INDUSTRIAL FIRE JOURNAL

FOR PROFESSIONALS PROTECTING LIVES, ASSETS AND INFRASTRUCTURE WORLDWIDE

Second quarter 2017 issue no.108

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Tall storeys

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Fluorinated waste solutions

Low-cost disposal method revealed during Queensland foam conference

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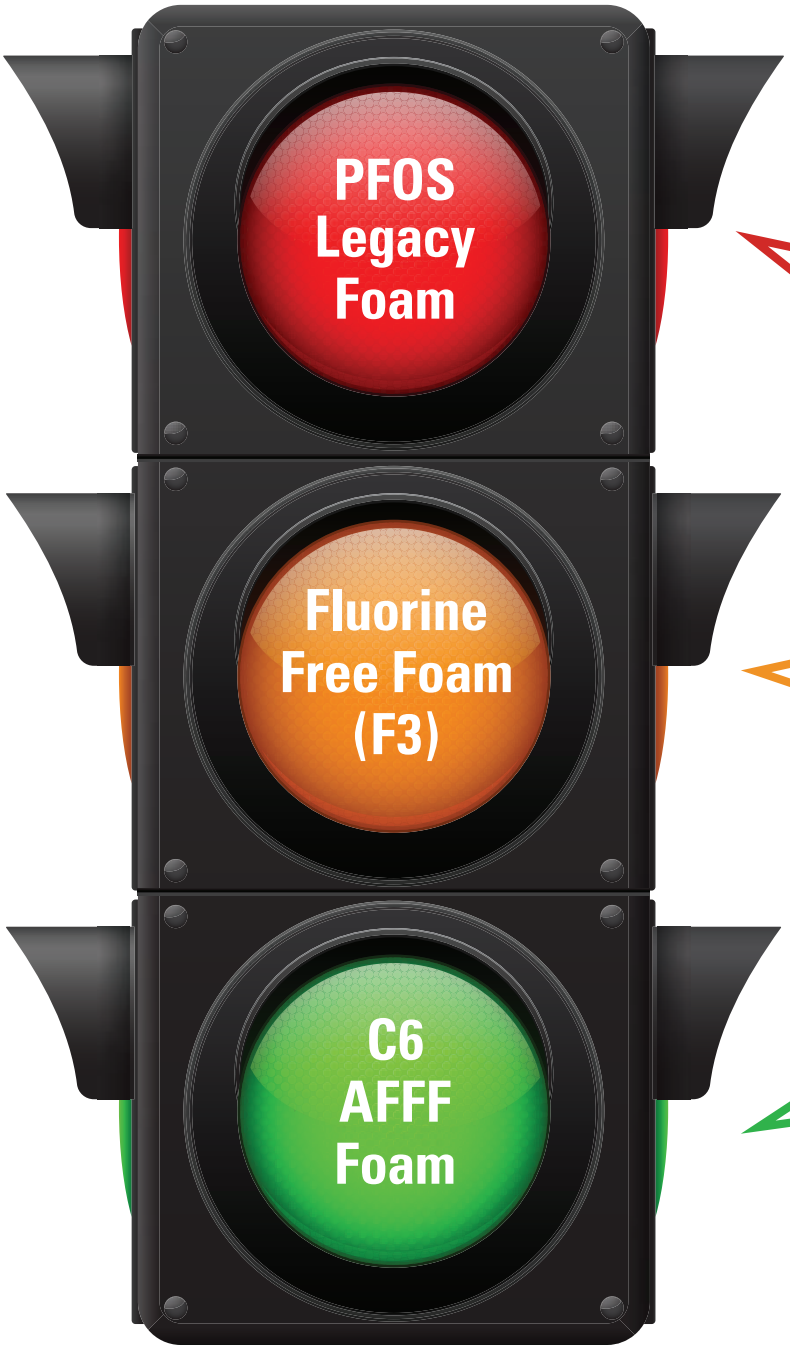

- 3M announced exit in 2000
- Persistent Organic Pollutant (POP)
- Banned in many countries
- Major ground water contaminant at training sites
- Replaced by most foam users

- Limited performance / applications
- Slower extinction / shorter burnback
- Fuel pick-up / foam flammability
- High aquatic toxicity
- No track record on large fires

- Superior extinction / burnback
- High safety margin
- Low aquatic toxicity
- No bioaccumulation
- Forty years of proven track record

Why have some failed to recognize the clear signals?

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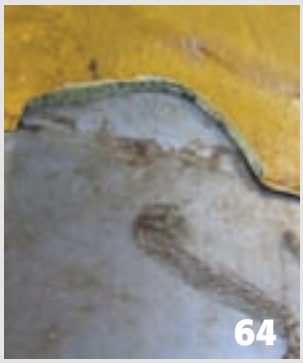

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Comment

Revolution is not a word much used in the fire industry for a variety of well-understood reasons but a low-cost, environmentally friendly method for dealing with fluorinated chemicals such as PFOS-containing foam concentrate or contaminated soils may just merit it.

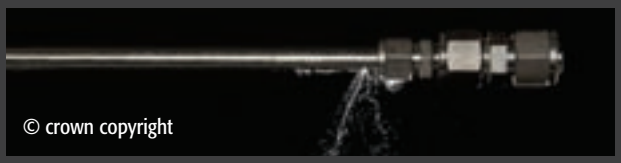
The method, presented during the Queensland Government's fire-fighting foam management seminar (see p42), involves feeding the waste (solid or liquid) into cement klinker kilns. The high temperatures mineralise the waste to the original mineral source of the fluorine, calcium fluoride, which is then used to manufacture cement.

According to Cement Australia's subsidiary Geocycle, the method is several magnitudes cheaper than current methods and is environmentally neutral. With lawsuits related to historical contamination of land and waterways by fire-fighting foam on the increase, any developments in the field of fluorinated chemical waste disposal should be welcomed.

Also to be praised are the efforts by industry and emergency response agencies to train together, thereby facing up to the fact that industrial incidents – however infrequent – can and do occur. In this issue (p10) we see emergency responders both industrial and municipal in Hampshire, southwest England, trial a new format of exercising that is less time-consuming than traditional methods – but just as effective. I hope that operators of both high-hazard and medium-hazard facilities are sufficiently inspired by this type of low-disruption exercise to consider engaging with their local responders in similar ways.

Jose Maria Sanchez de Muniain, Editor

RESEARCH PROPOSAL FOR FLAMMABLE MISTS



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A research proposal focussing on flammable mists is shortly to be released by the UK's Health and Safety Executive.

Mists of high-flashpoint fluids such as hydraulic oils, lubricating oils, diesel and heavier fuels can ignite and produce explosions at temperatures below their flashpoints.

A review in 2009 identified 37 historical ignition incidents involving flammable mists, including 20 explosions, of which nine were collectively responsible for a total of 29 fatalities.

In contrast with the well-established hazardous area classification for flammable gases and vapours atmospheres, the current guidance on mist hazards is limited, brief and largely qualitative, even if there is a legal requirement in the EU to consider flammable mists.

The HSE began work on this subject in 2011 with industry and regulatory partners; more recently it hosted a scoping workshop in March where the current knowledge gaps were discussed. These included the influence of orifice size and shape on mist formation; the influence of spray impingement; and the criteria for defining the flammable zone.

The research proposal is planned to be released this month (June). The HSE welcomes prospective partners and interested parties should contact:

Dr Paul Grant, paul.grant@hsl.gsi.gov.uk.

HANDBOOK FOR ASSESSING RISK

A handbook that describes common scenarios for assessing risks associated with industrial sites has been published by the European Commission's science and knowledge service, the Joint Research Centre.

The new handbook aims to help EU Members and other countries to reduce the impacts of a number of major incidents. The hazards covered include LPG, anhydrous ammonia, chlorine, LNG, liquefied oxygen and flammable liquids.

The Handbook of Scenarios for Assessing Major Chemical Accident Risks has been written by the JRC in collaboration with the Land-Use Planning Task Force, a group of industry and competent authority experts from EU Member States.

It describes common scenarios for assessing industrial risk and focusses on the proximity factor related to residential areas, transport infrastructure and other public spaces. According to the Executive Summary: "It has long been acknowledged that risk methods and land-use planning processes are embedded in local culture and pre-existing legal systems. However, technical aspects associated with the consequence analysis, in particular, selection of scenarios and scenario attributes, are not subject to this constraint and yet they are distinctly different from country to country. Up until now, there has been no common accepted practice among Member States for determining which scenarios should be taken into account in the land use planning process."

The Handbook aims to help member states take a more consistent approach to decision-making regarding the use of land by high-hazard industry as well as the associated risk assessment and management. It fills a gap in the 1996 Seveso Directive as to what constitutes an appropriate safe distance, which currently can be interpreted according to national historical norms.

To download a copy visit https://ec.europa.eu/jrc

Twenty-year HFC replacement warranty

A manufacturer of HFC-based clean agents has introduced a 20-year replacement warranty in spite of their planned global phase-down.

Chemours says that its new FM-200 Eagle Customer Protection Programme aims to address concerns related to changing EPA fire suppressant regulations.

The 20-year replacement warranty programme guarantees that if EPA regulations prohibit the use of hydrofluorocarbon clean agents at any point in time, Chemours will replace the FM-200 agent with an EPA-approved alternative.

