected in the F3 foam [1]. This concentration is 6 orders of magnitude (a million times) higher than target levels being set for PFAS in F3 foams. For example a level of 1 ppb total PFAS (by TOP assay) that has been stipulated as the acceptable level in F3 foams by Queensland government [11, 12] and the US National Defence Authorisation act (NDAA) which has also stipulated a target of 1 ppb [13] total PFAS.

It's clear that without effective fire suppression system decontamination F3 foams are likely to exceed regulatory thresholds, contribute to environmental contamination, or potentially impact human health if applied in repeat training or incident extinguishment.

HOW TO MEASURE PFAS

To assess whether effective decontamination of fire suppression systems has been achieved a method to measure the concentration of PFAS that are present in firefighting foams is required. All PFAS-containing firefighting foams contain fluorosurfactants which are polyfluoroalkyl PFAS that are precursors to the regulated PFAS. Standard chemical analysis that measures a few individual PFAS such as USEPA method 537, 533 or 1633 does not detect the parent polyfluoroalkyl PFAS (precursors) that have been identified in firefighting foams. These methods may report a 'total PFAS' but this is meaningless in the context of decontamination, as the principle PFAS contained within most firefighting foams that will contaminate the fire suppression systems have not been detected.

When these polyfluoroalkyl precursors interact with soil and groundwater, they are biotransformed to create perfluorooctane sulphonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulphonate (PFHxS), perfluorohexanoic acid (PFHxA) etc. which are regulated. However, as the precursors are not detectable by conventional chemical analysis, methods are required that can detect these precursor fluorosurfactants and two technologies are currently widely available commercially (1) TOP Assay and (2) Total Organic Fluorine analysis by Combustion Ion Chromatography (TOF-CIC).

PFAS decontamination work needs to be verified using TOP assay or TOF-CIC to be able to detect and measure the fluorosurfactants present in firefighting foams and entrained on surfaces within fire suppression systems.

ASSESSING CONTAMINATED SURFACES

To assess a contaminated surface it is recommended that swab tests are applied that have been demonstrated to effectively represent the mass of PFAS on the surface of a fire suppression system. Swabs used in testing need to be assessed using TOP assay to quantify the polyfluorinated PFAS present.

ASSESSING DECONTAMINATION TECHNOLOGIES

Water is a very poor solvent to dissolve the bilayers of self-assembled PFAS (SA-PFAS) that form lattices of supramolecular assemblies and bind on surfaces, so water (and hot water) cannot effectively decontaminate PFAS from fire suppression system infrastructure. A method to remove these assemblies from the surface of fire suppression systems is required to enable successful decontamination.

Some PFAS decontamination technologies use coagulants [14] which have been described as cationic (positively charged) hydrocarbon surfactants that bind to anionic (negatively charged) PFAS and cause then to sediment. This technology is being used for water treatment but has been adapted for decontamination but evidence of it's success has not been provided as analysis of the precursor fluorosurfactants present in the firefighting foam has not been done. Data showing that effective decontamination has been achieved need to use TOP assay. Also as many of the precursor fluorosurfactants in firefighting foams are cationic, they will not bind to the coagulation agent. Therefore, it's not clear how this technology could decontaminate a surface and so far, data has not been presented using TOP assay demonstrating that it is effective.

Tetra Tech is using a specialized biodegradable cleaning agent termed PFAScrubTM to effectively remove PFAS residuals from fire suppression systems. This technology has been shown to effectively remove PFAS from surfaces.

WASTE DISPOSAL

The waste generated from decontamination requires disposal via a route that effectively destroys PFAS. Tetra Teach have developed an approach that can separate PFAS from the cleaning agent as a concentrated form, meaning the cleaning agent can be recycled and reused. This can significantly reduce waste disposal costs and provide a more cost-effective decontamination solution.

SUMMARY

Foam transition may seem complex and does require multiple fire engineering and environmental skill sets. Finding a team of consulting fire and environmental engineers together with experienced decontamination and fire engineering contractors can be essential. Cost effective and pragmatic solutions are possible when organisations are considering foam transition. Tetra Tech has done foam transition projects across 4 continents we can smoothly manage all aspects of a foam transition project, from dealing with fire regulations, insurers etc. to disposing of old foams and environmental compliance.

1.Ross, I., Now AFFF is defunct, what's the way forward?, in International Fire Fighter. 2021: https://www.researchgate.net/publication/352020572_Now_AFFF_is_defunct_what's_the_way_forward. p. 31-34.

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Evaluation of the fire protection effectiveness of fluorine free firefighting foams

FINAL REPORT BY:

Gerard G. Back
JENSEN HUGHES
Baltimore Maryland, USA

John P. Farley
NAVAL RESEARCH LABORATORY
Washington, DC, USA

January 2020

NFPA RF Report 2020

165 UL Fire tests show Fluorine-Free Foams need higher rates:

- 2 – 4 times AR-AFFF rates for IPA Fires (Gentle Application)
- 3 – 4 times AR-AFFF rates for Mil Spec Gasoline (Forceful Application)
- 6 – 7 times AR-AFFF rates for E10 Gasoline (Forceful Application)

NFPA RF Final Report

FAA Part 139 Cert Alert No 21-05 2021

Safety concerns of Fluorine-Free Foams identified:

- 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 exist today at Part 139 air carrier airports.

FAA Cert Alert

US FAA Part 139 Cert Alert No 21-05 issued October 4, 2021

"While FAA and DoD testing continues, 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."

DYNAX CORPORATION
PO Box 285, Pound Ridge, NY 10576 USA
T 914 764 0202 techinfo@dynaxcorp.com
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ENSURING THAT FIRE TESTING OF NEW GENERATION FOAMS IS RELEVANT TO REAL APPLICATIONS

By: : ERIC PAILLIER, TOTALENERGIES; NIALL RAMSDEN, LASTFIRE; BARBARA CHISHOLM, LASTFIRE

INTRODUCTION

The transition to fluorine free foams is arguably the greatest issue currently facing industrial firefighters, particularly those with large diameter storage tank hazards. It is generally recognised that this transition has to happen. It is not a case of "if", it is a case of "when". This has been made clear by regulators and policy developers globally, such as the European Commission, due to the increasing evidence of long term environmental damage and occupational health issues associated with PFAS containing foams. Based on this, major oil companies, including TotalEnergies, are closely monitoring developments and working together with other industry groups to ensure that this transition can be accomplished within a reasonable, practicable timescale without unacceptable impact on risk reduction.

Whilst there are many stakeholders involved in the transition - regulators, environmental specialists, fire engineers, test facilities, suppliers and insurers to name a few - it is ultimately experienced end-users who know what risks and hazards they face and what is required from a foam. We recognise that the new generation foams are different and may require some changes in tactics and application equipment to optimise effectiveness. The objective is to achieve this optimisation in a cost-effective and practicable way.

While there are some foam applications in industrial settings that are provided for life safety protection, many are for business and asset risk reduction. This is an important factor to take into account. The transition gives the opportunity to review overall Fire Hazard Management policies and possibly consider alternative risk reduction measures in some cases.

With that background, the most critical issues to consider in the transition process are the extinguishing performance and the vapour suppression characteristics of new generation foams.

Many oil and petrochemical companies are working together, as a group of end users with common interests, under the LASTFIRE (www.lastfire.org.uk) umbrella to develop a database of testing and other related knowledge to enable rational decisions to be made based on independently achieved, end-user driven results and knowledge. The range of testing carried out has been very extensive ,but it is always useful to have more data and TotalEnergies have supplemented the LASTFIRE work with some of their own, as is reported here.

Fire testing of new generation foams

It becomes more and more difficult and expensive to carry out large scale fire testing using "real" fuels because of environmental constraints at test facilities and, of course, there are cost considerations - as an example LASTFIRE is currently carrying out large scale testing (50m x 6m fire pit) at the GESIP, Vernon facility and the costs are in the order of €50,000 for every day of testing with only 3-4 test per day being feasible.

It is therefore critical that the results of any test, whether small or large scale, can be interpreted and extrapolated to real World situations.

Typically, small scale standard tests are used to establish patterns of behaviour and a more limited number of large scale tests is used to validate this behaviour for real World situations.

One issue that has been questioned about the validity of both small and large scale testing is that of fuel depth because often the fuel is put onto a water base. This is done, for example, in most standard hydrocarbon fuel testing protocols such as EN1568, CAP168 and LASTFIRE.

In order to develop a better understanding on how this effects foam performance and hence assist in analysis of the results in terms or real World effectiveness, TotalEnergies carried out a series of tests to establish how foam can plunge through varying depths of fuel layer when applied in different ways and then carried out fire tests under the same conditions. Although this was the specific aim of the work, other interesting observations were made, as reported here, thus adding to better knowledge of how fluorine free foam characteristics affect performance. This knowledge can now be taken through to developing better application techniques.

A purpose built Perspex tank was used to view foam plunging into the fuel using different application nozzles simulating real World application techniques on the small scale.

Figure 1. Foam from a "pourer" plunging through 50mm of Jet A fuel (coloured blue

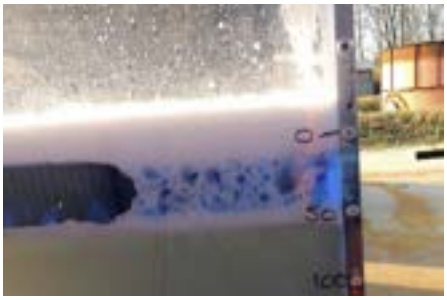

Figure 2. Side view of foam from a pourer plunging through 50mm of fuel. Note foam in the fuel.

Figure 3. Photo of foam resting on interface of fuel and water

The nozzles were calibrated to have the same flow rate (11 lpm) allowing comparison of different application types rather than application rates, although the effect of this parameter might be studied in a later series of tests. Tests were also carried out with modifications to the nozzles - in the case of the Uni 86 nozzle a gauze was added to the outlet to change the foam properties and in the case of the LASTFIRE system nozzle a device to push more foam against the tank wall was added thus giving much gentler foam application.

It is recognised that a relatively small number of tests were carried out, but they gave the opportunity to make an initial evaluation of the effect of fuel depth and also foam properties. The application rate of foam solution used was approximately 2.2 lpm/m2 in all cases. This compares with NFPA 11 application rates of 4 lpm/m2 for the pourer application and 6.5lpm/m2 for the monitor application so represents a significantly lower rate than real World rates - as should always be the case with small scale test carried out under controlled conditions. A fluorine free foam was used at its nominal rate of 3% proportioning. (The foam solution was made as a calibrated premix).

The different nozzles clearly showed differentcapplication aspects as shown in the figures below.

Figure 4. Foam from a "monitor" being plunged into 25mm fuel - note only minor penetration through fuel due to forward momentum of foam application.

Figure 5. Comparison of plunging effect with different pourer arrangements into 100mm of fuel.

Figure 6. The forceful pourer clearly showing foam blanket exposure penetration and fuel exposure, with fuel pick up causing continuing burning on the foam surface in front of the impact point.

Figure 7. Another illustration of the impact point continuing to burn with the forceful pourer

Figure 8. Foam pourer adapted to give gentler application - note impact point is extinguished

Figure 9 Uni 86 Foam nozzle with (on left) and without (on right) mesh

Figure 10. Discharge from standard (without mesh) Uni 86 monitor nozzle - note foam break up and consequent relatively gentle application

Figure 11. Discharge from Uni 86 Monitor nozzle with mesh - note "rope" of foam - and consequent heavy impact

Fire control and extinguishing times of one set of tests using Jet A fuel are shown in the table below

Fuel Depth	50 mm Jet A-1		150 mm Jet A-1	
Nozzle	Control	Extinguishment	Control	Extinguishment
LASTFIRE System	6' 50"	9' 08"	5' 50"	7' 28"
LASTFIRE System + Modification	6' 20"	7' 32"	5' 30"	7' 57"*
UNI 86	6' 10"	6' 40"	5' 20"	6' 36"
UNI 86 + mesh	5' 50"	10' 10"	5' 56"	10' 16"

Note: the UNI 86 nozzle was mounted 1,700 mm above fuel level with 275 mm freeboard to fuel surface in the Lastfire pan. A standard preburn time of 3 minutes was applied in all cases.

* This figure seems anomalous as it shows an extinguishing time greater than that for the nozzle with more forceful application but the time was extended due to a persistent remaining small flicker that appeared to be due to deposits on the test pan from a previous fire. i

KEY POINTS

• The "monitor" application of foam showed that penetration of fuel layer was very limited provided there was forward momentum. The foam appeared to almost skid over the fuel surface.

• The non fire tests with the monitor nozzles showed no significant fuel penetration of either the 50mm or 150mm depths. The fire tests with these nozzles showed no significant differences between the tests with different depths of fuel - as would be expected given that no penetration through to the water layer would occur in either case.

• The non-fire tests showed that the system nozzle, where discharge was at right angles to the fuel surface , under these flow conditions penetrated the fuel when the depth was 50mm but not when it was 150mm. The fire test results clearly show that the extinguishing time was significantly greater (9'08" compared to 7' 28") when the foam had penetrated through the fuel into the water base. Observation of the foam penetrating through the fuel in the non-fire tests clearly showed that some settled on the water surface (Figures 2 and 3) and undoubtedly some was dissolved in the water, so, in reality, the result could be expected as a lower nett application rate would occur on the fuel surface

• Although the mesh on the UNI 86 nozzle seemed to improve the foam discharge in that it made a coherent "rope" type trajectory and reduced fire control time, it resulted in increased extinguishing time - possibly because although it probably caused less fuel pick up in the bubble structure itself, the impact was more forceful and splashed fuel onto the foam blanket at the initial stages of application and made the foam less able to seal against the tank edges.