To qualify, facility managers need to use an authorised FM-200 manufacturer/installer; review the registration requirements and complete the application form on the website; submit documents within 30 days of system commissioning; secure a service and maintenance agreement with an authorised manufacturer/installer; ensure any system refills use FM-200; and keep all service and maintenance records during the warranty term.

The Kigali Amendment that was signed in October 2016 resulted in hydrofluorocarbons such as FM-200 being added to the list of substances managed by the Montreal Protocol. The Amendment requires a reduction in HFCs to 15% to 20% of the baseline by 2036 or 2047, depending on the countries involved.

FIRE-FIGHTING FOAM SPILLS IN AUSTRALIA

Two spills of fire-fighting foam containing PFOA occurred in the Brisbane area of Queensland, Australia within the space of three weeks in April. On April 10, 22,000 litres of foam leaked from a faulty Qantas hangar at Brisbane Airport, about a quarter of which is believed to have made it into the Brisbane River and local waterways. Residents were advised to avoid recreational activities and eating seafood from the affected area – advice that was still in place several weeks after the spill. Levels of PFOA 50 times higher than the safe recreational limit were found in samples from Boggy Creek near the airport. Subsequent tests indicated this level was declining, but environmental medicine expert Dr Andrew Jeremijenko warned that the environmentally persistent nature of the chemical meant the impacts of the spill could be felt in the area for decades.

The Queensland Government was criticised for taking three days to warn the public about the spill. Both the state and federal governments maintained there was no conclusive evidence of harm to human health from PFOA.

Qantas has been issued with an investigation notice by the Queensland environment department and could be fined more than AUD$180,000 (US$133,000). The notice requires Qantas to undertake monitoring of marine life and sediment and report on the extent of environmental damage.

The airline met with local commercial fishers in April and indicated that the company would offer compensation where there was 'clear evidence of any commercial harm'.

Qantas said it was investigating the leak and a specialist contractor had been hired to clean up the spill. The airline is now seeking an alternative to PFOA foam. A joint Queensland-Commonwealth investigation over the failure by Qantas to contain the foam is also underway.

The second smaller spill took place on 28 April at a waste disposal site in Narangba, Moreton Bay when a transport container carrying fire-fighting foam ruptured. Around 550 litres of liquid mixed with AFFF foam escaped and ran off into a drain.

Initial testing suggests the liquid did not contaminate the local creek but the investigation and clean-up is continuing.

HEAVY FINE FOR REFINERY

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An oil company has been fined GB£1.65 million (US$2.1m) following a refinery explosion

The blast caused internal structures to collapse and led to damage totalling more than GB£20 million (US$25m).

The incident took place during the early hours of 14 November 2013 at the Stanlow Refinery in Ellesmere Port, Cheshire, north-west UK, which is owned by Essar Oil. Stanlow has a refining capacity of 12 million tonnes per year and it is the second largest in the country after Fawley Refinery. It is linked to the UK oil pipeline network, with oil delivered to the Tranmere Oil Terminal via ship and pumped to Stanlow, where it is then refined and stored for delivery.

Problems started during the start-up of its main distillation unit, when extremely flammable hydrocarbons were allowed to enter an unignited furnace. The heat from a nearby furnace triggered the explosion, which destroyed the furnace and started a number of fires. The incident was reported to the EU as a major accident under schedule 7 of the Control of Major Accident Hazards Regulations 1999.

An investigation by the UK's national regulator, the Health and Safety Executive, found that Essar Oil failed to take all measures necessary to prevent or mitigate a major accident. Three key failings were identified; a safety critical valve was ordered and installed incorrectly and Essar failed to correctly validate its operation; Essar failed to adequately assess the installation of a new safety critical trip, not recognising that the system had a by-pass line which defeated the trip's operation; although Essar's policy was to isolate main fuel lines to the furnace, the hydrocarbons entered the furnace via a secondary fuel line which had not been isolated when shut down.

Essar Oil pleaded guilty to breaching Regulation 4 of the Control of Major Hazards Regulations 1999 and was fined GB£1.6 million (US$2.1m) with costs of GB£57,644 (US$73,000).

After sentence, HSE Principal Inspector Joanne Eccles said: "The industry should take notice of this case, there were no injuries but mistakes were made and could have been prevented".

International standard on occupational health and safety opens for public comment

ISO 45001 specifies requirements for an occupational health and safety management system that enables an organisation to provide safe and healthy working conditions for the prevention of work-related injury and ill health. It includes the development and implementation of an OH&S policy as well as objectives that take into account applicable legal requirements and other requirements to which the organisation subscribes.

The international standard will help provide a single, clear framework for organisations of all types and sizes who wish to improve their OH&S performance and protect those working on their behalf. It will eventually replace OHSAS 18001, an existing standard that sets out the minimum requirements for occupational health and safety management best practice. Although OHSAS 18001 is widely used around the world, it is not a full international standard.

Comment on the standard was opened to the public on 19 May and will be closed on 18 June 2017. Publication of the standard is expected at the end of the year.

INCIDENTS IN FOCUS

An incident where a 900kg hot water storage tank exploded, killing a nearby worker, and then subsequently flew 130m up into the air killing three people in a laundry facility 150m away, is being investigated by the US Chemical Safety Board.

The incident that took place at the Loy Lange Box Company in St Louis, Missouri, on 3 April also affected sites owned by Faultless Linen and Pioneer Industrial, the latter's roof being struck by a 4m-long pipe attached to the storage tank.

The catastrophic failure of the vessel occurred due to corrosion of part of the tank, which separated and led to a blast equivalent to 150kg of TNT. This launched the tank through the roof, crashing into the roof of Faultless Linen. Four people were killed in the explosion. One of the victims was an employee at Loy Lange Box Company and the three others were employees of Faultless Linen.

According to the CSB, a recommendation made by a contractor in 2012 to replace the bottom portion of the tank was not implemented by the company.

A few days before the explosion a leak from the tank was reported and repairs had been scheduled for the same day as the explosion took place.

An explosion in South Africa's only inland refinery injured 11 people and forced the shutdown of operations on 22 May.

The Natref Oil Refinery, near Sasolburg, Freestate, in the north-west of South Africa is a joint venture between Sasol and Total.

Natref's emergency services were activated and all personnel were evacuated from the area while the situation was brought under control.

One man was reported as having sustained moderate injuries and ten others minor injuries.

Operating units in the vicinity of the hydrogen compressors were shut down but production at the main refinery continued, said Sasol. Around five units in the affected area remain closed while investigations take place.

The last serious incident at Natref was in November 2004 when a gas leak resulted in a fire which resulted in the death of two people.

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FIREX INTERNATIONAL, EXCEL, LONDON, UK, 20-22 JUNE

The international event that connects the fire and security markets has engaged three leading keynote speakers.

Firex co-locates IFSEC, the Safety & Health Show, Field Service Management Expo, Facilities Show and Professional Clothing Show in one venue.

The organisers have confirmed that keynote speeches will be delivered by Professor Brian Cox, Dame Kelly Holmes and Simon Weston.

As well as presenting numerous TV and radio programmes Professor Cox is a professor of particle physics at the School of Physics and Astronomy at the University of Manchester.

Dame Kelly Holmes won Gold for Great Britain in the 800m and 1,500m at the 2004 Athens Olympics. She still holds the British records for the 600, 800 and 1,000m distances.

Simon Weston CBE is a British Army veteran who rose to prominence after suffering severe burn injuries in 1982 during the Falklands War. He was awarded an OBE in 1992 in recognition of charity work.

Other highlights of Firex include live demonstration by testing organisation Exova Warringtonfire and certification body Exova BM Trada. Each day, Q-Mark and Certifire-approved contractor London Fire Solutions will demonstrate best practice passive fire protection product installation on Exova's stand. The stand will also feature a number of displays including a burnt fire door, three types of burnt fire resistant glazing, burnt structural steel and a burnt service pipe and collar. The 4th International Tall Building Fire Safety Conference will also take place alongside Firex. Day 1 will consider the design and fire engineering in tall buildings. Day 2 will cover management and insurance of fire risk in tall buildings, and Day 3 will focus on fire-fighting in tall buildings.

For more information visit www.firex.co.uk.

EMERGENCY SERVICES SHOW, NEC, BIRMINGHAM, UK, 20-21 SEPTEMBER

Visitors to the ESS will hear UK fire services sharing their experience of attending industrial accidents.

Free to attend for all those working in fire prevention and rescue, including industrial brigades and overseas visitors, ESS enables visitors to see and handle the latest fire-fighting equipment.

In the Lessons Learnt seminar theatre, UK emergency services and partner agencies will share their experiences of responding to real incidents such as the Didcot Power Station building collapse in Oxfordshire, which resulted in four fatalities and a major recovery operation. Merseyside Fire & Rescue Service will also lead a session on the Wirral gas explosion in New Ferry, which left 34 wounded and destroyed several buildings.

Other seminars covering PPE, research and development and the health and wellbeing of emergency services personnel are also planned. In the networking hub of the show, the Collaboration Zone, over 80 voluntary groups, charities and NGOs such as search and rescue organisations will be sharing details of the support they offer.

For more information visit www.emergencyuk.com.

17TH INTERNATIONAL WATER MIST CONFERENCE, BARCELÓ ARAN MANTEGNA HOTEL, ROME, ITALY, 25-26 OCTOBER

The conference webpage for the IWMC is now online and attendees have until 15 July to take advantage of the early-bird period.

The IWMC is organised by the International Water Mist Association, the first association of its kind dedicated exclusively to water-mist fire-fighting and related technologies.

The conference website currently includes travel accommodation information with full programme line-up expected in early July.

For more information visit www.iwma.net

IN RETROSPECT: STOC EXPO EUROPE, ROTTERDAM, THE NETHERLANDS

Stoc Expo Europe 2017, which took place 28-30 March saw an 8% rise in visitors to the Ahoy centre with a nearly 3,000-strong attendance. A new conference format designed to boost networking included 'speed networking' at the beginning of each session as well as seven expert panel sessions hosting over 30 speakers from oil majors, tank terminals and financial institutions.

The international event for the tank terminal industry introduced an innovative smart badge system that enabled visitors to register their interest in an exhibitor's stand. At the end of each day visitors received a summary email with links to the products and services, which eliminated the need to carry heavy brochures.

The inaugural Global Tank Storage Awards ceremony celebrated the achievements of terminal operators, ports, equipment suppliers and individuals making a difference in the bulk liquid sector.

Loadtec Engineered Systems was named best technology provider, LBC Cepsa won the award for most efficient storage terminal, and Elios by Flyability was crowned most innovative technology.

The next Stoc Expo Europe will take place at the Ahoy Rotterdam on 20-22 March 2018.

For more information email Nick Powell at nick@stocexpo.com.

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A win-win concept

A helicopter crash and multiple incidents related to its burning debris set the scene for a new multi-agency exercising format in Hampshire, UK, reports Jose Sanchez de Muniain.

In April, emergency responders in Hampshire, southwest England, trialled a 90-minute multi-agency training exercise. This marked a departure from the prolonged three-to-four-hour training exercises that have previously been the norm, and it is hoped that the format will have greater appeal to private industry as well as lead to more frequent training sessions.

It is 08.00 in the morning and the umpires and organisers of Exercise Winner are gathering at Vector Aerospace's facilities in Gosport to assess the performance of four types of emergency responders during a complex, three-scenario training exercise.

Heading the exercise are Chas McGill MBE, Hampshire Fire & Rescue Service, and PC Mike Batten, Hampshire Constabulary. Both are highly experienced in organising complex training exercises that involve multiple emergency response agencies working together with organisations that range from airports, refineries, and stately homes to shipping line operators. For today's project, it is the aerospace industry.

One of the aims of the project is to test the principles of JESIP, the Joint Emergency Services Interoperability Programme. This was set up in 2012 to attempt to address once and for all the difficulties surrounding inter-agency communications during large-scale incidents.

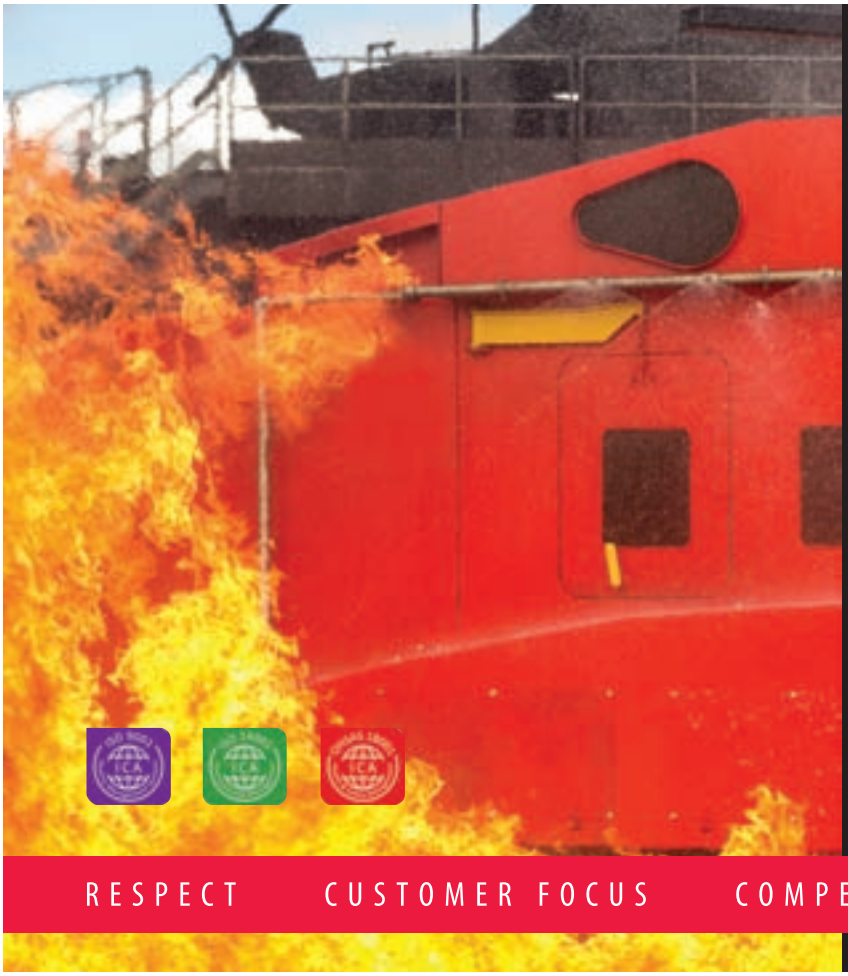
JESIP resulted in practical guidance to help improve multi-agency response as well as a standard approach to multi-agency working, including training and awareness products to enable organisations to train their staff. Its five principles and models can be applied to any type of multi-agency incident: co-locate; communicate; co-ordinate; jointly understand risk; and share situational awareness.

Whilst waiting for the briefing I meet one of the umpires, Colin Falconer, operations manager for BOC Gases, the largest industrial gas separation company in the country. Having served with Hampshire Fire & Rescue for 27 years as a retained firefighter, he will have the benefit of seeing the exercise from two perspectives.

'I'm not interested so much in the operational side of it. I want to see that the services are working within the spirit of the JESIP framework and understand it, making sure that information is being passed on accurately and everyone understands what the plan is.'

At 08.30 PC Mike Batten leads the briefing outlining the scenario: an aircraft approaching Vector Aerospace's airfield has crash-landed, with resulting debris striking two vehicles carrying four occupants. After screeching across the concrete apron, the main fuselage has come to a stop next to the entrance of a hangar, depositing additional burning debris and aviation fuel inside and injuring people in the hangar.

Top: a firefighter from Vector Aerospace rushes to deal with the burning helicopter. Below: responders approach a nearby hangar which has been set alight by burning debris.



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Vector Aerospace resources were the first on the scene, followed by Hampshire FRS, Hampshire police and the Hazardous Area Response Team from South Central Ambulance Service.

Three distinct scenarios will be taking place simultaneously: two vehicles with persons trapped on the roadway; an airframe with crew trapped; and a hangar with persons reported missing/injured.

The exercise umpires, armed with their evaluation sheets, are split between the three scenarios, plus wherever the command and control group decides to set up to coordinate the incident. Witnesses sport differently coloured tabards to signal their role: purple for umpires, orange for directing staff, blue for observers, and red for the site's safety officer. The umpiring team is ready, and spirits are raised further when Batten tells them that bacon rolls are being provided by the host site after the first exercise, and again after the second.

The exercise will begin properly with a call from Vector Aerospace's control room to the Hampshire FRS control room. The first on-scene deployment will be Vector's own ARFF vehicle, closely followed by Hants FRS, police, and medical response in the form of the Hazardous Area Response Team (HART) from South Central Ambulance Service NHS Foundation Trust.

HARTs were established in 2004 to provide medical teams to patients in hazardous environments, essentially bringing treatment closer to the patient in such situations and giving them a greater chance of survival. Due to the nature and requirements of their roles, team members are highly trained in a variety of response specialisms.

In the HART vehicle is team leader, Paul Haly, who explains that HARTs normally deploy in teams of six."sually for an exercise such as this we would expect to have one full team participating with members from a second team acting as directing staff. Today we will be exercising with one team so we will be taking on a variety of roles throughout the exercise."

At the incident ground preparations are in full swing, with smiling victims being made up with horrific-looking injuries and receiving instructions for their roles ('your leg is trapped under a pedal', 'yes you can speak, say your chest is hurting'). Smoke from a portable smoke machine is gradually filling the hangar. The tray full of flammable liquid is being primed for ignition next to the Lynx helicopter's air frame.

During this build-up the umpires get to know each other better. "This is exactly what we need to be doing but we don't do enough of it,' says Tim Pettis, emergency planner for Southampton and Hampshire County Councils, and a seasoned umpire at this type of exercise. Pettis adds that in the event of a large-scale incident, for example one involving a release of toxic gases, he would be involved at a strategic level, advising on how to protect public health. 'It's all [good] learning. A lot of our challenges are around command and control and on-scene integration of agencies. Ultimately something [useful] will come out of this."

For some, the focus isn't just on the quality of communications between the various municipal responders, but the communications between municipal responders and the operators of the site where the incident occurs.

Getting businesses and industry involved in collaborative working is crucial, says Colin Falconer. "At the end of the day, if you have an incident on your site, when you make that 999 call you need to have systems in place, as well as people who are familiar with your risks and understand what your principle controls are. Likewise, site operators and businesses have to be aware of what the responders' expectations are. Having been in the service myself, there's nothing worse than driving up to the front gate of a refinery or chemical plant at 3am and being told you can't come in. Or the security guard waves in the general direction of the incident, and says: 'it's just there mate Just a minute, where's the responsible person?'"