• The difference in amount of impact area splashing caused by different foam application types was very obvious as can be seen in Figures 6,8,10 and 11.

CONCLUSIONS

Whilst recognising that the number of tests carried out was relatively small, this test series has highlighted some important features of testing to make sure that it is relevant to real World situations and also assisted in identifying parameters to help optimise application of fluorine free foam.

In particular, it has been shown that having a fuel depth that is penetrated by foam application into an underlying water base can reduce extinguishing efficiency and so represent a worse case than having deeper fuel.

This validates the work that has been carried out by LASTFIRE and others where fuel has been floated on water in that it this does not give an advantage to the foam over real life situations.

In addition, the work has shown the importance of application method in optimising foam effectiveness.

TotalEnergies will continue to support the initiatives of LASTFIRE and other organisations in ensuring that the transition to fluorine free foams will be based on a firm foundation and that optimised combinations of application rate, foam concentrate and application method are identified and implemented.

Further test work involving different fuels and different application methods is planned.

DOES FLUORINE FREE MEAN NO FLUORINE??

The term "fluorine-free" is increasingly used these days in connection with firefighting foam agents.

However, the understanding of what is meant by this term stretches between "products to which no fluorine compounds have been added intentionally and with the purpose of increasing performance" all the way to "no - i.e. zero – i.e. not a single molecule of - (organically bound) fluorine".

But what can users realistically expect from a "fluorine-free" firefighting foam concentrate? Is zero Fluor organic compounds (still) possible?

INORGANIC FLUORINE CHEMICALS:

In principle, a distinction is made between so-called inor¬ganic compounds and organic compounds of the element fluorine. Inorganic fluorine compounds do occur in nature e.g. as salts (fluori¬des) or minerals (e.g. fluorite). Water-soluble fluorides are present in traces in natural waters and are essential for many life forms. Particularly mammals like us need fluorine as integrative element to build teeth and other body tissues. This is why e.g. fluorides are used for caries prophylaxis in medicines, toothpastes or are even added to drinking water in some countries.

Inorganic fluorine compounds do not belong to the group of fluorine compounds known as PFAS and are therefore not subject to the legal regulations concerning this group, hence fire¬fighting agents!

ORGANIC FLUORINE COMPOUNDS

PFAS are organic fluorine compounds characterized by fluorine atoms being exclusively bonded to carbon. In contrast to many inorganic fluorine compounds, their organic counterparts – the so called PFAS - do not occur in nature. They are extremely stable and are considered non-degradable (persistent). All fluorine compounds used in firefighting agents belong to this group.

PFAS are used in large quantities in many industries and applications and therefore are – also because of their persistence - now widespread in the environ¬ment globally. Since concerns were raised about adverse effects of various PFAS on nature or human health knowing the overall or local pollution is of big interest these days. Hence, analyzing different materials for the presence and kind of PFAS as well as their respective concentration has become important as well.

THE DETECTION LIMIT

Envision an analytical method as a magnifying glass used to look into a solution to detect the type and amount of organic fluorine compounds present in it. Like any given magnifying glass, each analytical method has only a certain "magnification capacity" and is blind to everything that is too "small" for

Fluorite, a Fluor mineral – by Rob Lavinsky, iRocks.com – CC-BY-SA-3.0, CC BY-SA 3.0; https://commons.wikimedia.org/w/index.php?curid=10155362

it. This is called the measurement- or detection limit.
The detection limit depends on the method (in our example the magnifying glass) and also depends on the test environment or background: finding a small bread crumb on a white tablecloth it is not a problem, but doing so on a lawn would be almost hopeless.
Not only does the absolute size of the particle (which in our example would correspond to the magnification capacity of the magnifying glass) influence the detection limit, but also the test environment. Analysts call this "matrix effects". The measuring limit of individual PFAS (e.g. PFOS or PFOA) in drinking- or groundwater (in our picture the white tablecloth) is very low and can be as low as 0.001µg/kg (=0.001 ppb), depending on the laboratory.
In firefighting foam agents or fire water (in our example the lawn), on the other hand, a realistic measurement limit is 1-10ppb, i.e. 1000-10000 times higher.
The measurement limit is always greater than zero which means that one cannot say whether a sample is actually completely free of fluorine compounds, but only, that it does not contain more than the value of the detection limit.

PFAS ANALYSIS

There are in general two different options to analyse for PFAS in a sample material:

Analysis of individual substances

This method, for example, is required to determine the content of individual substances such as PFOS and PFOA, or small groups of substances such as the group of C9-C14 perfluoro carboxylic acids or their precursors in firefighting agents, as accurately as possible in accordance with current legal regulations . For this purpose, reference substances are needed for any molecule which is to be to be determined in order to be able of assigning a measurement signal to a particular substance and its content in a sample without any doubt.
Currently, about 30 individual substances can be determined in this way, but with a rather high accuracy of 1-10µg/kg (=1-10ppb).

Measuring Total Organic Fluorine

If the type or identity of fluorine compounds present in a sample is unknown, or if the target is to prove a sample doesn't contain any fluorine compounds (within the boundaries of what is technically possible), one has to analyse for the total organic fluorine content.
One method for the determination of the total content of organically bound fluorine is TOPA . This method does not look for particular organic fluorine compounds but chemically converts all of them into their degradation end-products . Hence, any C6-compound is converted into the C6-perfluoro carbon acid , any C8-compound gives the corresponding C8-acid etc..
The carbon acids of organic fluorine compounds are a much smaller group of chemicals compared to the group of their precursors, hence easier to identify and quantify (e.g. by comparison of their detection signals to those of reference substances). The information which particular organic fluorine compound a certain detected carbon acid originated from gets lost in the process for the benefit of
a) not needing a pure reference substance for each and every substance that might be in a sample and
b) therefore, being able to also detect unknown organic fluorine compounds.
Care must be taken to ensure that the sum of the detection limits of all individual substances in a group must still be significantly lower than the legal threshold for this group.
In another method , organic fluorine compounds are completely converted into inorganic Fluoride by incineration of sample material at high temperatures in pure oxygen atmosphere. The resulting Fluoride is then analysed. This test is not substance specific.

SO WHAT DOES „FLUORINE-FREE" ACTUALLY MEAN?

In spite of the many suggestions from the industry, the legislator has so far not attempted to define the term "fluorine-free". However, we know from the above that "fluorine-free" cannot mean the complete absence of any fluorine compounds, because we cannot measure down to a zero level. The detection limits of any method are always greater than zero.
In the case of firefighting foam agents, premixes made up thereof or fire runoff waters, yet another problem arises from the fact that they have a matrix that is very unfavorable for trace analysis. In our breadcrumb-example, this would compare to a particularly high lawn, which pushes the detection limits to significantly higher numbers.
It is therefore technically impossible to prove that a firefighting foam concentrate actually does not contain any fluorine compounds. Hence, "fluorine-free" cannot mean zero content of fluorine organics in the sense of not a single molecule present.

„Fluorine-Free" foams in the environment

This becomes particularly precarious if - after a foam application, even though a "fluorine-free" foam extinguishing agent has been used - traces of PFAS are found in the soil, water or groundwater. Of course a possible reason could be a contaminated firefighting foam agent, but other root causes are thinkable too:
a) the detection limit for PFAS e.g. in groundwater is much lower than in the firefighting foam agent itself (hence PFAS were not found in the foam but are in the groundwater), or
b) the contamination results from other releases since fluorine compounds are not only present in firefighting foam agents, but also in an almost infinite number of products.
c) The contamination was already there as PFASs are also widespread in the environment and can even be detected in drinking water.
One could now assume that a finding below the legally anchored limiting values is no cause for concern. Unfortunately, this is not the case for two reasons:
1) There is no harmonised or legally binding Europe-wide definition of the term "fluorine-free" in connection with foam extinguishing agents available as guidance.
2) there is no legal standard in the EU harmonizing thresholds

for PFAS in soil, natural waters or groundwater.
Consequently, it is often up to local authorities to set the limits for a tolerable contami¬nation or a contamination level requiring remedia¬tion.
The detection of fluorine compounds in orders of magnitude of a few hundredths or thousandths of the legal thresholds can nevertheless result in remediation being scheduled and in disputes about associated costs.
The limiting values discussed for environmental contamination are sometimes low enough that even the background contamination now present in water, packaging materials, equipment or storage vessels can lead to reaching or even exceeding them.

„Fluorine-Free" foams in international standards

But how can "fluorine-free" be understood?
There are various approaches to defining the term "fluorine-free". The European foam standard EN1568:2018 states: "fluorine free foam concentrates (F3): these foam concentrates are dedicated to meet fire performance ratings and are targeting applications similar to AFFF and/or AR-foams without using fluoro-organic compounds. These foam concentrates are based upon mixtures of hydrocarbon surface-active agents and non-fluorine containing stabilizers. "
Like other similar definitions (e.g. UL 162), it is assumed that organo-fluorine compounds can only get into foaming agents by deliberate addition. This, however is not the case, because many other sources of low-level contamination can also be considered (e.g. water, packaging materials, equipment or storage vessels).

How to define „Fluorine-Free"

Due to the lack of official/legal definition/-s of the term "fluorine-free" and in the course of open and clear communication, manufacturers and users of firefighting foam concentrates need a clear definition of what to understand by "fluorine-free".
Considering that a) Fluorocompounds have only been used to improve the fire-performance of firefighting foams and b) considering as well that PFAS are meanwhile found almost everywhere on the planet a suitable definition for a fluorine free firefighting foam agent could be:
Fluorine-free is a firefighting foam agent if it is being manufactured without the intentional addition of fluoro-organic compounds (PFAS) for the purpose of improving its performance in such a way that, according to current commercially available analysis, they do not contain any fluoro-organic substances in excess of the regionally ubiquitous background contamination (e.g. in the drinking water used for production).

WHAT CAN USERS DO?

Users of foam extinguishing agents can currently minimise their risk by taking the following general measures:
1. thorough professional cleaning of all equipment by experienced service providers before switching to fluorine-free extinguishing agents and (ideally) replacement of all plastic parts that have been in contact with fluorine-containing extinguishing agents;
2. Do not refill systems and vehicles with "fluorine-free" foam agents unless PFAS contamination is proven to be below detection limit;
3. source F3 foam extinguishing agents only from manufacturers who can prove physical separation of production lines for "fluorine-free" foam agents from those for fluorine-containing products.
4. proof of the fluorine content in "fluorine-free" products through current testing by an accredited laboratory.
5. complete and up-to-date documentation of all cleaning measures, testing and refill for submission to the authorities.

1. PFAS = Perfluoro alkyl substances means the entirety of all chemicals consisting of or containing carbon-Fluorine bonds
2. According to ECHA (rest_pfhxa_bd_draft_19694_en.pdf) about 64% of all emissions of short chain C6-Fluoro compounds are emitted by the paper industry, 35,8% by the textile industry and 0,2% by firefighting foams.
3. This means an analytical resolution good enough to safely meet the legal limits
4. (EU) 2019/1021; (EU) 2017/1000; (EU) 2020/784; (EU)2021/ 1297; see also our Technical Information Nr. 64 „Regulation of per - and polyfluorinated substances in Europe "
5. TOPA= Total Oxidizable Precursor Assay
6. These are the perfluoro carbon acids
7. Perfluor hexanoic acid - PFHxA
8. Perfluor octanoic acid - PFOA
9. TOF = total organic fluorine: electrochemical or chromato¬gra¬phic detection of Fluorides
10. Of many cleaning recommendations circulating on the market, only a few are really suitable for reducing the residual fluorochemical build-up after cleaning to such an extent that the level of contamination of fluorine-free firefighting foam concentrates which are filled into the cleaned vessel can be reduced below the detection limit. Rinsing with water alone is not suitable for this in almost any case.

ABOUT THE AUTHOR

Dr. Thomas Leonhardt
Product Manager at
Fabrik chemischer Präparate von Dr. Richard Sthamer GmbH & CO. KG

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NINETEEN PFAS-FREE FOAMS (F3S) FAILED ICAO LEVEL C AND US MILSPEC TESTING:

PROMPTING PUBLIC SAFETY CONCERNS

By: Mike Willson BSc(Hons), MCIM of Willson Consulting

400 fire tests by US Federal Aviation Administration (FAA) using its new $5million, 2,500 square-foot (232m2) 'state-of-the-art' indoor test facility, found all 19 PFAS-free or Fluorine Free Foams (F3s) tested, were unable to pass either ICAO Level C or US MilSpec. They failed indoors, and failed when re-tested outdoors. Yet a growing list of C6AFFFs is able to meet or exceed both challenging fire tests, consistently passing.

Such F3 failures prompted publication of FAA's Cert-Alert 21-05 in October 2021 warning of public safety concerns with F3s. These safety concerns included significantly increased extinguishment times; issues with fires re-igniting; failing burnback tests; possible incompatibility with other firefighting agents such as Dry Chemical Powder, other F3s and inferior foam quality when using existing delivery equipment. It also recognized that existing firefighter strategies and rescue training could increase F3s shortcomings, requiring exhaustive overhauls and extensive re-training. Current forceful 'attack' practices ingrained in aviation firefighter responses, may no longer be effective with F3s, placing lives at increased risk. Factors reinforced during extensive large scale Naval fire testing at China Lake, California during 2021.

It raises important questions about the value, suitability and potential safety of these F3 products. Could we be increasing danger to firefighters and general public by accepting premature F3 transitions, associated huge conversion and re-training costs, thereby potentially increasing risk to lives and property?