It soon becomes obvious that for the people gathered together in Gosport this morning, the exercise is much more than a box-ticking exercise with a few more bells on than usual. It is a chance to prepare for the type of incident that they know will happen sooner or later.

"There were several high-profile incidents in refineries in the 60s and 70s, including pipe-work failure due to construction materials or corrosive materials passing through the pipe-work,' comments Falconer. "A lot of work has been done to prevent that, but we are still boarding oil for processing hydrocarbons or distilling liquid oxygen 24 hours a day, and the physics and chemistry don't change. You have to get those conditions completely right or you can have a major incident.

"I think because there hasn't been a major incident for some time, memories have faded, and many people who were in the services who gained experience from those incidents have left. Most people haven't seen that sort of thing." Falconer's father, as it turns out, used to head up the industrial emergency response unit at Fawley Refinery.

Recognising a problem is one thing and doing something about it is another. While we wait for the exercise to begin, Falconer explains how his company is putting theory into practice.

"' left Hampshire Fire five years ago and in that time there has been a big turnover of people. I was very conscious that the fire responder stations to waterside industries may have no understanding or experience with the sites, so I arranged some visits from local stations. We demonstrated the properties of liquid nitrogen from the perspective of asphyxiation, and those of liquid oxygen from that of combustion. Although liquid oxygen is inflammable, it strongly supports combustion. We had a digestive biscuit soaked in liquid oxygen, surrounded by brave firefighters standing around, and put a flame to it. "Ooomph, I've never seen so many brave firefighters take a step back so quickly – I have 1,500 tonnes of this agent in storage."

With that thought resonating in my mind, Exercise Winner finally kicks off and Vector's crash tender arrives, unloading a team of firefighters who quickly begin disgorging hose and tackling the flammable liquid fire by the helicopter.Hampshire's two fire engines arrive a few minutes later, followed by the HART vehicle.

With activities taking part in three different places, it is difficult to keep track of what exactly is happening. After 40 minutes it's time to ask exercise organiser Batten what the verdict is so far as regards inter-agency communications and incident handling.

"It could be better. I've just seen that fire, police and ambulance have finally come together by the Vector truck, but that's now 40 minutes in and I would have expected that to have happened some time ago. I think there are many isolated pockets of work going on, but I don't know whether anyone has actually drawn together all the various working elements to get an overall picture."

The incident commanders are yet to congregate around the fire command vehicle, parked around 70m away from the incident. 'It is a complex scene and you need to make sense of it quite quickly," adds Batten. "Until the debriefing it will be difficult to know what exactly is happening."

I wander down to the fire command vehicle and find nobody around but people soon begin to arrive. Outside the command vehicle I meet Paul Haly of HART again. He explains that the location of the incident is not large enough to warrant using an interoperability radio channel, which would enable him to communicate with the police and ambulance services by radio. Instead he'll use his team's radio channel.

'If it's going to be a protracted incident then it makes sense to adopt an interoperability channel. But at the moment we are responding to this situation as if it were a more complicated and large-scale road traffic collision, adopting much the same principles that we would apply to that situation. And now we have a focal point which keeps all the commanders together.'

Chas McGill of Hampshire Fire & Rescue Service, a communications interoperability expert, has no issue with the non-radio decision. "That's fine. Interoperability doesn't always have to be about radios, it's about talking with each other and communicating face to face."

Back on the fire ground, people's attentions are turning towards the RTC, where the methods being used and the time being taken to extricate a victim – an hour and ten minutes and counting – is causing some light-hearted commentary. "When they get the victim to hospital they won't be x-rayed, they will be carbon-dated," remarks one bystander.

Vector Aerospace site safety officer Brian Davis comes over and says that collaborations between industry and public emergency responders are important, reinforcing Falconer's point. "If we do have an incident we will be relying on these guys, so for us it makes sense that we all know each other. From their perspective, they get to use a real air frame, which they don't have access to every day."

Davis adds that Vector's response capabilities constitute two fire trucks and a 4x4 control vehicle. "Today has been a learning curve because the incident has involved a civil aircraft, which requires a slightly different response to one involving a military aircraft – not in terms of equipment and initial response, but in terms of the organisations that are called in to assist."

Over an hour into Exercise Winner and it is beginning to dawn on some people that some significant aspects have not been picked up by participants. The area where the aircraft has come down is potentially a crime scene, and the accident could be the result of terrorist attack even. Is evidence being preserved? Has the flight recorder been found? Has the Air Accidents Investigation Branch been contacted?

"Of course, if this had been a real incident the response would have been quite different," explains Dan Tasker, group manager at Hampshire Fire & Rescue Service. An incident with an airframe would usually have involved three or four pumps alone. Two appliances would have attended each of the other two incidents, while four pumps would have been used for the burning hangar, totalling between 60 and 70 firefighters.

'For an incident like this we would probably also have an air ambulance landing with basics doctors on board too,' he says, adding that it is not often that an incident location has so much handy landing space.

As the teams retire to their well deserved bacon rolls and coffee, the pre-exercise tensions are gone. There are smiles all round and a new sense of camaraderie. When the next incident happens, the crews may not be smiling but they will at least know each other a little better.

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High-intensity training

Smaller-scale, more frequent and intensive exercises supported by industrial partners may be the practical solution for multi-agency exercises in the future, writes PC Mike Batten.

The decision to condense Exercise Winner into two 90-minute exercises followed a review of previous exercises, which typically revolved around a single three-to-four hour scenario.

The new smaller-scale exercise would allow a 30-minute period for the responders to be deployed into the exercise and a 'golden hour' to actually deal with the scenario.

I was particularly keen to address previous problems we had encountered with resourcing sufficient police officers for the exercise, as well as giving them a better pre-exercise build up. We were also determined that the training should follow JESIP doctrine and stress its five principles.

We went back to basics and combined a class-based training element, adopting a 'crawl-walk-run' approach to make up a two-part package.

'Crawl-walk-run' is a recognised method of learning, commonly used by the military, particularly the US and UK. The methodology perfectly suited our circumstances and provided us with a good means of imparting the JESIP joint doctrine in a practical, easily understood manner.

Top: the exercise involved four locations with three incidents happening simultaneously. Below: the fire command vehicle, parked around 70m from the incident area.

We took a group of officers with very little or no exposure to larger-scale incidents and imparted knowledge through classroom-based training and tabletop exercises. The training consisted of a presentation of JESIP with real-world examples, including videos and accounts of real incidents.

The tabletop exercise was based on a hazmat incident caused by a multi-vehicle collision on a motorway. The training was presented by myself and Hampshire Fire & Rescue officers Chas McGill and Dave Graham.

This served as the foundation for the live exercise, the 'run' phase, where officers put into practice what they had learned in the classroom. The ultimate aim was for officers to have a better understanding of what the JESIP Joint Doctrine means in practice, and how to use it successfully to achieve 'joint working' and successful incident resolution.

The training was delivered to the same two shifts of police officers that would subsequently attend each session of the exercise. The class-based training was delivered in January with the exercise in April.

During this time we also went to Hampshire Fire & Rescue Service and South Central Ambulance Service's Hazardous Area Response Team, who were keen to be involved. Once all partners were engaged, we formalised the exercise structure and resourcing with Vector Aerospace.

Vector provided a secure exercise area and the involvement of their on-site fire service as well as support facilities. The venue afforded us a safe learning environment out of public view, minimising any inconvenience to the public. The supply of an old Lynx airframe also greatly assisted with the realism.

There were elements of the on-site, internal response that Vector wanted to test, so we ensured these were incorporated from the outset, including a media management element.

During the build-up we invited and briefed representatives from each agency as well as private industry to act as umpires, using the JESIP Umpire Evaluation Log. This was a major part of the training, as we wanted to ensure that we

captured all the learning from several different perspectives. Umpires were assigned to each of the three sectors within the exercise, as well as to wherever the command point would be established on the day. We also arranged for the exercise to be professionally filmed.

When the emergency services are called to industrial premises, it is important that the site operator understands how the responders will establish command and control, and the framework they will use to understand the incident and develop a response strategy. This has to involve the site operator, so it's important that they take part in the training process. This should be an important component of future emergency and local resilience planning.

On the day of the exercise, each scenario was set up with live casualties in two cars who would need to be extracted. There were also two live casualties in the airframe and a mix of live casualties and dummies in a hanger. For added realism, we employed a smoke generator and a propane-fuelled burn tray to simulate burning aviation fuel.

The umpires observed how well the various responders integrated their activity. Of particular interest was how well the various agencies and incident commanders employed and adhered to the JESIP principles. Personnel were deployed according to a timeline, both to simulate actual response times and to prevent mass arrival.

The exercise was repeated with HFRS crews arriving in reverse order and a different team of police officers. HFRS and HART had the benefit of reviewing and acting on lessons learned in the first exercise, whilst the police team was fresh.

Overall the two exercises were very successful. The 90-minute format was more intense and all responders were able to put their theory training and JESIP principles into practice. It was generally agreed that the second exercise ran more smoothly, almost certainly due to the experience gained in the first exercise.

The 'victims' receive last-minute instructions about their injuries.

Exercise Winner's format directly addressed many of the hurdles associated with large-scale, protracted exercises as regards to the financial costs and logistic complexities for individual fire, police, and ambulance services.

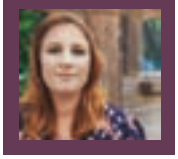
Smaller scale, shorter, intensive exercises supported by – and in company with – industrial partners and stakeholders may provide a better solution to ensure training is relevant and frequent enough to enable a better learning experience for all concerned.

Mike Batten, Hampshire Constabulary

Taken for granted

Ensuring the reliable performance of a fire-water mains system is a matter of taking responsibility and facing the realities on the ground, write Kees Kappetijn and Tessa Heye.

Kees Kappetijn and Tessa Heye are consultants at Kappetijn Safety Specialists



Basic documentation on performance; an adequate inspection, testing and maintenance policy; and a quality-driven replacement parts policy are amongst the key aspects that are required to ensure a fire-water mains network performs when it is needed.

A well-functioning fire-water mains network can make the difference between redeemable damage to company assets and bankruptcy as a result of the complete obliteration of the company. Not forgetting that the safety of often large numbers of firefighters depends on it.

For the high-hazard industry, cooling water and fire-water systems belong to the category of basic infrastructure that includes roads, sewage systems, primary facilities and water treatment systems. It has to be there, the corporate processes depend on it and it should function preferably in such a way that its presence is forgotten. But that's where it all goes wrong – the availability of the basic infrastructure gets taken for granted.

We forget not only that these complex systems are subject to wear, damage and ageing, but also that their specifications and performances were determined when they were first installed and that they require proactive upkeep and periodic testing and inspection.

Exotic mussels and cockles that arrive in ships' ballast tanks are unwelcome visitors in fire-water networks around Dutch ports.

For a fire-water mains network there is an extra layer of complexity in that its functionality is subject to boundary conditions during fires and incidents. The required performances are extreme in that they have to be provided within five seconds and potentially maintained at full performance for a long period of time.

While water or lack of it can make the difference between life and death during a deployment to an industrial fire, cooling water and extinguishing water systems and their associated aspects (pumps, hydrants, monitors, faucets and closers) often don't receive the attention that they deserve.

Inspection, testing and maintenance programmes are not drafted or are not followed; the insides of pipelines are not periodically cleaned; changes are insufficiently documented and communicated; and supplementary parts do not have the same specifications as the originals. It is not unusual for a site plan to be altered and new structures constructed on top of underground pipelines.

Many things can be done to place the fire-water mains network high in the list of corporate management systems. Ideally in a position where proactive upkeep is the norm and where replacement of parts can be gathered from a periodical inspection as opposed to from failure during an incident. And where technical norms and safety demands determined the budget, not the year-target of the purchasing department.

The situational factors and the judicial regime of water mains in the Netherlands provide a useful context for these challenges.

A river delta area in northwest Europe, the Netherlands is a flat country with a lot of surface water, of which over 25% lies below sea level. It hosts many industrial areas with concentrations of high-hazard companies that fall under the Seveso category, such as refineries, storage tank farms, chemical factories, container storage with hazardous substances, waste disposal, container transport, railyards, etc. In total there are over 500 companies divided over multiple clusters, many of which are in ports with connections to open water and intensive intercontinental shipping.

The development of industrial activities with large quantities of chemical substances dates back to post WWII and subsequently took off in the 60s and 70s, with large industrial areas being established by companies such as Shell, BP, Akzo,

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DSM, DOW and Exxon. Today, these areas are commonly owned by multiple parties focussed on one or more specialisms.

Requirements to install and maintain a fire-water mains network on site are embedded in the environmental license. The operational performances of a network, however, which includes pump capacity, volume of water, pressure, flow rate, water throw, are determined by the operator and are based on safety studies of the industrial processes and the possible incident scenarios. The length of a network can vary from several kilometers to possibly 80km of pipeline in the case of refineries. Companies with large quantities of chemicals can be mandated by the regional safety authority to maintain a corporate fire brigade. In that case, the requirement will also stipulate details on the performance of the fire-water mains network and the policy for inspection, testing and maintenance.

These legal high-level requirements, however, do not take into account a number of factors that relate to the practicalities found on site. The supervisory requirements that are theoretically necessary to ensure adequate maintenance, for example, do not take into account the real-life conditions found on the ground.

Here, many fire-water mains networks do not meet the required performance standards; they have suffered accelerated deterioration as a result of the action of salt, acid, water, oxygen and bacteria. In addition, the extinguishing water networks are also significantly affected by factors related to the link with the open sea. Ships that fill their ballast tanks in countries such as Korea, Japan or Brazil and dump those in a Dutch port are also depositing exotic mussels, shells, cockles, tube worms etc. They end up in extinguishing water networks and block pipes, filters, pumps and ancillary equipment. Another consideration for maintenance staff, firefighters and inspectors who work with the network is that the water can also contain more invisible hazards. Even though the water in Dutch rivers and ports is getting cleaner, cholera and paratyphoid can still be found there. And don't forget the threat of legionella, which thrives in hot summers and in the still water inside the pipes.

The risks connected to a fire-water mains network demand a control strategy from different safety angles and thus also different supervisory authorities. Whether there is sufficient extinguishing water during an incident is a question for an incident management team, for which the safety authority is responsible. Whether a system is maintained properly and there is no risk of emissions into the environment falls to the environment agency. In what measure the maintenance crew and fire brigade can work safely with the network and without any risk to personal health is a question for the labour inspectorate. Assessing the threat of foreign organisms inside the fire-water mains network is the responsibility of the food and consumer product safety authority.

The risk profile of a fire-water mains network at this high level, however, is often unknown by the operator, because the relevant information is often scattered in different locations. To make things worse, the Dutch authorities don't currently have an integrated supervisory policy.

There are five basic aspects that enable the professional safeguarding of an extinguishing water network.

First is the availability of basic documentation regarding primary performance. Documentation and safety studies that provide the performances and specifications of the fire-water mains network should be available to provide the reference for whether the performances are being maintained. Such information can disappear easily as a result of corporate takeovers, outsourcing of maintenance and changes in personnel. Another complicating factor here is often that changes and extra additions to the network are not sufficiently documented over time – if at all. How the extra demand for water affects the original capacity of the network is thus pure speculation.

Second is the drafting and executing of an inspection, testing and maintenance policy. Control and maintenance of a fire-water mains network should be anchored in an ITM plan. The policy could refer to associated guidelines such as the NFPA or FM-Global. At the very least it should lead to a proactive approach where things that are under-specification are replaced, as opposed to merely replacing things that are already broken.

Thirdly, procurement of replacement parts should be about quality and not budgets. One should not consider the availability of cheaper alternatives on the market that appear similar but are internally weak(er). Replacement of parts of the fire-water mains network should primarily be driven by safety and reliability from an engineering point of view, followed by procurement procedures and costs.

The fire-water mains network should be branded as safety critical in the safety management system of an organisation. That means that alterations and additions are automatically part of a management-of-change-process. This should lead to changes always being viewed at a strategic level, and for these to be documented and communicated.

Lastly, where a service provider is used, then they should be actively monitored. As such service provision is often more budget-motivated than quality-motivated, it is important to determine the quality of the fire-water mains network, and the activities necessary to realise that quality, via clear key performance indicators. This ensures that the operator's ITM plan becomes part of the relationship with the service provider. A clear division of responsibilities ensures that the service provider carries out those activities for which the operator remains ultimately responsible.

Even with the implementation of these guidelines, fire-water mains networks will continue to wear and corrode as the result of the passage time. However, complying with these guidelines will ensure that the systems will perform when needed, because any significant corrosion, blockages, damage or breakdowns will have been identified and eliminated in a timely manner.

High-hazard companies that have to be prepared for large-scale incidents are increasingly investing in high-quality materials and processes, shrinking the environmental footprint and improving their emergency response. It is time for that investment to be extended to the fire-water mains network.

The fire-water mains network should be regarded as a critical element of the safety management system.

Spike issues

An engineered solution played a small but vital part in ensuring the integrity of the fire-protection system of the gas development project on Sakhalin Island, Russia.

A special relief valve had to be engineered to remain in an open position during pump start-up to cope with spikes of up to 700psi.

The Sakhalin project is a two-phase, on- and off-shore oil and gas development on Sakhalin Island, Russia, located in the Okhotsk Sea. The project is owned and operated by Exxon Neftegas. Combined, the Sakhalin phase 1 and 2 reserves contain an estimated 1,200 million barrels of crude oil. The project includes Russia's first LNG plant, and is expected to contribute billions of dollars to the Russian economy. The first Sakhalin 1 well was drilled in 2003.

After construction of Sakhalin-1, a water hammer spike was detected in the firewater system. Hydraulic analysis revealed that the problem was caused by entrapped air at startup of the main, diesel-driven vertical turbine pumps, which created nearly a millisecond spike of pressure up to 700psi.

As fire protection systems are typically designed to a maximum operating pressure of 250psi, a pressure spike of this magnitude placed significant stress on all parts of the system, including pipes, valves, pumps, and other components. This could lead to leaks and premature equipment breakdown as well as safety and environmental hazards.

Anxious to avoid a similar situation in the Sakhalin-2 system, Exxon Neftegas, through Worley Parsons Engineers, contacted Bermad to determine how the problem could be solved.

Following a review of the situation and the project requirements it was decided that the ideal solution would be to construct a special relief valve which, in contrast to a standard relief valve, would be kept in a normally open position.