How do we rationalise these failures with other Standards (like NFPA11:2021 and NFPA403:2018) suggesting F3 'equivalency' to C6 foams? Could there be some confusing unintentional elements to other existing fire test approvals, which is somehow distorting results? This would be a major concern when most expect fire protection's duty of care to be focused on providing increased, not reduced, fire safety.

It justifies further examination, which has relevance beyond the Aviation sector, into all aspects of fire protection, including industrial applications.

PUBLIC SAFETY CONCERNS ISSUED IN AVIATION CERT ALERT

October 2021 saw US FAA issue Cert Alert 21-05 to all US airports1, expressing public safety concerns regarding F3s, just when it was expected to be adopting F3 alternatives under the 2018 FAA Reauthorisation Act (FAA-RA) directive.

It confirmed "While FAA and DoD [Department of Defense] testing continues, 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.

While FAA and DoD continue the national testing effort, the FAA reminds all Part 139 airport operators that while fluorinated foams are no longer required, the existing performance standard for firefighting foam remains unchanged (whether that foam is fluorinated or not). Airports that are currently certificated under Part 139 will remain in compliance through use of an approved firefighting foam that satisfies the performance requirements of MIL-PRF-24385F(SH)."

This was a BIG call, particularly when the FAA-RA required finding a PFAS-based alternative by October 2021, due primarily to concerns of legacy C8 PFAS in products no longer produced. FAA has not walked away from its duty of care, always re-assuring US Aviation stakeholders that it would not compromise on public safety, nor risk jeopardising lives unnecessarily.

Current MilSpec qualified C6AFFFs are recognised highly effective combatants to jet fuel and gasoline fires, hence FAA's and US DoD's continued reliance on C6AFFFs, and understandable reluctance to relinquish such clear benefits. Importantly US Navy's fleet is not changing, declaring only the best agents in lowest quantities will be used for shipboard use. So why consider second best is OK elsewhere? How are offshore platforms 'adrift' in our oceans any different? Surely using best 'tools' should be a common goal for all DoDs, aviation and industrial foam users around the world, in every facet of operations, ensuring

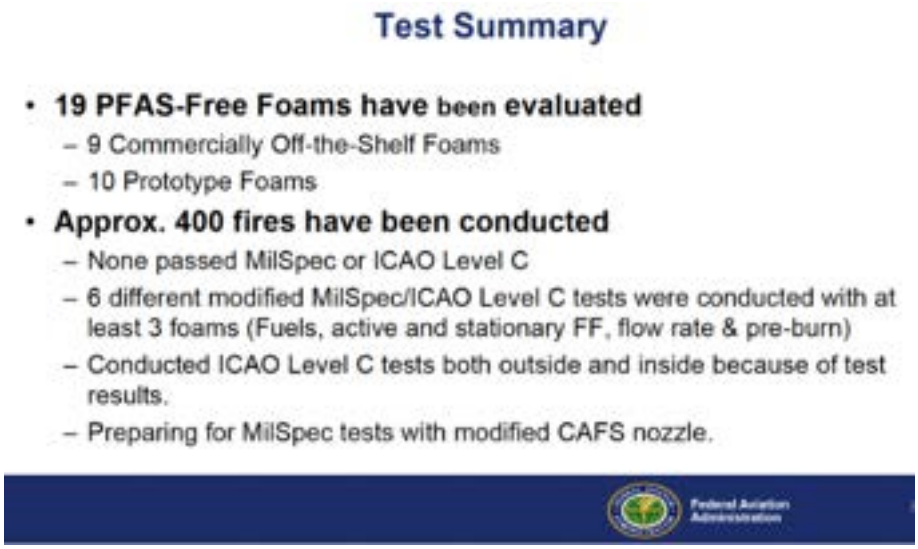


Fig.1: FAA test summary to REDAC highlights around 400 tests conducted using 19 F3s: all failing to pass both MilSpec and ICAO Level C – indoors and outdoors.

duties of care that fire protection is not compromised. ...Aren't all lives equally precious?

19 F3S AND 400 FIRE TESTS RESULTED IN FAILURE OF ALL F3S TESTED AGAINST ICAO LEVEL C AND MILSPEC

The evidence to make FAA's judgement came from around 400 extensive, rigorous fire tests carried out on 19 F3s (9 commercially available products, 10 developmental). None was able to pass either ICAO Level C or US MilSpec (current version Mil-PRF24385F[SH] Amdmt.4, 2020) at similarly low application rates, hence generating significant public safety concerns.

FAA's testing confirmed several F3s did not extinguish either test, some exceeded two minutes extinguishment on Mil-Spec (30 seconds requirement). Others exceeded three minutes against ICAO Level C's 120secs requirement (increased from 60secs in previous edition). Six of nine F3s failed burn back testing. It is assumed those F3s claiming ICAO Level C certification, were included as test leaders, but all foams failed indoors and re-testing outdoors.

What should disturb regulators, legislators and foam users alike, are these stark findings and lack of progress since 2019, in FAA's September 2021 research, presented to its Research, Engineering and Development Advisory Committee (REDAC). Despite $multi-million investments, have we hit a 'Law of diminishing returns' developing F3s? Without 'magic' new ingredient(s) to provide fuel repellency and vapour sealing, perhaps required F3 fire performance levels can never be achieved?

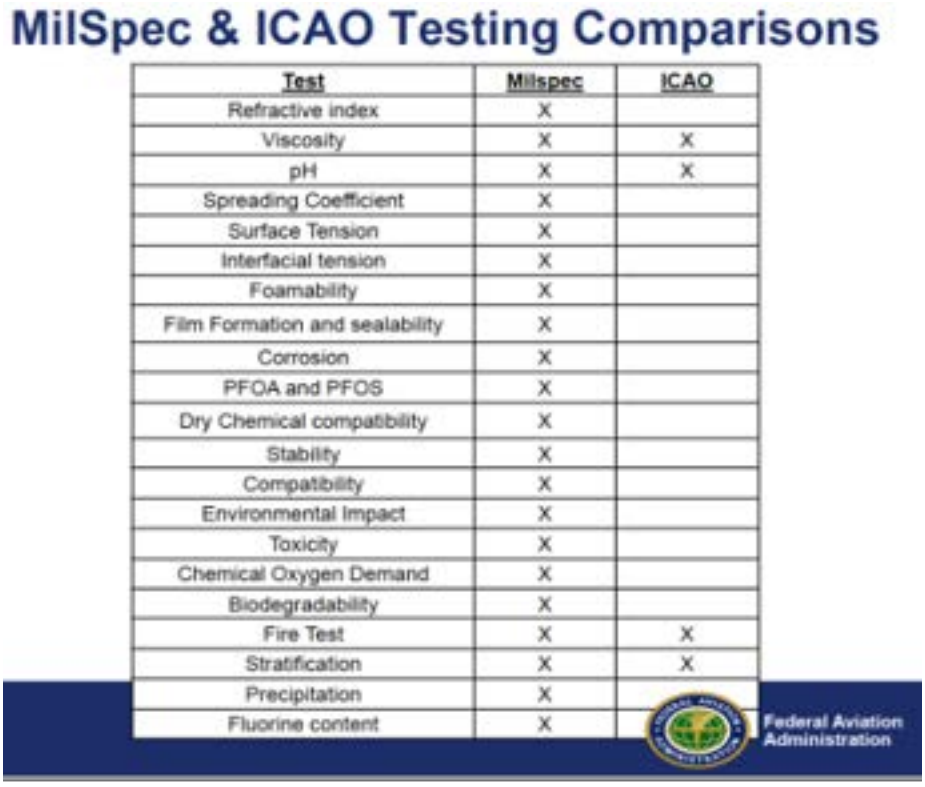
FAA's extensive, rigorous test results are not isolated. Other tests run by Naval Research Laboratory (NRL), Department of Energy's Battelle Research, National Fire Protection Association's Research Foundation (NFPA-RF), and UL (Underwriter's Laboratories) have all confirmed that leading F3s available today (including developmental products), cannot match the fire performance of more environmentally benign, high purity short-chain C6AFFFs, particularly on flammable fuels like gasoline, which has now raised significant public safety concerns around F3 suitability.

EVIDENCE SUGGESTS NO 'EQUIVALENCY' AS MAJOR DIFFERENCES BETWEEN MILSPEC AND ICAO LEVEL C TESTING

FAA-RA's requirements may seem premature, without any clear, rigorous proof of F3 product acceptability to MilSpec (current version Mil-PRF24385F[SH] Amdmt.4, 2020), or seemingly ICAO (International Civil Aviation Organisation) Level C. Both have similarly low application rates, but there the likeness ends. These are radically different test regimes, so it's surprising to see NFPA 403:2018 suggesting they are somehow 'equivalent'.

NFPA 403's assessment seems to dismiss extra depth and rigor from MilSpec, focused on operational realism and more extensive testing under tougher conditions. Can we be suggesting the rather cursory, single freshwater only ICAO fire test, with special test branchpipe (often unrepresentative of most aviation hand and turret nozzles), at or near cool 15oC (59oF) foam solution, fuel and air temperatures, has 'equivalency'? ICAO has no challenging secondary test requirements covering hot storage, summer operations, corrosion, dry chemical compatibility, aquatic toxicity and biodegradation requirements, as demanded by MilSpec. So how could they be treated 'equally' when MilSpec clearly goes far beyond ICAO Level C, better representing likely operational challenges being faced in major aircraft or Defence fire situations? Surely test challenges and rigor equate to increased reliability and safety?

MilSpec requires 7 separate fire test passes in fresh and saltwater at full, half and five times strength, plus mixing with several other qualified products, ensuring reliability, effectiveness and extinguishment speed are maintained on volatile fuel: gasoline, even when operational systems may be impaired. Periodic repeat testing under MilSpec verifies continued validity, whereas ICAO Level C allows a one-time pass only, without repeats nor public visibility of certification. Only leading C6AFFFs meet/exceed the tough demands of both MilSpec and ICAO Level C, without adverse health and environmental issues faced by legacy C8 PFAS, now banned in EU and widely being phased out elsewhere.



Test	Milspec	ICAO
Refractive index	X	
Viscosity	X	X
pH	X	X
Spreading Coefficient	X	
Surface Tension	X	
Interfacial tension	X	
Foamability	X	
Film Formation and sealability	X	
Corrosion	X	
PFOA and PFOS	X	
Dry Chemical compatibility	X	
Stability	X	
Compatibility	X	
Environmental Impact	X	
Toxicity	X	
Chemical Oxygen Demand	X	
Biodegradability	X	
Fire Test	X	X
Stratification	X	X
Precipitation	X	
Fluorine content	X	

Fig.2: FAA highlights far more rigorous testing requirements under US MilSpec. A single freshwater fire test on Jet A1/Kerosene, without storage stability, reduced strength, dry chemical compatibility or periodic repeat validation testing meets ICAO Level C requirements. How is that 'equivalent'?

MilSpec was developed to rectify evident failures where vapour sealing and resistance to forceful mixing with fuel were lacking, to ensure lives and critical assets were safely protected and not compromised. MilSpec responded to demands that any recurrence of three tragic aircraft carrier disasters (USS Oriskany, USS Forrestal and USS Enterprise 1966-69) with combined 206 lost lives, 631 people badly injured, 36 planes destroyed plus 40 seriously damaged, was unacceptable and must be permanently prevented. Particularly pertinent as consequences could have resembled 'Chernobyl' since a nuclear powered aircraft carrier with around 4,600 people on-board was severely damaged by fire. Rigor and challenge are part of MilSpec's 'DNA', ensuring real event representation, pushing beyond most fire approval testing. Tough challenges are vital in retaining vigilance and readiness when defeating the worst incident outcomes, as complacency kills. FAA and US DoD duties of care dictate vigilance and readiness, extending into firefighting, successfully achieved over 50+ years.

Aviation relevance to industrial users includes offshore platforms, FPSO (Floating Production, Storage and Offloading) vessels with lessons extending into other more concentrated, life safety critical industrial operations.

ARE EXISTING APPROVAL STANDARDS HIDING POTENTIAL DANGER FROM F3S?

It also raises difficult questions around whether existing fire test approvals provide effective assessment of F3s suitability on perhaps our most commonly used, transported, stored fuel as a major hazard: gasoline? Are they misleading us? Perhaps unintentionally exposing us to increased dangers? Why suggest F3 'equivalency' to C6foams on easier heptane, when extensive testing shows inferior results on more volatile gasoline?

Extensive rigorous comparative testing by NRL, NFPA-RF, Batelle, FAA, and UL have shown heptane is easier for F3s to extinguish, without representing gasoline, as intended. Most current approval standards still use heptane despite these revelations, including EN1568-3, UL 162, FM5130, ISO 7203-1, Lastfire and IMO. Increasingly heptane is considered unrepresentative of F3 fire performance on volatile flammable hydrocarbons ... like gasoline, E10/E15 variants (gasoline with 10% or 15% Ethanol added) and Jet A/A1 fuels. Why are approval agencies not changing? Requiring an additional gasoline (or agreed surrogate) fire test for F3s might correct this anomaly, while also providing more realistic F3 design application rates.

Have existing approvals led regulators and foam users into incorrect assumptions, by suggesting leading F3s and C6AFFFs fire performance 'equivalent', as widely desired? The proven reality seems they usually cannot, ...without higher application rates, longer extinguishment times, more foam usage, changed delivery devices, system re-designs preventing forceful application (resulting in reduced reach), increased runoff and greater destruction from more smoke, bigger fires, slower control. We're seeing it already in major incidents where F3s were used.

Four sets of detailed, repeated, peer-reviewed scientific work, using rigorous certified test criteria, delivering important factual conclusions confirming F3 inferiority appear 'lost', side-lined or dismissed. It's disturbing to witness in such a life safety critical area. ...Why are we allowing, even endorsing it, by favouring less rigorous, unrepeated tests under ideal conditions, where higher application rates and shorter preburn times unsurprisingly deliver more encouraging results?