The result, the FS-748-BL-AB multifunctional valve, is equipped with a lifting spring and double chamber actuator that enables multi-functional operations. At pump startup, the spring holds it open, allowing all the air to vent from the system. Once the system reaches 1-1.5bar of pressure, the valve closes and enters its pressure-control operational setting. During operation it operates as a normal fire-pump relief valve.

All three diesel-driven, vertical turbine, main fire pumps for the Sakhalin-2 project were subsequently equipped with 10-inch nickel aluminium bronze FS-748-BL-AB multifunctional valves, with Monel tubing and fittings for corrosion resistance. The manufacturer also provided all operating and maintenance manuals for the new valve in both English and Russian versions per client request.

The multifunctional valves successfully prevented high-capacity, fire-pump water-surge issues at Sakhalin-2, preventing damage and ensuring optimal safety and longevity of the fire protection system.

Since then, the valve has been used in several other fire protection systems, including Exxon Mobil's offshore Hebron field in the North Atlantic, for which over a dozen multifunctional valves were supplied containing special materials, including super duplex stainless steel.

The 748 model has now been updated to the 730-48 valve, and is on its way to becoming a preferred choice for water hammer protection in fire protection systems with vertical turbine fire pumps.

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Go large

The increasing size of industrial facilities is driving the design of ever more powerful and versatile response equipment, writes Jose Sanchez de Muniain.

The introduction of a mobile, remote-controlled monitor that can flow at nearly 18,927lpm (5,000gpm) is the latest innovation unveiled by US Fire Pump to assist the safe extinguishment of large-scale incidents.

Chris Ferrara

The Remote Track Monitor can be operated from a trailer or deployed with the track unit.

The Ferrara name became famous when the manufacturer's Inundator Super Pumper broke the Guinness World Record for highest pumping capacity fire engine with a flow rate of 20,789lpm (5,492gpm) measured in 2015 in a test performed under NFPA guidelines. While the company founded by Chris Ferrara changed hands in April this year to the REV Group, Chris Ferrara's other company US Fire Pump is continuing the tradition of offering specialist solutions for large-scale industrial incidents.

A number of developments have been made to the existing range manufactured by US Fire Pump. The performance of the High Velocity Pump on the record-breaking Super Pumper has been enhanced to pump over 23,650lpm (6,250gpm) from draft and to over 37,800lpm (10,000gpm) from a pressurised source. The pump, which was originally offered in cast iron only, is now available in bronze or stainless steel to accommodate salt water applications. The constant search for pushing the limits of water application, says Ferrara, is purely driven by the market: "When you look at industrial facilities, they are getting larger; storage tanks are getting larger while the footprint of these facilities is getting smaller. So there are smaller alleyways and smaller access areas. Years ago it would take four or five fire trucks to fight a fire but with this equipment it takes one fire truck, which means you can get closer to the fire," says Ferrara.

Bigger fires also require bigger flows of water, continues Ferrara: "When you look at a fire column, the heat produced is so great that an aerial device flowing only 4,731lpm (1,250gpm) is not even going to break the thermal barrier to penetrate the fire. You have to have a delivery device of 30,283lpm (8,000gpm) to penetrate the thermal column and put the fire out. Big fires take big water devices and big water flows," he says.

High-hazard industry appears to be taking the message on board. Last year a Super Pumper was delivered to Sasol's emergency management team in Secunda, 120km east of Johannesburg, replacing a 16-year old Eagle 1 fire truck. Also last year Oman's largest oil company, Orpic took delivery of a Skyflow SP-100 Ladder capable of flowing nearly 19,000lpm (5,000gpm) from a 30.5m height; the specific requirement here, says Ferrara, was tackling a potential fire on a coker unit positioned 75m above ground. More recently the company has taken an order from a large refinery in Canada for seven large industrial Mobile Pump Units, each capable of supplying up to 23,658lpm (6,250gpm), which will be configured into two sets trailer-mounted fire-fighting systems and one for training and back-up: two MPUs will push each 17,034lpm (4,500gpm) from draft at 4.5m to a relay MPU that will push 34,068lpm (9,000gpm) of water at 175psi.

However, the key message isn't just about size, emphasises Ferrara, who points out that a solution has to bring together a number of elements, starting with the hazard: "Ideally we like to visit the site and develop a water system from which an operator can chose a total solution, from a fire-fighting

standpoint. We are just filling the needs of our customers.''

The latest answer to the complex and changing requirements of high-hazard industry is the Remote Track Monitor, launched at the Fire Departments Instructor's Conference held in Indianapolis in April.

A patent-pending device that is specifically designed to tackle hazardous incidents without putting firefighters' lives at risk, the system comprises a remote-controlled monitor and a separate remote-controlled vehicle that runs on two tracks and which transports the monitor. The Remote Track Monitor can be controlled from over 400m away, using its forward and rear mounted cameras which transmit footage to the operator's tablet; at night the vehicle's LED lights enable its movement to be visually tracked.

The unit, explains Ferrara, has been two years in designing and testing. The rubber tracks were specifically selected to enable the unit to push through any debris likely to follow an explosion, as well as to manoeuvre over tank dykes, mud or snow. The remote-controlled monitor is transported on a trailer which means, depending on the type of incident, it can be operated while on the trailer or, if necessary, deployed with the track unit into the hazardous area. There, the track unit can then offload the monitor and leave the fire ground or remain on scene. ''If the track unit is pulled out then it can then be put to other uses, such as transporting foam totes to the monitors,'' says Ferrara.

The diesel-powered unit is capable of lifting just under 1.5 tonnes in weight but its operation does not require a certified forklift truck driver, as per US Occupational Safety and Health Administration requirements, which increases its versatility. An optional grabbing attachment also widens the unit's range of applications, enabling an operator to remotely take a hazard and transport it to a less sensitive location. ''There are other remote controlled monitors that flow around a fifth of the water than this one, but we wanted to achieve more versatility,'' says Ferrara.

The theme of doing more with less runs through other innovations that the company introduced in April, as demonstrated by a new lightweight and compact submersible pump and power unit that is capable of flowing over 11,000lpm (3,000gpm). ''The basic concept here is that you can turn your three-quarter-tonne pick-up truck into a 3,000gpm pumper capable of feeding three fire trucks from alternative water sources,'' says Ferrara.

While the FDIC saw a whole raft of innovations from US Fire Pumps a big announcement is planned during Texas A&M Engineering's Industrial Fire School taking place in July. While Chris Ferrara is not revealing anything at this stage, whatever is planned is likely to involve water, and lots of it.

The new hydraulic submersible pump and power unit can be transported on the back of a pick-up truck.

Sudden mist

A modular and mobile high-flow generator capable of producing 4,500 litres per minute of fine water mist is the latest high-power cooling solution for industrial fire-fighting, reports Jose Sanchez de Muniain.

In optimum wind conditions the system that has been launched by Liberty Gasturbine Holland can generate a 180m-long, 40m-wide throw with a maximum height of 80m. The water droplets, which are blown out of the turbine at speeds of up to 650km/h, measure an average of 400Mu, covering an area between 1,500 and 2,500m2, the latter when in a fixed position. As well as standard water the system can flow seawater, foam premix or foam concentrate.

The key benefit of the system is its cooling capacity, which is estimated by LGH to be six times higher than could be achieved when using a straight stream or fog stream generated by a monitor, with the same amount of water.

The TRS2500FOG turbine is primarily aimed for use at refineries, chemical facilities and storage tank farms, where the heat of a fire in one area could spread to adjoining tanks, in the so-called domino effect.

The TRS2500FOG consists of five main components; the base frame with batteries, pumps, hydraulics, control system; the U-frame, which connects the base to the turbine frame; the turbine itself; the operator's panel; and a separate fuel tank

The modular design, explains LGH managing director Michel Kooij, meets the modern requirement in industrial fire-fighting for equipment that can be configured differently according to the incident and/or hazard. In relation to the TRS2500FOG this means the operator can choose different set-ups of fuel tank, water/foam supply and transportation method.

The system has been designed to be operated by a single firefighter with a simple cable or wireless panel, which hydraulically controls the speed of the turbine as well as its angle and direction.

If pumping foam, the manufacturer believes the system is powerful enough to potentially extinguish a fire on a 40m-diameter storage tank; however this is not its intended primary use, which is cooling and/or creating a thermal barrier, and the TRS2500FOG should not be used to replace a large monitor: "We are talking to fire chiefs of the larger chemical plants and refineries and they all agree that cooling is the most important aspect after extinguishing, to avoid boil-overs and spread of fire," says Kooij.

The use of turbine engines in these types of applications is not new; their history goes back to the burning oil wells in Kuwait in 1992 after the Gulf War. LGH has sold around 28 similar systems over the last 12 years to various high-hazard installations. In fact, through the use of different attachments the turbine engine-driven system has also been used as an inert gas generator flowing at 25m3/s; in applications involving drying surfaces or melting snow; and as a decontamination turbine.

What is new in the TRS2500FOG system, however, is its nozzle, which injects the water or water/foam into the outlet stream of the turbine. This nozzle has taken two years to design and test and it is responsible for the longer throw, smaller water droplet size and wider spread of the stream. It is designed to produce droplets 400Mu-wide because this has been found by LGH to be the best compromise in terms of throw length and performance; a smaller droplet would increase length but lose performance. The manufacturer's research also indicated that using this droplet size resulted in the same cooling capacity as using six times the volume of water.