Concerns with these approvals 'over-representing' F3's abilities, perhaps

unintentionally but misleadingly, could have major life safety implications in major fires where F3s may become used. Maintaining our duty of care, requires speed and effective, reliable fire performance. Seconds count when saving lives.

Speed delivers key benefits:
- Saves lives.
- Reduces injuries.
- Reduces smoke production - a silent killer.
- Minimises noxious breakdown products usually including carcinogens (eg. dioxin, benzo-a-pyrene, benzene), also persistent toxins.
- Reduces run-off volumes, foam usage and resulting environmental harm.
- Reduces asset damage, incident and clean-up costs.
- Makes repairs possible, reducing re-opening delays, reducing trauma.
- Prevents destruction or closure, retains community jobs and future viability.

Perhaps it's time for a re-think ...before more lives are lost unnecessarily?

Particularly when C6 PFAS are considered neither harmful, nor bioaccumulative, nor toxic, with a short human half-life averaging 32days (not multi-years like C8s), and quickly excreted in urine. US Centre for Disease Control's (CDC) latest 2017-18 NHANES PFAS blood serum survey confirmed C6 PFAS (PFHxA) was not detected in any age group or demographic across the total US population, despite inevitable C6 consumer product exposure from upholstery and carpets to clothing, pharmaceuticals, and mobile phones. It also confirmed legacy C8 PFOS and PFOA blood serum levels declined 32% across the US population compared to 2011-12 levels. Perhaps legacy wounds start healing?

So why aren't our legislators accepting this, while conducting scientific risk assessments to separate low risk C6s from 'ring-fencing' high-risk PFAS, including legacy C8s?

DUTY OF CARE

We all have a duty of care to ensure life safety is not compromised. A position in danger of being 'over-ridden' by some Legislators, perhaps unintentionally compromising existing fire safety.

Had FAA not made this strong stand, raising public safety concerns about unacceptable F3 fire performance, the global travelling public to/through US airports would be less safe, potentially facing increased risks of death or injury in future aircraft accidents, were F3s permitted for use. Perhaps this questions safety at major airports outside USA, where MilSpec is infrequently used. Most airports and offshore platforms regulated by ICAO rarely use Level C, mostly lower category Level B foams (using higher application rates) which have historically performed well with fluorinated foams, but little F3 incident effectiveness is evident. Where F3s have been used, evidence sounds warning bells of lockdowns from excessive smoke, slow fire control/extinguishment, run-off overflows causing environmental disaster and aircraft destruction. Are unnecessary F3 risks already being taken with public safety?

Is complacency a result of 'too few' major aviation or industrial incidents to verify real-time F3 safety performance against existing approvals and perhaps contradictory 'hot house' test data, delivering encouraging results desired from a few 'best candidates'? Perhaps Legislators are premature in 'encouraging' F3 transitions, when hidden dangers may outweigh perceived 'benefits'?
We should all be extremely concerned. Are we headed for 'regrettable F3 substitutions' in many high hazard areas, adversely affecting firefighter safety, life and property protections?
F3s could enable higher health and environmental impacts from slow control, huge amounts of smoke, more detergent usage, toxic/carcinogenic run-off overflowing containments. All resulting from slower, less effective F3 use. We've already witnessed it during major incidents in Australia (Melbourne's 2018 chemical fire) and Dubai (Boeing 777 destruction and a life lost in 2016). Do we want that repeated, ...everywhere?

Regulators and legislatures will have moved on to 'solving' new 'hot topics' when the wrath of grieving families could be our litigations to deal with. Try explaining why this 'idealistic' choice was made. Why we dismissed firm scientific evidence and thorough, rigorous fire test data from numerous trusted sources, preferring to follow more encouraging, rarely repeated, less rigorous results we wanted to hear?

C6AFFFS COULD BE OUR BEST SAFETY DECISION

High purity C6AFFFs are not shown to be harmful, assist in minimising this trauma, by at least ensuring our best media usage, delivering proven and required levels of public safety. Adopting fastest, most effective responses during future major fires is expected, proven to minimise human health and environmental impacts from whole major incidents, without unnecessarily compromising lives or critical assets.

Growing evidence leads us to conclude FAA's public safety assessment is correct. "...candidate fluorine-free products must be fully evaluated, mitigated, and/or improved before FAA can adopt an alternative foam that adequately protects the flying public." FAA underlines everyone's primary duty of care: keeping people safe - without causing undue harm. Isn't it time we re-considered improving fire safety for everyone ...before disaster strikes? It could be today, tomorrow, or just a ticking 'time-bomb' ... for you perhaps?

1.https://www.faa.gov/airports/airport_safety/certalerts/media/part-139-cert-alert-21-05-Extinguishing-Agent-Requirements.pdf

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DOSING SYSTEMS

Suitable For The Transition From AFFF To SFFF and How To Verify The Dosing Rate Of A Water Driven Pump Proportioner

During the market transition from AFFF to SFFF (fluor free concentrates) it is important to know the viscosity of the SFFF concentrate, to choose the right type of proportioner.

As regulatory authorities now are pushing for soonest possible transition from PFAS-containing concentrates to SFFF concentrates, many proportioning systems are re-evaluated to ensure compatibility. Different concentrate manufacturers offer a variety of foams which comes in a wide range of viscosities, including very high viscous fluids. To be able to select a compatible proportioner one needs to know the properties of the concentrate.

PROPORTIONERS WITH GEAR PUMP

Water motor driven pump proportioner equipped with a Gear pump are suited for high and very-high viscosity concentrates, when the proportioner is operating in the higher range of a systems maximum flow rate, such as deluge and large fire monitor systems. Firemiks has with excellent result tested Gear pumps models with a Fluorine-free foam with 8,000 cP (Brookfield Viscometer Spindle #4 at 30 rpm). The reason Gear pumps works well with these very-high viscous concentrates is that they are equipped with robust counter rotating gears which seals better with high viscosity fluids and creates a continuous flow that does not agitate the concentrate. FIREMIKS model equipped with a Multi V-rib belt drive increases pump rpm making it possible to use Gear pumps also when using medium viscosity concentrates.

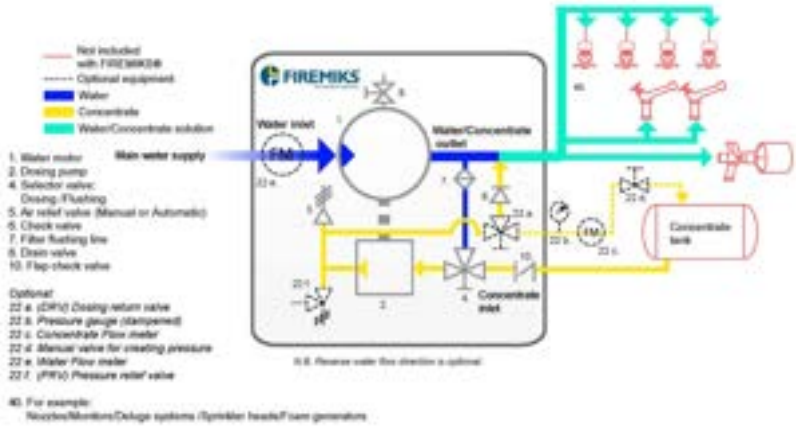
PROPORTIONERS WITH PISTON PUMP

Water motor driven pump proportioners equipped with Piston (plunger) pumps are on the other hand suited for use in systems using low and medium viscosity concentrates, and the pump works from low start-up flows in relation to the systems maximum flow rate, for example sprinkler system applications, due to the flat pump curve profile that piston pumps have. Important to know is that Piston pumps have a limit upwards to high viscosity concentrates, normally around 4,000-4,500 cP (Brookfield Viscometer Spindle #4 at 30 rpm) due to the Piston pump reciprocating principle; for each revolution, the plunger sucks concentrate and then presses it out and the concentrate goes from zero to full speed twice per revolution. If the static viscosity is too high with non-Newtonian concentrates, the concentrate will not flow smoothly and therefor the correct dosing rate might not be achieved.
FIREMIKS is uniquely positioned to offer proportioners with both types of pumps, Gear and Piston (a selected line of 3% piston pump models is FM-approved). This combined with our sturdy multi-vane motor that offers optimal reliability based on 40 years field experience. Among several important factors, besides flows and pressures, we always gather info from the customer regarding the concentrate type and viscosity before we propose which type of pump that will match the customers need.

Important for all systems is that one should ensure that diameter on the foam supply piping is large enough for the concentrate delivery and to avoid longer concentrate lines. Recommendations are specified in our Data sheet for each model.

Functional testing of FIREMIKS water driven pump proportioner with Dosing return valve.
To enable easy and quick functional testing of the proportioner Firemiks offer the option DRV (Dosing return valve). With this feature one can test the unit without consuming the concentrate, allowing for an easy regular inspection of the unit. With an added flow meter and pressure valve on the return line to the concentrate tank, to simulate the water back pressure, one gets a concentrate volume/min to be calculated together with water flow measurements to achieve the actual dosing rate.
This gives substantial saving of costs during many years. Apart from no consumption of concentrate there is no cost for cleaning up and destruction of dispersed foam after the test, an important environmental benefit if choosing this option.

One example: an 8000 lpm unit with 3% dosing rate. 4 tests/year at max speed for one minute. 8,000 lpm x 3% = 240 litre of foam concentrate x 4 times = 960 litre at for example a cost of 3 euro/lit = 2,880 Euro.- in saved cost/year apart from savings on clean-up costs of dispersed foam.



How to correctly verify the dosing rate by measuring water flow and dosing pump flow.

To verify the dosing rate, one needs to verify the correct volumetric function of both the water motor and the dosing pump. The accurate way to obtain this is to verify the water flow through the water motor with a calibrated independent flow meter, and the concentrate flow pumped by the dosing pump with a calibrated independent flow meter. Thereafter calculate the figures obtained to the formula in accordance with EN 13565-1, NFPA 11, FM 5130:

$$\frac{\text{Concentrate flow}}{\text{Water flow + Concentrate flow}} \times 100 = \text{Dosing rate \%}$$

To use an independent water flow meter is also the only correct method to validate the performance of the water motor, i.e. that it is keeping its designed volumetric function.

REVOLUTION COUNTER WITH FLOW RATE DISPLAY

A revolution counter with flow rate display can be used as a convenient way of estimating the water flow through the water motor. This can help e.g. to get an indication of overflow in a system. As described by FM Approval guide: "...may be used to provide a general estimate of the extinguish water flow..."

REVOLUTION COUNTING WITH HANDHELD TACHOMETER

An alternative way to measure the rpm is to use a digital hand-held tachometer (contact or non-contact) to verify rpm, and then compare the value with the max flow rpm as shown on our Data sheets. This is recommended to ensure that a unit is not over-speeding, i.e working within the upper flow limit specified in Data sheets.

THE LIMITS OF REVOLUTION COUNTER METHOD

The revolution counter method assumes the correct functioning of the water motor to give an estimate of water flow. This means that it cannot be used to correctly verify the dosing rate, as the dosing rate is directly dependent on the performance of the water motor, which is not verified by this rpm method.
Likewise, it would be possible to estimate the concentrate flow of the concentrate pump by using the rpm method, and similarly this would not be a valid method to verify the dosing rate.
The revolution counter method is not an approved method to verify dosing rate as described by EN 13565-1, NFPA 11, FM 5130.

ALTERNATIVE METHOD TO MEASURE PUMPED CONCENTRATE

An alternative method to measure the pumped concentrate that do not require a flow meter, is to pass it into a separate container and weight the amount during a defined time (Nordtest method NT Fire 042).
You are always welcome to contact us for guidance and recommendations on practical solutions how to calculate dosing rate for a specific project.

For more information, go to www.firemiks.com

LASTFIRE - APPROACH TO FLUORINE FREE FOAMS

By Niall Ramsden

As the Project Coordinator of LASTFIRE, the industry group of fuel production and storage companies developing best practice guidance in storage tank Fire Hazard Management, it is a privilege and an honour to be asked to write this editorial for this special, foam focussed, edition of The Catalyst.

Since the early 90s, LASTFIRE has constantly been carrying out research on a number of topics including crude oil boilovers, LNG vapour suppression and radiant heat measurement. All are important issues, and the work has resulted in pragmatic advice for those on the front line based on end-user driven testing, but nothing compares with the importance (or cost!) of the current focus on testing for the transition to fluorine free foam. We have to face the inevitable – this transition is going to happen. The only question is "when?". In some cases – very soon! Yes, AFFF and FP foams have served us well, but we are not going to be able to use them in the future. Another given, despite the histrionics of some "independent experts", most of whom have never even been involved in large scale testing, let alone a real incident, is that we can make fluorine free foams work. Of course, we can! They may (and I emphasise "may") require some different tactics, different training, more efficient application equipment with better foam properties, higher

application rates or longer run times - but we can make them work! All the work LASTFIRE has done to date suggests that no major changes should be required in most cases.

The key is to make them work as efficiently and effectively as possible for the long term and so avoid unnecessary "regret spend" – and this is where the effort must be directed.

I have served on NFPA11 for more than 30 years and on EN13565 Part 2 for not much less – and I am very proud to have been part of great teams on both committees, but if we look deeply into the basis of the standards, there is very little formal test work or even incident data behind them. The figures quoted for application rates and run times are mainly based on opinions with relatively little test work to support them. They have worked, but perhaps this is because there is a very large, unnecessarily high, and wasteful safety factor between the applied standard rate and what would be the critical rate – after all, some of the rates were used in the days of standard protein foam!