The nozzle system has been enhanced with two caps that can be quickly removed to clear any debris that could block the system, such as mussels and other particles, without the need for nozzle adjustment as per a previous version. The process takes less than a minute.

Since the unveiling of the technology in summer last year LGH has received interest from airport authorities that see its potential application in ARFF, where a common incident involves burning fuel underneath the aircraft resulting in toxic gases being released inside the cabin: "All the fabrics and plastics in the plane start to melt and burn and 95% of passengers are actually dying from toxic gas inhalation and not from being burned," explains Kooij, "What the turbine does is blow away the flames, heat and burning kerosene, cooling the undercarriage, enabling passengers to leave via the shoots and even to be soaked with water without risk of injury, as would be the case with the strong stream of a water monitor. And the passengers can still breathe cool air as well."

The new system is available for short or long-term hire: for the last 15 years LGH has had an emergency response team based in Holland that is available 24/7 for call-outs worldwide and is equipped with six standby turbines, which can also be air-lifted by helicopter.

The company is currently in advanced negotiations with seven potential clients located in six countries, all within the chemical and refining sectors. In addition, LGH is also in discussions with two major airport authorities. "We are extremely happy because the response from the market has been way better than we expected," says Kooij.

The turbine generates water droplets only 400Mu in diameter, ideal for cooling storage tanks.

Robot turbines

The successful deployment of a mobile fire-extinguishing turbine has prompted the delivery of a second unit to the largest site in the Bavarian chemical triangle.

Wacker Chemie has ordered a second Magirus Aircore TAF 35 turbine for its plant in Burghausen, Germany, 110km east of Munich on the Austrian border, where 10,000 employees are based and where innovative fire-extinguishing technology is tested for potential use at other sites. Around 3,000 products are manufactured at the 2km2 site from raw materials comprising silicon, methanol, ethyline, acetic acid and rock salt.

The TAF 35 has been built by the Italian engineering firm Emi Controls in partnership with the German fire-fighting manufacturer Magirus. Similar units have been supplied to Audi in Germany and Mexico, Miro refinery in Germany, Ilva Steel in Italy, Evonik in Germany and Italy as well as a number of municipal brigades in South Korea, Italy, China and Turkey.

The Aircore units at Wacker are mounted on a crawler that can be quickly transported to any part of the site on a swap-body vehicle. Their especially-patented nozzle technology can spray up to 1,500 liters of water or foam per minute in a fine mist, which has the side effect of shielding the machines for heat.

The turbines have a throw distance of up to 80m and have a variable height position of up to 4m. The turbine section is rotatable by 360 degrees, can be raised by 50 degrees and lowered by 20 degrees. In addition, a mounting on the lift arm enables the crawler to overcome ledges or pipelines during use.

The first turbine was commissioned in December 2015; since the end of last year both are being used to protect open sections on the pipeline as well as to extinguish incipient fires.

The Aircore last saw action during an incident in summer last year when a fire developed in the chemical production site following a leak of a corrosive, flammable liquid that combusted immediately. Initial extinguishing attempts, described as only 'moderately successful', were followed by the deployment of the turbine, which extinguished the fire in minutes. Vincenzo Bucci, head of technology for Wacker's fire department in Burghausen, takes up the story: "We used the remote control to direct the Aircore TAF35 safely to the fire, raise the turbine with the lift arm and – thanks to the built-in camera system – directly target the source of the fire, without endangering any firefighters.

"Water or foam was selectively and efficiently used for direct fire-fighting. No comparable fire truck on the market can do this." Bucci added that he was particularly impressed by the low noise level of the turbine, which meant that even when at its loudest, it still allowed communications between the responders.

The potential further deployment of the same technology at other Wacker Chemie locations in Germany and abroad is currently under consideration: "Burghausen is our biggest plant; this is where we test techniques and devices like the Aircore for later use at other production sites," says Bucci.

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Fast decon for hazmat

Three multifunctional fire and decontamination vehicles have been delivered to National 119 Rescue's headquarters in South Korea.

The three new vehicles are designed to deal with all decontamination requirements for people, equipment and vehicles that have been exposed to hazardous substances.

Part of the Korean National Security Agency, 119 National Rescue was established in 1995 to provide rapid support to central government in the event of major and special disasters.

The three-axle trucks are fitted with extinguishing systems and a decon unit, with additional decon equipment carried on two-axle trailers. The aim of the equipment is to enable a minimum number of personnel to quickly provide decontamination during small and medium-sized incidents. Additional gear carried in the trailer can be used to deploy a mass decon facility for major incidents.

People and objects are decontaminated first at the rear of the vehicle, using a shower and a shoe-sole cleaning system, and then inside the vehicle within a wet cell.

The vehicles, which were made by Rosenbauer, also carry an area decontamination system consisting of two storage tanks, an integrated pump that is operated in pump-and-roll mode, a chemical mixer and a row of spray nozzles. The system is activated by the driver inside the cab, which is protected from atmospheric contamination by a three-level, overpressure filter system.

A cleaning line for mass decontamination can be set up outside the vehicle using the equipment in the trailer. This includes a three-line shower tent for personal decontamination, a drive-in, decon line for vehicles, as well as mobile technical cleaning units including water supply, folding tanks, a chemicals mixer, tent heating and air conditioning systems.

Power is provided by an integrated 40kVA generator as well as a portable RS14 generator in the trailer.

The new vehicles are designed to facilitate a hazmat response for small and medium-sized incidents.

FIXED TIC FOR AERIAL APPS

A new thermal camera that has been specifically designed for aerial apparatus applications has been launched by Flir. The KF6 is securely mounted onto aerial platforms and at the end of straight sticks to give firefighters a high-angle thermal view of elevated structures.

By identifying hotspots as well as seeing through smoke and in darkness, it can improve situational awareness as well as assist in planning fire attacks.

The camera's 640x480 infrared resolution provides thermal images with sharp detail, aided by a wide 69 degree field of view and Flir's so-called flexible scene-enhancement technology.

The KF6 also offers live, thermal video on a monitor at turntable level, on an in-truck LCD, or on a screen on the platform via a single cable with a MIL-C connector. It is also possible to connect it to multiple displays using a wireless system.

The camera is capable of withstanding harsh operating conditions and is unaffected by smoke or water. Its rugged housings meets MIL-STD-810G specifications and it has undergone extensive IEC testing.

MORE ROOM TO MANEUVER

A roomier option for crew cabins is now available from fire-fighting vehicle and technology supplier Ziegler. The Z-Cab XL is designed as a premium option in the Z-Cab range and comes in a number of different versions.

The cabin in based on a modular system and is designed for comfort, freedom of movement, and optimum crew communication.

In order to accommodate individual requirements, the Z-Cab XL comes in different widths and lengths. It can be configured with a generous width of 2.5m, or as a narrower 2.3m-cab for urban areas. There are also options for seat design, with ergonomic upholstered seats available. The new cabin improves on crew safety with the option of the Z-Protec airbag and belt-tensioning system that protects the crew in the event of an incident. The outer seats are equipped with head airbags for all body sizes to protect against serious head injuries. The cabin is mountable on all conventional fire engine chassis.

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In the mix

The use of a water-driven foam proportioner brings a number of benefits to a foam attack, writes David Owen.

David Owen is business development manager at Hawkesfire

The mechanics of fire suppression are best summarised as 'evolution not revolution' and foam proportioning is no different, with water-driven proportioning equipment becoming the preferred option for fixed extinguishing systems and mobile fire units over traditional technology such as bladder tanks, balanced pressure proportioners and fixed inductors.

A water-driven positive pressure displacement foam-proportioning unit is made up of two main elements; a water-powered motor and a mixer pump. The technology is characterised by the fact that it requires no other power source other than the incoming water supply. As there is a proportional relation between volumetric flow rate and revolution speed of the motor, changes in the volumetric flow rate have a direct effect on the speed of rotation of the motor drive shaft within the mixing pump.

One of the key benefits of the water-driven system is its flexibility to deal with different flow rates. Different proportioners can handle flows from 50lpm through to 20,000lpm. In addition, as each unit has a turn-down ratio of 10:1, there are a range of options; foam concentrate injection can range operationally from 0.1% to 1%, 0.3% to 3% and 0.6% to 6% or fixed mixing rates ie 0,5%, 1%, 3% or 6%, depending on the type of proportioner.

When it is necessary to mount foam attacks of sufficient volume to ensure control in large tank scenarios, the capability to provide large amounts of foam solution is imperative, as is the ability to mount proportioners at various points in the water-supply chain. This provides operational flexibility on the fire ground, which typically involves mounting a unit far enough away from the fire that it doesn't pose an unacceptable threat to firefighters. With water-driven foam proportioners, the run-out of hose or fixed pipe work is only limited by the pressure and flow available and, in addition, there are no back-pressure issues associated with inductors, because of the pump piston's positive displacement nature.

Indeed, while large volume fire-fighting techniques certainly have their place, there are numerous hazards that can be dealt with by using mid-range flow rates. With Fire Dos' units, these mid-range flow rates are accommodated typically around the 6,000lpm mark, in conjunction with monitors or fixed pourers.

Any discharge device can be used, from low-expansion branch pipes to high-expansion generators. It doesn't matter what's on the end as the positive displacement pump can overcome downstream backpressures as long as there is sufficient pressure from the main system pump. In the case of the Fire Dos proportioner, the pressure loss is typically no more than 1.8 Bar.