When you then consider that most standard test procedures for foam such as EN1568, UL162 or ICAO CAP168 have not had high levels of validation against large scale testing to check they truly represent the scenarios they are intended to simulate, then you realise that what we do in terms of application rates, designing systems and the associated preplanning is built on a relatively small set of rigorously achieved data. Why should you design a system for a specific application rate and a specific run time? This limits development and ingenuity. Standards do allow options with "equivalent performance" but how do you demonstrate this?

Other questions we have to ask are "What is an acceptable safety factor between test rate and applied rate, and what circumstances does it allow for?" Longer preburns, higher fuel temperatures, different fuels?

NFPA11, in its latest (2021) edition has started to recognise that another approach might be required and, for fluorine free foams for most critical applications, recommends that test work be used to establish appropriate application rates. It specifically mentions the work of LASTFIRE and the NFPA Research Foundation as examples of test programmes.

We are undoubtedly demanding greater levels of testing with fluorine free foams than was ever required before. Has anybody proof that new generation "C6" foams will successfully extinguish a 100m diameter crude oil tank that has been burning for 6 hours? I don't know of any such test – but this is the sort of requirement being requested for fluorine free foams. (Actually, based on a multi-tank incident in Houston a couple of years ago, you could question the efficiency of C6 types - although the truth of course is that the problems were mainly associated with logistics and tactics, as is often the case with such large incidents.)

The current situation will give more opportunity to get a better data base and understanding of optimising foam properties and application. That can only be a good thing. Cost is a major factor in testing and there must be some risk-based justification to any that is done. LASTFIRE has carried out a very extensive programme including a wide range of configurations, fuels, application techniques, flow rates etc. Whatever you do though, there will always be somebody to pick one small aspect in isolation and question its validity rather than look at the overall work or its relation to the true risk. For example, some of the large scale (300m2) tests we have done are in a rectangular concrete pit with hot metal sections. The validity of using a rectangular pit for long flow tests has been questioned – but we have done work in circular tanks as well! (Visual observation suggests that foam flows more easily in the circular pan.)

So, with that background, let's look at this situation as an opportunity rather than a problem! It gives us the chance to develop a much greater knowledge of foam properties and which ones really matter – it is definitely not just expansion and drainage time!

The key is working together in different sectors - learning from each other, sharing knowledge and experience, even though the applications might be different. It is this approach that LASTFIRE is taking. We don't need scare tactics or emotional claims about reduced safety. A recent one is claiming higher exposure to toxic combustion products if the fire burns for a few seconds longer. Safety is always the priority but give professional firefighters the credit they deserve. They do understand how to handle these issues! As a counter against this particular claim, look at the video on PFAS contaminated clothing produced by the US Fire Administration and the Federal Emergency Management Agency The Hidden Dangers in Firefighting Foam - YouTube

A lot has been achieved – just look at what has been done in the Defence sector by the USA Department of Defence under the SERDP programme, and by various airports – including major hubs such as Heathrow, Amsterdam and Copenhagen. There is of course always more to do and LASTFIRE's plans for 2022 include additional crude oil fire testing with longer preburns, polar solvent, water miscible fuel testing and, of course, further use of the large 50m x 6m pit along with more small scale testing to assist in optimising the combination of equipment and foam concentrate. Constant monitoring of other relevant issues such as clean out techniques and disposal is also part of the brief.

There are many stakeholders – foam suppliers, equipment suppliers, approval bodies, standards authorities, insurers. environmental specialists and testing laboratories – but ultimately there is only one group who truly understand the risks and the hazards they deal with – the end users – and that, in the industrial sector, is who drives and directs the LASTFIRE work.

So, in summary, we have an opportunity. Let's stop the marketing driven rhetoric and concentrate on what is important. We have to do it, we can do it, we will do it!

Niall Ramsden,
Project Coordinator of LastFire

MAKING THE TRANSITION

FROM A PFAS CONTAINING FOAM SYSTEM TO SFFF

By John-Olav Ottesen

Fomtec decided some months back to adopt the "SFFF" which stands for Synthetic Fluorine Free Foam following the adoption by NFPA (in their 2021 edition of NFPA 11) and also by FM (as indicated in their latest edition of FM 5130). In this article we also wanted to use the umbrella term of PFAS containing whilst noting that depending on where a facility is located different regulations may apply depending on whether the firefighting foam is "C8" or "C6" as many of the considerations relating to making the transition to SFFF are the same whether the existing foam is C8 or C6.

C8 or C6 ?

Understanding what foam you currently have in the system does make a major difference to the urgency you as an end user need to be aware of when planning the transition. This all comes back to where you are located and the legislative regulations that are being applied for various PFAS chemicals. In the US, state by state regulations are being introduced restricting the use of PFAS containing firefighting foams – with no derogation to whether or not the foam is C6 ! In Europe and the UK it's different as since 2017 and EU 2017/1000 and the subsequent amendments / additions of 2019 and 2020 we have legal restrictions and deadlines on the use of PFOA – in effect our C8 foams. This current legislation prohibits the use of the C8 foams for anything other than firefighting (No training and no testing), and from January 1st 2023, only if you can contain the discharge. The extension where discharge can be contained is until July 4th 2025.

Unfortunately for those end users who purchased C6 foam after 2015, or who maybe in the process of specifying a system today legislation is expected this year which will restrict production and use of a chemical PFHxA, which will encompass the C6 foams ! With the document still in draft we can only speculate on the time line for the possible restriction of use of C6 foams, but additionally we should consider whether fluorosurfactants will be available due to the way regulations are proposed limiting and possibly cutting off the supply of fluorosurfactants to the foam manufacturers located in Europe!

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SO WHAT ARE THE CONSIDERATIONS WHEN MAKING THE TRANSITION TO SFFF ?

Below are a sample of the questions / concerns that have been raised by clients who have already completed or are starting their planning process for the transition:

- What are my legal obligations?
- What type of (PFAS version) foam concentrate do I have?
- Do I need to be concerned with PFAS regulation if discharges are captured and processed?
- What does drop in replacement mean?
- Is there a different impact between new installations and existing?
- I need to follow NFPA, FM design standards. What impact does that have?
- Can I use the existing discharge device density?
- Can I use the existing pump and water supply capacity?
- Can I use my current proportioning system?
- Can I keep my existing discharge devices?
- Do I need to clean the system pipework and how clean is clean?

The first three points have been covered above so looking at the next point and the desire for all end users that the SFFF alternative should be a "drop in replacement". We take this to mean that the old system tank can be drained of the PFAS containing foam and the tank refilled with the same volume of a SFFF and the system will work as designed for the PFAS containing foam ! Excluding the need for cleaning / decontamination, which we are not going to address within this article, it is very unlikely, based on the current status of SFFF's that a true drop in replacement is possible. Whether due to differences in the physical properties of the SFFF concentrate which can impact pump, proportioner and concentrate piping between the tank and the proportioner, or due to the foam qualities generated by the existing discharge devices, or due to any differences in application density that are required with the SFFF to successfully extinguish the fuels used. All are factors that MUST be considered and evaluated when making the transition to SFFF.
Obviously there is a major advantage if the system has not yet been installed as the design can be reviewed and new bills of material drawn up to address any of the differences.

Design standards will of course factor into the transition plan and respectfully following NFPA standards and utilising UL 162 or FM 5130 approved systems provides a level of security to the end user above the European EN 13565-2. As has been covered in previously articles the distinct difference between the UL and FM systems and the EN one is that the fire performance of the foam agent is linked to the foam qualities generated by the discharge devices. Additionally both UL and FM approve the bladder tanks and proportioning equipment that should be used with the particular SFFF.

The most critical question for the transition is "can I use the existing discharge (application) density". Being able to answer this question impacts what the SFFF system will need to comprise of. Evaluating the question does require addressing in detail the existing system:

- What is the hazard type – tank protection, dike protection, process equipment, loading rack, warehouse, aircraft hangar etc..
- What is the existing system – fixed/ oscillating monitors, fixed nozzles, foam makers, foam chambers, sprinklers etc..
- What is the existing fuel – plus whether any plans for additional /

different fuels in the future
• What was the design standard followed for the existing system – is this still applicable ?
• Are the design calculations and hydraulic calculations available for the existing system ?

Once we have the details on the fuel types and information on the current application density and know if type II, type III or sprinkler discharge then we can review this against the appropriate design standard being applied. At all stages of trhe process decisions should be based on DATA and not opinions. With over 1,000 fire performance tests to date within the Fomtec Enviro Programme we can vouch for the dangers of assumption. To share an example; acetone is the reference fuel used by many approval bodies for the ketone group of chemicals, and Fomtec has UL 162 and FM 5130 approvals for topside and sprinklers on acetone. Two years ago a client approached us for a transition where MEK (Methyl Ethyl Ketone) was one of the fuels and fortunately we decided to run fire performance tests on the specific fuel and found that we needed to increase the application density, and concentration to successfully extinguish and pass the burn back portion of the tests !

Knowing the application density required for the SFFF is going to determine whether the pumping and water capacity is suitable or needs to be amended. This is also going to impact the downstream piping network and new hydraulic calculations will be required based on the application density.

CAN I USE MY EXISTING PROPORTIONING SYSTEM ?

Consideration must be given here to what type of proportioning is used, and whether this is suitable for the SFFF foam concentrate, and also for the flow required based on the application density. Other considerations relate to the requirement to clean and decontaminate the existing system, and also to whether the requirement is for an approved system (if working with UL or FM). For example if the existing system is a bladder tank and ratio controller then even if the application density and hence the volume of foam concentrate and flow rate remain the same the likelihood is the bladder and proportioner will need to be changed. Then if the system should be UL or FM then the bladder tank and proprtioner will need to be listed / approved with the relevant SFFF !

Use of existing discharge devices brings us back to the UL and FM approach where foam qualities across a range of discharge conditions (flow and inlet pressure) are tested against the top side fire performance test. In cooperation with Viking / KCA Fomtec has UL and FM approvals for the Enviro USP and Enviro ARK with multiple discharge devices across the flows / pressure range. In our experience few bund protection systems are protected with foam makers with inlet pressures of 10 bar, so we test and approve not only based on what we can achieve but also based on our experience of systems in the market. Ideally we would recommend using discharge devices that have been tested and approved with the SFFF. Whilst this is still true for monitors, foam makers and foam chambers this is particularly true for foam sprinklers.

Whether for implementation or planning purposes the transition away from PFAS containing foam systems to an SFFF system solutions incorporating tested and approved SFFF agents from Fomtec along with tested and approved hardware from Viking are available now for many applications. For further information contact us at enviro@fomtec.com

THE FOAM TRANSITION: AN UPDATE

By Jochem Van De Graaff

In the past months, an acceleration of the transition to fluorine-free foam is noticeable. More and more parties become aware of the fact that action is needed. We notice two more things: an increased demand for transition-related testing, and the further development of even better performing fluorine-free foam concentrates. The most recent concentrates are rapidly becoming serious threads to their fluorinated nephews.
Earlier we wrote an extensive white paper with a detailed step-by-step suggestion for making a safe transition. With this article H2K shares the first experiences with carrying out transition processes for various private and public clients.

INITIAL FINDINGS

A good starting point for making the transition is to find out what the current situation regarding foam is within an organization. It is important to have the incident scenarios, incident control scenarios and design requirements clearly in mind before starting the transition. This seems simple, but as it turns out this question is difficult to answer for organizations with fixed installations and/or mobile equipment. There are several reasons for this.

Firstly, in most organizations there have been subtle changes in business processes, installations, procedures, or techniques over the years without incorporating these adaptions into a fire safety system. As a result, the original design features of the fixed or mobile suppression systems no longer match the actual situation in practice. Whether this is the result of inaccuracies in following a Management of Change procedure (MoC), blind spots, or other reasons, most important outcome is that it's questionable if the current system is not or very limited suitable for the potential incident scenario.

Secondly, it is sometimes unclear if and how Inspection, Testing and Maintenance program (ITM) was carried out. We have come across installations that can hardly be (live) tested at all. No provisions for this testing have been made in the design of the system. And as a result, it is impossible to demonstrate whether the current extinguishing system is working. Let alone that such a system can be used to demonstrate practical functioning for an as-should situation after the completion of a foam transition.
In such cases, partial or complete re-design of a system needs to be done to convince authorities of the transition effectiveness. Costly of course, but inevitable to prove proper working.

Thirdly, in many places we find a chronic lack of attention to the quality of foam concentrates. Stratification of concentrates, pipe parts that contain foam concentrate but cannot be sampled, and in many situations, it is unclear exactly what type of foam concentrate is available. It is also not always clear whether it contains a C8 or C6 fluorinated concentrate, or a blend thereof. And with regards to the distinction in the regulations regarding C8 and C6, the expiry period is of course relevant!

In short: in numerous cases, we found very worrying matters that indicate too little focus on the ITM policy. It is easy to assume that a system or vehicle

once commissioned is working and will continue to work. The transition must therefore not only be about future technical and procedural issues but also about adapting behaviour on to existing incident response and equipment. After all, in addition to replacing the concentrate, the goal is also to ensure a good fire safety management system. For this, more emphasis on ITM, as we see in the current situation, is necessary.

In addition, it has also been observed that in an earlier transition from C8 to C6 foam, not always sufficient testing has been carried out. In a practical test, we made a comparison between a C6 foam concentrate and new fluorine-free foam. In the test, the C6 foam was found not to be able to extinguish this specific product. To everyone's surprise, the fluorine-free variant had no problem with extinguishing. In the latter case, too, you can conclude that the MOC procedure in the transition from C8 to C6 foam has not been carried out at a sufficient level. Perhaps even (but data about this is no more available) the C8 foam has also not been effective. It turns out that practical testing on liquids that occur in the processes is very valuable and necessary!

DEVELOPMENT OF FOAM CONCENTRATES

For about five years now, H2K has been testing fluorine-free foam concentrates in its own practical way. No complicated standard tests, but a small-scale practical test. In the results from the past months, we see the concentrates of the 'big boys' perform more and more comparable. We also see that the viscosity of fluorine-free foam concentrates is decreasing which makes proportioning easier. In terms of viscosity, we see several foam concentrates that approach the specifications of their fluorinated counterparts.

However, in addition to an overall increase in performance, we do see that large and unexpected differences are occurring when testing different fuels with the same foam. Fuels in the same category (i.e., water-soluble etc.) perform on one fuel much better than another fuel from the same category. This is consistent with previous studies on the performance of fluorine-free foam concentrates. These studies confirm a great variety in performance, especially in relation to water-soluble fuels. One of the tests carried out for a client, illustrated these major differences perfectly. Test cycles were performed with both substances in pure form and mixed in with a solvent as was the case in the client's production process. When performing an extinguishing test with the same fluorine-free concentrate, the pure product was extinguished nicely, and the mixed product was not! It is therefore important not only to have focus on end products when transitioning, but also to keep an eye on all intermediate products in the process.

LACK OF GUIDELINES

During the transition, it is important for companies, but also for parts of the government that use foam concentrate, to have a clear view on the playing field. In the Dutch situation, the playing field is not yet clear on a few crucial components. An example of this is the extent to which installations need to be cleaned out. Currently no legislation exists in the Netherlands on this topic. For new foam concentrates (as is for all new products coming to market in the EU), the REACH/POP regulation is clear. From a certain moment (those lines are also still under development) no higher level than 25 ppb PFAS may be present in products and mixtures of products. For installations contaminated with PFAS, there is no limit available and yet no clearly defined obligation to clean the whole. If cleaning is carried out, must the 25 ppb-limit be adhered to, or do the stricter guidelines which apply to soil and water need to be met?

In addition, there is still no clearly defined standard that explains how the sampling of cleaned installations must be carried out. After all, there can be a difference between values that are found when the sample is taken from water that has been flowing through pipelines shortly or remained in place a little longer. It may also make sense to take a swap sample, but how should this be done?

The same applies to the timeline that will apply in a general sense to the transition. How long can anyone (producer, end user, etc.) count on the use of fluorinated products? The regulations are still under development. The ending point is clear: at some point all PFAS-containing foam will be banned from production, storage, and use. But the deadlines now provided are short in relation to the work that needs to be done.
Furthermore, parties also see problems with the possible exception for large areas (possibly an exception is made for an area of more than 500 m2). The exception only applies when foam concentrate is used (actual extinguishing) and not to selling. If this is the case, a stock that no longer meets the specifications can no longer be replaced? This creates continuity issues that will practically lead to the exception rule being difficult to use as a serious alternative.

The lack of clear frameworks leads to a (perhaps unjustified) feeling of uncertainty, which makes parties wait with a switch. There are now organisations (especially companies) that are waiting for a better framework, which creates legal certainty. Far fewer companies will enter the transition if there is a chance that after the transition, in which the PFAS-containing foam has been replaced with all the associated investments, cleaning still must be done. It helps when this framework is clear at the front end of the process, also will this lead to an acceleration of the transition. Regulating bodies should be aware that lack of a watertight framework delays reaching of the final goal: a swift and responsible transition away from PFAS-containing foams.

SUCCESSFUL TRANSITION

In the meantime, several parties have successfully transitioned. These parties have generally started with a few small-scale practical tests to get a feel for the possibilities and impossibilities of the new foam concentrates. A list of potential new foam concentrates has been made that, after testing on a larger scale, has been reduced to a potential replacement. Subsequently, this was scaled up to somewhat larger tests in which was tested whether the current equipment should be adapted to certain foam concentrates. After fine-tuning the systems (including proportioning, expansion, etc.), several realistic scenario tests were performed. This involved deliberate quenching with very small application rates and, and for example, deliberately creating a large fuel pickup to see whether the foam was able to hold up well even in unfavourable conditions.

In addition to valuable information about the behaviour of the new foam in realistic scenarios, the tests also

provided many photos, videos and insights that can later be used in training and education programmes. After all, one of the success factors for a successful transition is mainly the ability of people to make extinguishment effective.

PRACTICAL POINTS OF ATTENTION

We see new products appearing in the market all the time. The data sheets sometimes show special things. Extremely long shelf life of the foam concentrates (> 20 years) for example. It also happens that foam concentrates do not yet have all certificates (MSDS stating 'documents pending'), but in the meantime the foam is being offered to parties as completely certified. It is also not always clear whether the original standards and certifications of the complete system are still being met due to the necessary adjustments in the installations. Or, without a thorough test, it is assumed that the combination of new foam concentrate and old (sprinkler)nozzle still provides sufficient expansion. Foam manufacturers have more and more data from their foam concentrates about, for example, the required application rate. It is not always clear whether the transitioning companies sufficiently check these requirements against the design of the old or new situation.

We observe a rapid increase in companies that offer PFAS polluted fire water treatment. New methods are rolled out that not have been (scientifically) proven. Do these service providers guarantee effectiveness, are these services under some sort of warranty, is removal of extremely polluted waste included in the contract? Many questions that need solid answering before foam users should enter into expensive agreements.

Many of the above-mentioned points might not be malicious intents of suppliers and manufacturers, but as stakeholder within organizations one must act very careful before making regrettable decisions. On the spur of the moment, now and then irresponsibly shortcuts are taken. This leads to a lack of thorough research and testing. We also come across tunnel vision on foam concentrates, and not paying attention to scenarios, installations, status of ITM, training of crew, etc. Unfortunately, this leads to poorly carried out transitions. And then quick and cheap suddenly becomes an expensive experience.

FINALLY

A well-executed transition generally leads to a higher level of safety than before. As better performing foam concentrates hit the market and awareness to a careful process is more common, big steps can be made in safety levels. People have been actively working on scenarios, installations, and equipment in all phases of transition projects. This leads to greater knowledge about foam concentrates and their uses. That momentum must be passed on to the standing organizations to structurally embed new processes into education and training, but also for inspection, maintenance and testing in the organizations. In this way, the transition becomes primarily an opportunity to improve the (fire) safety situation. Isn't that what we all want?

These initial findings confirm our earlier assumption that transitions are tailor-made processes. We offer an elemental step-by-step framework in our white paper which can be downloaded from our website free of charge. There you can also find further contact details in case of questions. H2K is always willing to think along or offer guidance.

SFFF compatible

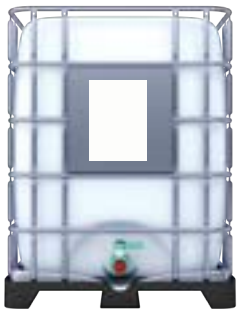
Synthetic fluorine free foam systems: the environmentally responsible alternative

Viking EMEA is pleased to introduce the first FM Approved fluorine free fixed foam system for Hydrocarbon and Polar Solvent applications. This system approval is initially focused at non-aspirated sprinkler discharge devices for use in closed or open head installations such as warehouses, chemical manufacturing areas, loading racks or aircraft hangars for example.

Viking and its partners have worked hard to develop a range of SFFF foam concentrates and compatible hardware for use in fire protection systems. It is important to note that SFFF foams are not always a drop in replacement for existing AFFF or AR-AFFF systems. This is why Viking worked with international approval and certification bodies, carrying out extensive fire and performance tests to recognised test standards, demonstrating real life performance of the complete system.

Visit **https://www.viking-emea.com/Fluorine-Free-Foam-Sprinkler-Systems/** or **contact us** for more information.

SFFF Compatible Products



ARK Alcohol Resistant Foam Concentrate

VFT Bladder Tanks

VNR Wide Range Proportioner

VK1001 Sprinkler

Photo: Fotolia © Romolo Tavani

Trusted above all.

VIKING

Viking S.A. (*ed.*) | 21, Z.I. Haneboesch, L-4562 Differdange/Niederkorn, Luxembourg | T: +352 58 37 37 1 | www.viking-emea.com

PFAS SOLUTIONS AT HAND

In the foreseeable future it will be prohibited to use fluorine-containing fire-fighting foam. Hans Huizinga, consultant at Kenbri Fire Fighting the Netherlands warns that companies in the chemical and petrochemical industry should not think lightly about switching to fluorine-free extinguishing foam, but he has a solution.

All over the world, organizations emphasise on fire safety and adequate (extinguishing) resources for emergency response. Nowadays, the environmental effects and obligations arise from the use of PFAS compounds in fire-fighting foam are added to these resources. The poly and perfluoroalkyls are a man-made group of chemicals, which are still present in many types of fire-fighting foam and are very harmful for the aquatic environment.
It is therefore logical that PFAS is high on the agenda of private and public organisations and that they want to phase out fire-fighting foam containing PFAS. The development of effective alternatives is there, but the transition to these fluorine-free foams (or F3) foams has significant implications and requires a thorough preparation and well-prepared Management of Change procedures.

PFAS CLEANING & TREATMENT SOLUTIONS

Kenbri, in collaboration with our partner Arcadis, is represented in PFAS Cleaning & Treatment Solutions. With this collaboration Kenbri can offer a total package of services, Huizinga says. PCTS is an initiative with a focus on non-destructive treatment and cleaning of PFAS contamination in soil, water (groundwater, wastewater and surface water) and the complete fire suppression infrastructure.
"This includes a complete plan of action, but also determining the quality and carrying out accredited tests with fluorine-free extinguishing foam on specific hazardous substances." Kenbri has taken care of the transition processes for a number of major petro-chemical refineries in the Rotterdam port area. During this process Kenbri oversaw the complete Management of Change programme.

PFAS SOIL CONTAMINATION

"Firefighters use Class B foam in static and mobile extinguishing systems, such as sprinkler installations and foam extinguishing vehicles. They use this foam in the event of incidents at airports, in the petrochemical industry, at military bases and in difficult-to-control fires. Because PFAS-containing fire-fighting foams have been used in the past and are still being used at the locations mentioned, we now find contaminants in soil, groundwater and wastewater (sludge) there," informs Huizinga.
However, the trend is the transition to fluorine-free foam. New F3 foams and modern techniques offer sufficient extinguishing power for the vast majority of fire scenarios and also meet the standards set by, ICAO, IMO, Lastfire, UL and NEN-EN 1568. Just like the current PFAS-containing foams, it can be easily added to the water whilst using existing admixture equipment.

QUICK AND SAFE TRANSITION

A transition to a fluorine-free F3 foam requires good preparation, because it has consequences for the fire safety and risk analyses. This includes making technical adjustments and paying attention to the environmental aspects of the old and new foam.
Huizinga mentions some essential steps:
- Determine whether the new foam is suitable for the different fire scenarios.
- Determine whether and which adjustments are required in existing extinguishing systems to obtain an optimal mixing of the extinguishing agent with the extinguishing water.
- Always test to determine whether the alternative, fluorine-free foam actually delivers the performance specified by the manufacturer or certifying organisation.
- When the alternative foam proves to be effective, decide to exchange the fluorine-containing foam concentrate

PFAS TRANSITION PROGRAMME

'Are you about to make a responsible investment decision and verify whether the adapted firefighting systems adequately limit the risks? And do you want to continue to comply with the set standards and regulations at the same time?' Arcadis and Kenbri Fire Fighting can help companies in all phases of engineering and project work, including:
- Electrical, civil, architectural, mechanical and chemical engineering
- Establish fire safety policies based on regional, UL and NFPA guidelines and standards
- Preliminary design and final design of extinguishing systems
- Cleaning your existing systems up to an acceptable level
- Commissioning and operation of fire protection systems
- Installation of firefighting, detection and alarm systems
- Supervision on the installation of firefighting, detection and alarm systems executed by subcontractors.

ENVIRONMENTAL SERVICES

Cleaning mobile and static extinguishing systems before the switch to a fluorine-free foam concentrate is of essence. Fluorine residue in tanks and piping will contaminate the new fluorine free foam concentrate in a short period of time to a level where the fluorine free foam will need to be treated and disposed of as a fluorine containing foam.
Hans Huizinga continues "We also provide practical services such as:
- Taking in and processing the old foam concentrate in an environmentally responsible & controlled manner.
- Cleaning of mobile extinguishing systems with Fluorine Fighter™ a cleaning process and liquid specially developed by Arcadis. After the cleaning process the effectiveness of the process will be substantiated with specific analyses and reports."

In short, PFAS cleaning solutions are within reach and are being executed. The PCTS partnership, in which Arcadis and Kenbri Fire Fighting play a leading role, is fully equipped to solve any PFAS cleaning issue.
For more information: www.kenbri.nl and www.pfasoplossingen.nl

Author:
Hans Huizinga, Fire Safety Consultant
hans.huizinga@kenbri.nl
Tel: +31 (0)187 – 493 588

KENBRI FIRE FIGHTING

FOAMTRONIC
ELECTRONIC FOAM PROPORTIONING

The Knowsley FoamTronic® is an electronic foam mixing system which very accurately mixes foam concentrate and water based on the actual firewater demand of the system. This is achieved by continuous monitoring of the firewater and foam concentrate flows using electromagnetic flowmeters and real-time adjustment of a concentrate control valve. The accuracy and stability of the system is based on the selection of premium components and a unique control system with state-of-the-art logic developed specifically for FoamTronic®. The control system records all process values and alarms during operation or test which are available via a user-friendly interface.

FoamTronic® is the ideal solution for large volume foam systems and is ideally suited to large storage tank risks where the potential impact of ignition of a hydrocarbon release could be catastrophic. This type of fire can only be extinguished using a fully functioning foam suppression system which is regularly tested in accordance local standards and legislation, in most cases this requires the actual discharge of foam solution or even water to the risk area which causes pollution and environmental hazards.
Regular testing may be a mandatory requirement in some regions but even when this is the case it is only a snapshot at a given time and ideally consideration should be given to the daily status of the firefighting system

A key part of any foam system is the foam proportioner and whilst simple is always best when dealing with firefighting systems there are instances where a level of additional technology can provide other benefits and reassurances, especially related to accuracy and self-diagnostics.

FoamTronic® technology means that the proportioning accuracy of the foam/water mix is controlled to finite levels and will automatically adjust to changes in system demand, in operation this has the potential to save huge volumes of foam concentrate which would be used by less accurate mechanical systems. This means investment in capital infrastructure of foam pumps, storage tanks and foam piping can be rationalised to ensure best value. The FoamTronic® also has the possibility to create two different mixing ratios depending on the activation command coming into the system. The required mixing ratios can be set using the touch screen user interface.

An upgrade to a FoamTronic® system results in a suppression system that can be tested without any negative impact on the environment and at a very low cost. This is possible because the FoamTronic® can test the mixing ratio without mixing

firewater and foam concentrate, but still providing an accurate and reliable measurement of the mixing rate.

Retrofit into Existing Systems
An electronic foam proportioner can be installed as a replacement for any inline balanced pressure proportioner where a positive pressure foam concentrate supply is available. This retrofit will also be future proof against any further changes on the job site to foams of different types, percentages and viscosities which gives peace of mind when considering capital investment in equipment and the current uncertainty of foam concentrate suitability for some applications.

COMBINE THE FOAMTRONIC WITH A PRESSURE TANK

Tank terminals typically require an extensive amount of foam concentrate at multiple locations as the protected areas can be very large. A centralized foam stock with foam pumps is often used to pump foam concentrate to these multiple locations where firewater and foam concentrate are mixed. These foam pumps require a high degree of care to maintain them in good condition. Periodic testing is required, repairs of the foam pumps are certainly not uncommon. The testing and repairs are costly and affects the availability of the system and disturbs the operation of maintenance departments. For applications where

a large amount of foam concentrate is required at several locations, such as at tank terminals, a FoamTronic in combination with a pressure tank is a perfect solution. The foam concentrate is stored in a stainless-steel pressure tank. A set of nitrogen cylinders are activated when a fire occurs. The pressure of the cylinders is reduced to the desired working pressure for the foam system using pressure regulating valves. As a result the nitrogen will push the foam concentrate towards the FoamTronic.

THIS INNOVATIVE SOLUTION OFFERS THE FOLLOWING ADVANTAGES:

+ There is no electrical power and back-up needed for the foam pumps. The activation of the system requires a 24VDC output of the fire alarm panel to the solenoid of the cylinders.

+ The set-up is very simple and requires a minimal amount of piping and equipment.

+ Foam concentrates can be highly viscous; this system can handle all types of foam concentrates.

+ Long distance foam supply piping is possible due to adjustable foam pressure up to 25 Bar.

+ Yearly maintenance, periodic testing and repairs of the foam pump system is prevented. An annual inspection is required.

For more information and to arrange a discussion about a specific application visit us at www.knowsleysk.co.uk

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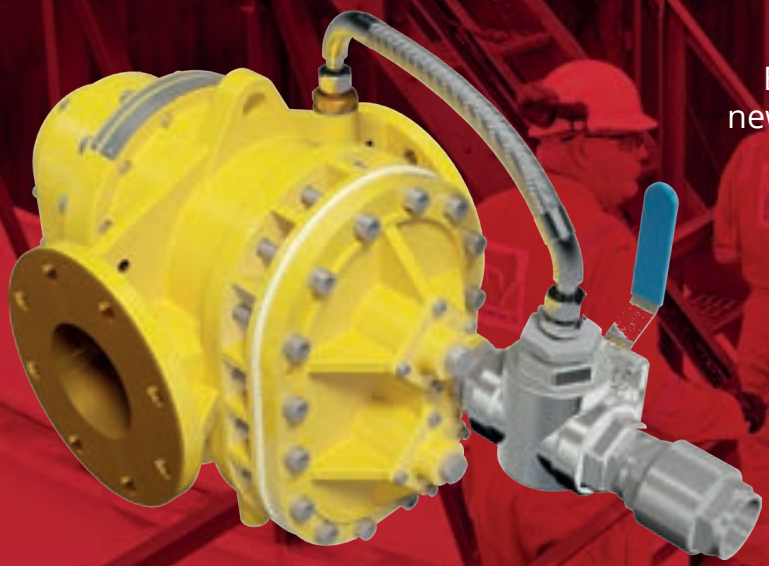

MECHANICAL

FoamTronic®

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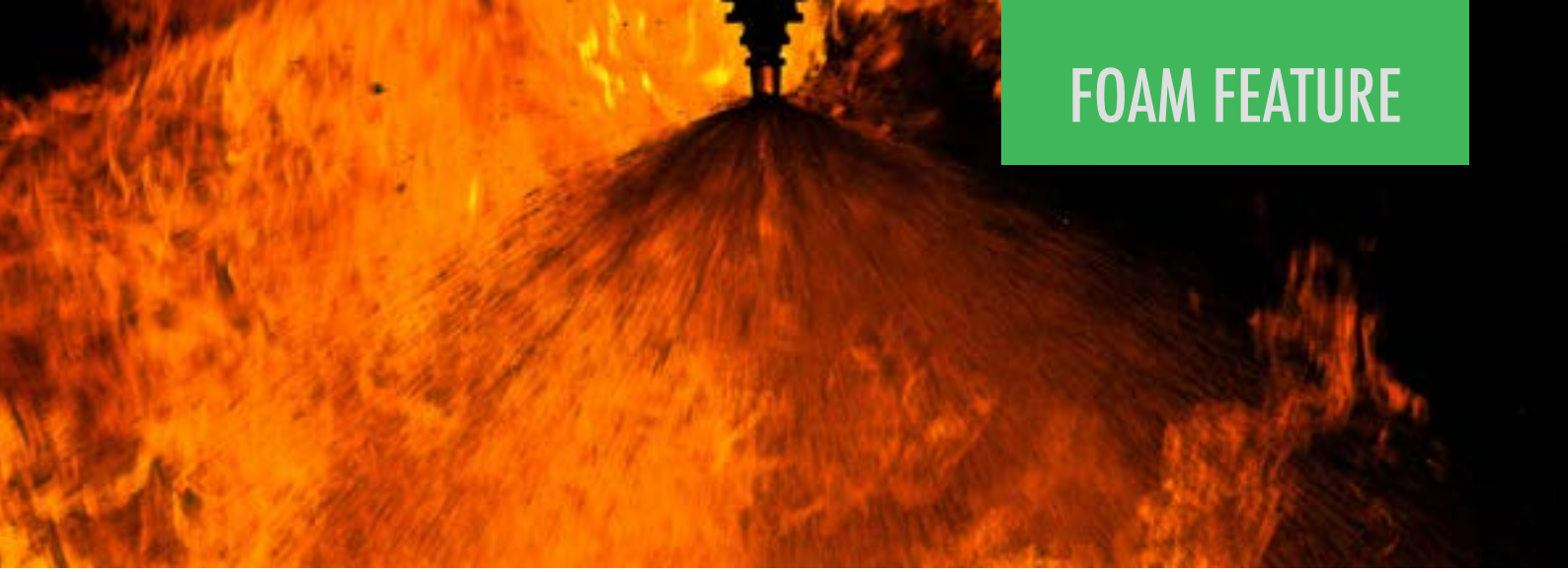

PFAS DEADLINES LOOMING AND THE CHALLENGES OF FLUORINE FREE FOAM DEPLOYMENT IN NON-ASPIRATED SPRINKLER APPLICATIONS... IS THERE A CREDIBLE SOLUTION ALREADY AVAILABLE TO YOU?

2021 was the year in which the legislative changes regarding the use of fluorinated firefighting foam reached critical mass in several regions around the world. With deadlines restricting the use of PFAS (Per- and polyfluoroalkyl substances) containing foam in North America and the European Union looming, end users are now feeling the pressure to transition their fixed fire protection systems to fluorine free foams thereby ensuring compliance. Some sectors of the firefighting foam user community such as aviation and oil refining have been ahead of the curve but now reality is biting for other sectors such as manufacturing and logistics. Deployment of foam through conventional sprinkler systems for ignitable liquid risks is common and poses particular challenges in finding the correct level of performance in fire conditions as detailed later in this article.

VIKING RAISES THE BAR FOR SFFF USE WITH NON-ASPIRATED SPRINKLERS.

We are in a situation where demand for Approved/Listed synthetic fluorine free foam (SFFF) systems is moving faster than manufacturers can bring solutions to market. This situation is not due to complacency or lack of effort, it is because replacing fluorinated foam systems with non-fluorinated is challenging, time consuming and expensive. Currently, there is only a small quantity of high quality SFFF's meeting the various requirements of FM5130 and UL162 on the market. Choices for SFFF's for use in non-aspirated foam sprinkler systems is even smaller.

At the end of 2021, Viking and their strategic partner Fomtec launched a unique SFFF product called "ARK" to address the challenges of deployment through standard sprinkler systems.

ARK was developed in combination with a selection of Viking sprinklers and hardware thereby ensuring its "system" credentials. The ARK foam concentrate became the very first SFFF to achieve FM Approval for use on Hydrocarbon AND Polar Solvent ignitable liquids. This achievement is the culmination of many years work with a strict focus on non-aspirated sprinkler performance. For certain applications such as manufacturing or process areas, but particularly warehouse storage, it is important to have a high performing foam working with non-aspirated sprinklers as there can be hundreds or even thousands of these small, cost effective foam discharge devices installed.

Although aspirated sprinklers are available, these tend to be expensive by comparison and some also miss high-level approvals such as FM and UL. They typically cannot be deployed in closed-head wet sprinkler systems and are larger in size, which may be an issue for installation compared to a conventional sprinkler.

A recent development to this already high performing SFFF product line is the ability to increase the height of sprinkler installation. Depending on the sprinkler model and design density, the FM Approval now allows installation heights up to 13.5m (45ft) which is another industry first for Polar Solvent applications.

As part of this FM system approval, there is a proportioning package comprising an extensive line of bladder tanks with wide range proportioners specifically designed and approved for use in closed head sprinkler systems where flow rates can be very low. This special proportioning device is able to manage the higher viscosities found with SFFF foams and comes with the assurance provided by test standards such as FM5130. Additional products, sizes and design parameters will be added to the product line in the coming months as well as a hydrocarbon focused SFFF concentrate.

SO WHY DOES FOAM DEPLOYMENT THROUGH STANDARD SPRINKLERS POSE A CHALLENGE?

Fire protection sprinklers and sprinkler nozzles are a simple but effective form of active fire protection used in many different applications globally. They are deployed in closed-head "wet" systems with a fusible element or as sprinkler nozzles in open "deluge" systems with the fusible element removed. For many years, we have been enhancing these systems with foam to tackle more challenging fire scenarios such as those posed by Class B ignitable liquids. Typical applications are refineries, aircraft hangars, manufacturing and logistics centres with ignitable liquids and other commodities, where water alone is less effective / ineffective or there is no suitable drainage and containment infrastructure in place.

Conventional fire sprinklers were not designed with foam use in mind. They are designed to efficiently distribute water in

the desired manner depending on the object or risk they are protecting. They are also small, discreet and due to the high volume used throughout the world, have a sensitive, almost commodity based price point. Despite this, used with the correct combination of system components and foam concentrate, they can perform very well as foam enhanced sprinkler systems.

FOAM QUALITIES AND DISCHARGE DEVICES

For foam application on ignitable liquids, it is important to obtain the correct "foam quality". The first of these qualities is the level of Expansion. This is a measurement expressed as a ratio of how much the foam solution expands when applied on a fire through a discharge device. Discharge devices could be monitors, foam chambers or foam branch pipes for example. All these devices are designed for use with foam, which agitate and/or aspirate air into the foam solution to boost the expansion. It is generally accepted that expansions between 6:1 and 10:1 are optimum for these aspirated devices.

The second important factor is the Drainage rate. This is a measurement of how quickly the expanded foam returns to a solution. Effective performance is a balance of the two, as the expansion is needed to form a blanket over the

Fig1. FM5130 Non-Aspirated Sprinkler Test

ignitable liquid and starve the fire of oxygen whilst the drainage is important to provide a continual cooling effect on the fire and surrounding structures.

Foam qualities play an important role in testing and certificating foam discharge devices with foam concentrates. This is because it is unrealistic to fire test foam discharge devices on a 1:1 scale as this would involve large testing infrastructure and cost and would also lead to inconsistency across different products and manufacturers. Therefore, these qualities' are obtained by flowing foam through the different discharge devices across the devices' range of the operation. Once the expansion and drainage values are noted, they are replicated later using a specially configured hose nozzle and used to run standard sized fire tests as prescribed in the appropriate test standard.

Fig2. FM Approval Guide – Fixed Extinguishing Systems

These foam qualities are proving to be much more critical in SFFF foams as the additional safety factors given in the past by fluorinated surfactants in AFFF based foam have been diminished. Independent studies such as the NFPA Research Foundation report on the effectiveness of fluorine free firefighting foams have confirmed what foam manufactures have known all along concerning the critical nature of foam qualities and SFFF Foam .

WHY IS A SPRINKLER UNLIKE OTHER FOAM DISCHARGE DEVICES?

A conventional fire sprinkler is considered a non-aspirated foam discharge device and typically gives a low expansion of no more than 4:1, with fast drain times. It is therefore important to select a foam concentrate that has been developed and independently tested by a third party specifically for use with sprinklers.

Factory Mutual (FM) and Underwriters Laboratories (UL) are considered the most relevant and challenging authorities when it comes to fixed system product testing. Their respective foam test standards, FM5130 and UL162 include material testing, fire performance testing (Fig2) and follow-up manufacturing audits, which gives a higher level of consumer confidence compared to other standards commonly referenced such as Europe's EN13565-1.

Both these organisations recognise that these conventional non-aspirated sprinklers are differenet in foam performance to other discharge devices and therefore, the traditional foam quality approach is not applicable. It is recognised that foam qualities cannot be dependably and consistently be obtained. Instead, each sprinkler type is tested under prescribed conditions with variables such as foam concentrate type, K Factor, application density, fuel type and installation height. The example sprinkler and foam concentrate approval in Fig2 gives clear design and usage parameters as a result of the fire testing.

Application design standards such as NFPA11, NFPA30 or FMDS 7-29 require the use of Approved / Listed foam concentrates that have been tested on the subject fuels with the intended sprinkler type. This can limit choice because such testing is difficult and expensive but the user does at least have the assurance of proven fire performance.

A difference with the European Standard..

EN13565-2 is the European standard for the design of fixed firefighting foam systems. The 2009 version of this standard required that non-aspirated sprinklers be used with foams that have a rating of 1A/B/C for Hydrocarbon only risks and 1A/B for those also involving polar solvents. This effectively means that the better quality foams, according to the EN1568 foam concentrate standard, shall be used when utilising non-aspirated sprinklers.

However, there is a flaw in this requirement as foams tested to EN1568 are certificated based on fire pan tests with a standard aspirated hose nozzle that generally gives good foam qualities. This test is very different to the realities of a sprinkler fire test as it does not consider the height of application, the fire updraft effect or the water deluge that is applied

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to replicate a period of water only discharge after depletion of the foam reserve. Another key element is the amount of foam that actually hits the fire pan as opposed to the surrounding area. In the EN1568 tests, all the foam from the test nozzle is discharged into the fire pan. Therefore, it should not be assumed that a 1A product would be able to perform adequately when discharged from a non-aspirated sprinkler.

The 2018 revision of EN13565-2 has probably made the situation worse. Despite the 2009 version giving equivalency of a test hose nozzle to a non-aspirated sprinkler, it did at least push the user to higher quality foams and adequate densities. This requirement has now been removed and users are simply requested to "consult the manufacturer". There is no caveat or guidance to state what the manufacturer has to demonstrate or prove so this leaves the situation open to interpretation and abuse.

Use of FM Approved or UL Listed foam concentrates tested with sprinklers is a sound approach to fire performance. Manufacturers using the freedom allowed under EN13565-2:2018 to justify the use of foams with non-aspirated sprinklers based on foam quality alone is not considering the full picture.

For additional information, please contact the author, Simon Barratt at barratts@viking-emea.com
Simon is the Foam Product Manager for Viking with 20+ years in the fire sprinkler and foam market.

REDEFINED PERFORMANCE
IN CLASS B FIRE AND VAPOR SUPPRESSION

Since their widespread introduction in the 1970s, Aqueous Film-Forming Foams (AFFFs) have set the performance standard for Class B firefighting and vapor suppression. But the fire protection industry is moving toward non-fluorinated products, and new options are needed to deliver effective firefighting for special hazard liquid fuel fires. Fortunately, options such as NFF 3x3 UL201 firefighting foam concentrate from Johnson Controls are now available.

For Class A fuels, water provides relatively effective, easy-to-apply fire suppression, but it has limited capability to fight Class B liquid fuel fires. Over the years, AFFFs have protected lives and property with effective fire suppression of Class B fires through their fluorochemical components. The fluorochemistry creates a film-forming foam blanket which spreads across the fuel surface and suppresses the fire by separating the flammable liquid from oxygen in the air. As firefighting foams transition to non-fluorinated

foam (NFF) options, delivering AFFF protection with NFFs has been a challenge.

THE CHALLENGES OF REPLACING AFFFS

Today there are more than a hundred commercially available AFFFs developed over decades, as no single formulation fulfills the requirements for every application. The same is likely to transpire with NFFs - foam manufacturers will continue to develop and improve NFF formulations over time to deliver a broad portfolio of options for specific hazards and applications; however, the inherent differences between AFFFs and NFFs present similar challenges across most applications.

- An NFF must first and foremost deliver a robust foam blanket that can quickly suppress a flammable liquid fire without the aid of a fluorochemical film barrier on the fuel surface. The foam blanket must then maintain its integrity post-extinguishment to inhibit reignition.
- But a robust foam blanket that cannot be effectively applied is not truly a viable solution. Factors that enhance a foam blanket's quality can also increase concentrate viscosity and effective foam expansion ratio, both of which may negatively impact foam application.

SUPERIOR FIRE SUPPRESSION WITH NFF 3X3 UL201 FOAM CONCENTRATE

NFF 3x3 UL201 is a foam concentrate developed by Johnson Controls and commercially available under their ANSUL®, CHEMGUARD®, SKUM®, SABO FOAM®, and WILLIAMS FIRE & HAZARD CONTROL® brands. Introduced in 2021, NFF 3x3 UL201 is formulated to deliver firefighting performance like a high-quality, alcohol resistant AFFF for emergency response applications.

Side-by-side videos of UL 162 testing of a commercial 3x3 AR-AFFF (left image) and NFF 3x3 UL201 (right image) may be viewed via link on each foam brand's website.

Underwriters Laboratories tests and lists non-fluorinated firefighting foam concentrates as Synthetic Foams under the UL 162 standard. Per this

Side-by-side videos of UL 162 testing of a commercial 3x3 AR-AFFF top image) and NFF 3x3 UL201 (bottom image) may be viewed via link on each foam brand's website.

standard, NFF 3x3 UL201 foam was tested at an application rate of 0.06 gpm/ft2, yielding a listed minimum design application rate (once the safety factor is applied) of 0.16 gpm/ft2 for Type III hydrocarbon fuel fires. However, NFF 3x3 UL201 foam was also tested and passed the much more challenging UL 162 Type III test protocol for AFFFs. This more rigorous protocol tests at an application rate 33% lower than the Synthetic Foam protocol.

Under the AFFF test protocol, NFF 3x3 UL201 demonstrated excellent fire control, extinguishment, and burnback resistance, and if it had been an AFFF would have received a minimum application design rate listing of 0.10 gpm/ft2. (A video link to side-by-side UL 162 AFFF protocol fire tests of NFF 3x3 UL201 and a similar-performing 3x3 AR-AFFF is available on the brand websites.) Furthermore, NFF 3x3 UL201 was tested and performed well on premium gasoline under the AFFF protocol, which is often a more challenging fuel for NFFs than the standard hydrocarbon fuels. Additionally, NFF 3x3 UL201 tested well and is UL listed with several polar solvent fuels, including E15, E85, ethanol, and ketones. NFF 3x3 UL201 is also rated in accordance with the EN 1568:2018 standard - Part 3 1A/1A, and Part 4 1A/1A for acetone and 1B/1A for isopropanol.

A TRUE NFF SOLUTION SHOULD DELIVER:

- Effective fire suppression
- On multiple fuel types
- At reasonable application rates
- With current industry hardware

EASE OF PROPORTIONING AND APPLICATION WITH NFF 3X3 UL201 FOAM CONCENTRATE

Achieving a robust foam blanket with superior fire suppression properties often necessitates physical property trade-offs that negatively impact foam application. High expansion ratios and increased viscosities can significantly limit the safe, effective application of firefighting foam. NFF 3x3 UL201 concentrate offers an effective low expansion ratio (3-to-1) and a low viscosity similar to that of a quality, 3x3 AR-AFFF. Therefore, it can be applied with most properly calibrated proportioning and response discharge devices – including standard, non-aspirated nozzle and handlines – for many applications. Other NFF concentrates that require higher expansion ratios might necessitate significant hardware modifications and aspirated discharge. More importantly, a higher expansion ratio can reduce foam throw distance, requiring closer positioning to the fire – potentially increasing risk to the responder.

NFF 3x3 UL201 foam concentrate is UL listed with a wide variety of proportioners and discharge devices, including inline eductors, IBP and wide-range proportioners, rim seal foam pourers, foam chambers/makers, large-volume foam monitors and nozzles. Listing details are available on the UL Online Certifications Directory.

While the challenge of delivering AFFF performance without fluorochemicals is formidable, NFF 3x3 UL201 clears many of the hurdles – including hardware compatibility, expansion ratios, viscosity and, most importantly, firefighting performance. As the demand for non-fluorinated foam offerings grows alongside expanding global regulations, the industry will come to rely on the benefits and features offered by premium, proven non-fluorinated solutions such as NFF 3x3 UL201 concentrate.

NFF 3x3 UL201 Foam Testing (independent party witnessed)

UL 162 Test Protocol for Type III Hydrocarbon - Forceful Application		Foam Application Rates gpm/ft² (lpm/m²)		Protocol Difference
		UL 162 Synthetic Foam Test	UL 162 AFFF Test	
Hydrocarbon Fuel	Test Rate	0.06 (2.4)	0.04 (1.6)	-33%
	Minimum Design Rate	0.16 (6.5)	0.10 (4.1)	-33%
Premium Gasoline Fuel	Test Rate	0.06 (2.4)	N/A	
	Minimum Design Rate	0.16 (6.5)	N/A	

		NFF 3x3 UL201 Foam Application Rates gpm/ft² (lpm/m²)	
UL 162 Synthetic Foam Test Protocol and Fuel		Test Rate	Minimum Design Rate
Type III Hydrocarbon - Forceful Application	Hydrocarbons	0.06 (2.4)	0.16 (6.5)
	E15 (15% Ethanol/85% Gasoline)	0.10 (4.1)	0.17 (6.9)
Type II Hydrocarbon - Gentle Application	Hydrocarbons	0.06 (2.4)	0.10 (4.1)
Type II Polar Fuels - Gentle Application	Alcohols	0.10 (4.1)	0.17 (6.9)
	Ethanol	0.06 (2.4)	0.10 (4.1)
	Ketones	0.10 (4.1)	0.17 (6.9)
	E85 (85% Ethanol/15% Gasoline)	0.09 (3.7)	0.15 (6.1)
EN 1568:2018		Test Rate	Design Rating
Water Miscible Fuels - Low Expansion	Part 3 - Heptane	2.5 lpm/m²	1A / 1A
	Part 4 - Acetone	6.5 lpm/m²	1A / 1A
	Part 4 - IPA	6.5 lpm/m²	1B / 1A

ABOUT THE AUTHOR

David Ash
Product Director,
Foam Products and Specialty Chemicals
Fire Suppression Products
Johnson Controls, Inc.

JOIFF

AND SHARED LEARNING

Some Industrial incidents during the past 6 months - the destruction and carnage continues.

One of the benefits of JOIFF membership is that JOIFF regularly circulates to its membership information on incidents that occur in high hazard industry. This is part of JOIFF's Shared Learning philosophy aimed at raising awareness, so that members can consider errors that caused the misfortunes of some, to educate against the same mistakes being repeated in their own location.

These are just a few of the incidents that JOIFF reported on during the last 6 months of 2021.

- Romania – 1 dead, 5 injured at fire & explosion at Petromidia refinery.
- Thailand - Fire and blast at Chemical Factory - rescuer killed, at least 60 injured,
- Germany - Chemical site explosion leaves 1 dead, 31 injured, 4 missing.
- USA - 2 dead, 30 hospitalized in chemical leak at LyondellBasell Chemical plant in La Porte.
- Russia - Major fire hits Gazprom gas plant.
- Mexico - 2 dead and 4 injured in refinery explosion and fire.
- Mexico - 5 offshore workers die, 6 injured in fire while performing maintenance offshore.
- Lebanon - Fire breaks out at oil facility in Southern Lebanon.
- Kuwait - Fire at Mina al-Ahmadi refinery.
- Canada - Container ship fire off British Columbia.
- Indonesia - Fire at Pertamina refinery complex.
- Algeria - 9 injured in refinery fire in North Algeria.
- South Korea - 3 killed after explosion at Yeosu Chemical factory
- India - Three killed, 40 injured in Fire at IOC Refinery

JOIFF would like to include in its mailings on such incidents the causes of any incidents and actions taken as a result, but this information is not readily available at the time of the incident being reported. When the reports of incidents are eventually completed, they tend to have restricted or abridged circulation rather than being made available to those in similar organisations with similar risks.

Is this why we are we still seeing indents causing a major loss of life and property and damage to the environment when the hazards and risks are known?
Quite apart from the human tragedies of injuries, deaths, homelessness and environmental destruction caused by these events, in many cases, these are an unnecessary cost of loss due to the experience and information that is available to prevent these incidents.

There is no such thing as "no risk" and a great deal of Emergency Services Management is built around reducing residual risk. For effective reduction of residual risk, the prime requirement is information – and what better information can there be than that from an organisation that has suffered from an incident in the type of risk that others need to reduce?

Can disasters caused by Industry be prevented? Of course they can, if information is made more freely available to allow management to learn from and act on the mistakes of others who have had the experience of similar previous disasters. Industry, Insurance and Risk Management Companies all need to ask themselves if they are doing enough to educate Industry on lessons learnt. Action from lessons learnt can unquestionably reduce the number of repeat incidents and when they do occur, with knowledge gained, those attending can more effectively and competently deal with them to reduce potential loss.

Those who fail to learn from history are condemned to repeat it.

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