The evolutionary analogy also holds true in an environmental context. There have been growing concerns over the use of foam in situations where large amounts of firewater run-off are generated. Although the development of C6 AFFF and fluorine-free foam has helped to mitigate these concerns, a quantifiable method of further mitigating those effects is simply through accurate, less wasteful foam proportioning coupled with equipment and foam testing methods that do not involve discharge to the ground.

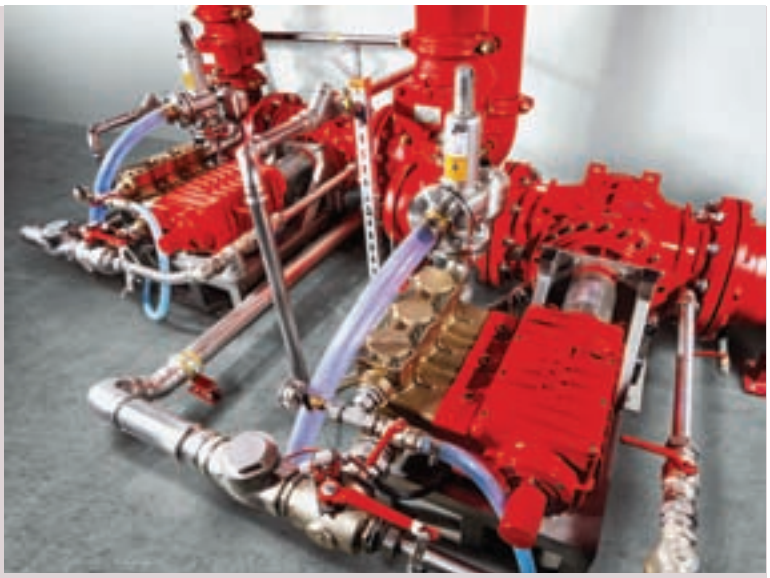
Traditional bladder tanks require a certain amount of foam solution to flow through the discharge device in order to then test the foam-proportioning rate via a refractometer. Not only is this wasteful of expensive foam concentrate, it also incurs additional disposal costs. These drawbacks are avoided by the water-driven proportioner, which returns foam concentrate back to the atmospheric storage tank and also uses flow meters to check water throughput. Furthermore, foam level testing is achieved through physical checks on the foam level rather than via the complicated process required by bladder tanks.

The relatively high viscosity of some foams is not a problem for a water-driven positive displacement piston pump. Wetted parts are either ceramic or highly resistant plastics, so aggressive foam concentrates don't affect the mechanism. Alternative materials such as Al Bronze are also readily available for harsh environments.

As with every evolution a step change in thinking is required, in this case a positive one. As bladder tanks were the favoured option in the past, users can find it difficult to assimilate that water-driven proportioners are not a 'one-shot' system. Unlike bladder tanks, which require a prolonged procedure for draining and re-filling, proportioners can be refilled during a prolonged incident as needed.

Whether it's to produce a wetting agent or traditional foam, a mobile capability is often the preferred option. Fire Dos' water-driven units for fire appliance or pod/trailer situations are sufficiently compact to be fitted into lockers, where the option to install the mixing pump on top of the ratio controller makes the package shorter but higher. They can also be incorporated into lifting skids when curtain-sided trucks carry Moffett Mounty-style fork-lift trucks to off-load IBCs of foam and the proportioner itself.

In the UK, this proportioning technology has been recently adopted by BP Kingsbury, BP Hemel, BP Hamble as well fire and rescue services in Essex, Manchester, Lancashire, Cheshire and Tyne & Wear. The use of water-driven proportioners continues to grow, particularly in the storage and refining sectors as well as municipal fire services.



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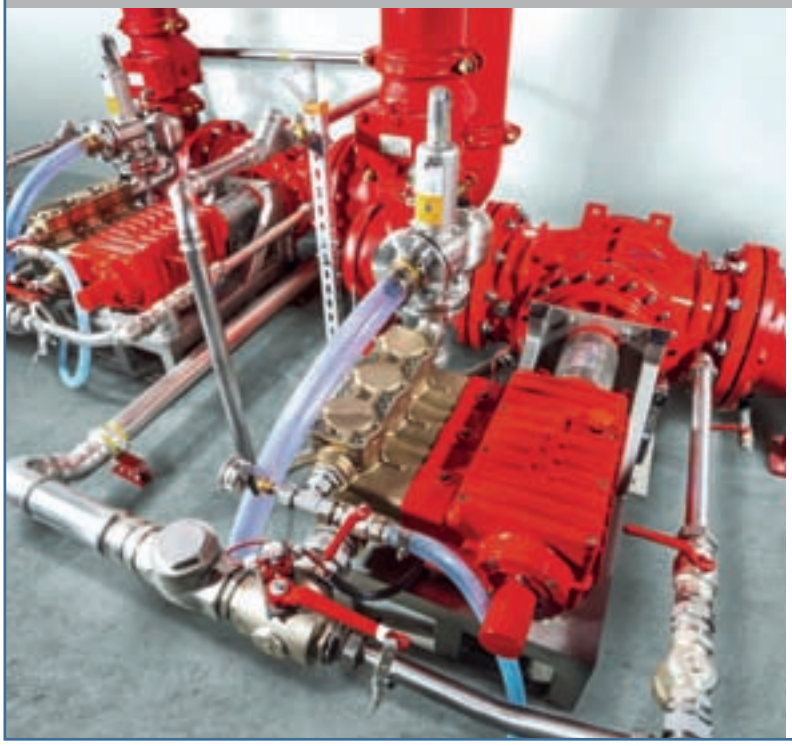

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Water power

Foam proportioners that mix water and foam concentrate without requiring supplemental power are continuing to grow in popularity, writes Jose Sanchez de Muniain.

The industrial fire brigade of Hexion in Letmathe, Germany has taken delivery of a foam trailer carrying a foam proportioner that can feed a monitor and two hand-held nozzles simultaneously.

Headquartered in Columbus, Ohio, Hexion is a world leader in the production of thermoset resins and operates around 60 industrial sites around the world. Its site near the town of Iserlohn, around 80km east of Dusseldorf, produces novolaks, resols, molds and powder resins.

The foam trailer was supplied by Schutz+Technik, an engineering firm that specialises in emergency vehicle design and conversion as well as fire engine and pump repair.

The industrial fire brigade of Hexion in Letmathe has been in operation from 1977 and is available for response 24/7, 365 days a year.

The trailer was commissioned in order to provide an interim rapid response prior to a full large-scale foam attack as well as to provide redundancy for larger incidents. It will also assist the fire brigade in fulfilling the requirements outlined in the TUIS framework, the transport accident and information sytem of the Association of Chemical Industries in Germany. The Firemiks proportioner was selected because it afforded a choice of dosing rates, a requirement necessary due to the wide range of chemicals at the site, which each require a different proportioning rate for effective extinguishment. The Firemiks FM 2400 proportioner can handle flows ranging from 240lpm to 2,400lpm at 16bar, with selectable proportioning rates of 1%, 2%, 3%, 4%, 5%, or 6%.

Firemiks proportioners require no supplemental energy as they use the pressure from the water to mix and discharge the foam/water mixture. The dosing rate adjusts automatically to the amount of water going into the proportioner; the more water that goes in, the faster the drive coupling rotates and the more concentrate is pumped through.

In addition to the proportioner, Hexion's trailer carries two 1,000-litre IBC foam container and an adjustable monitor that can flow straight and fog streams at 900lpm, 1,300lpm, or 2,000lpm. The foam proportioner supports the monitor and two separate B-Storz outlets for hand-held foam nozzles, offering the possibility to use all three simultaneously.

The Swedish proportioner manufacturer has also delivered a foam proportioner to engineering company Iskada for its installation in a fire truck destined for PKN Orlean's refinery in Mazeikiai, northwest Lithuania.

The Renault C 430 6x4 truck carries two watertanks with a total 4,000 litres of water and a foam tank with 2,000 litres of concentrate. The fire power is provided by a Johstadt NP6000S pump with a capacity of 6,000lpmat 10 bar and a Firemiks FM 4800-3-PP-F-ALU foam proportioner that can flow up to 4,800lpm at 3% dosing rate via five outlets.

Top: proportioner on a fire truck destined for PKN Orlean's refinery in Mazeikiai, Lithuania.
Right: the trailer for Hexion is designed to provide an interim rapid response prior to a large-scale foam attack.

FOAM GUIDANCE

Fire Protection Association Australia has published an information bulletin on the selection and use of fire-fighting foams. The document aims to increase awareness of the issues surrounding the selection of fire-fighting foams based on their performance, environmental impact, and system and equipment compatibility.

FPA Australia notes that although fire protection products must be environmentally responsible, other outcomes such as life safety, fire protection and environmental considerations cannot be achieved through the consideration of a single characteristic. Other aspects, including performance, personnel safety, environmental impact and compatibility with equipment and materials must be also considered.

Among the recommendations in the 24-page document are; that the use of foams containing PFOS should be banned and that existing stocks should be destroyed; that manufacturers should reduce and eliminate production of PFOA-containing foams; that foam users should seek evidence of foam performance for their application; that the discharge of foam should be eliminated where possible during training, testing and commissioning; and that all fire water should be contained, tested and disposed of appropriately.

*A copy of **IB06 Selection and use of firefighting foams** is available on Hemmingfire.com; search 'Fire Protection Australia'.*

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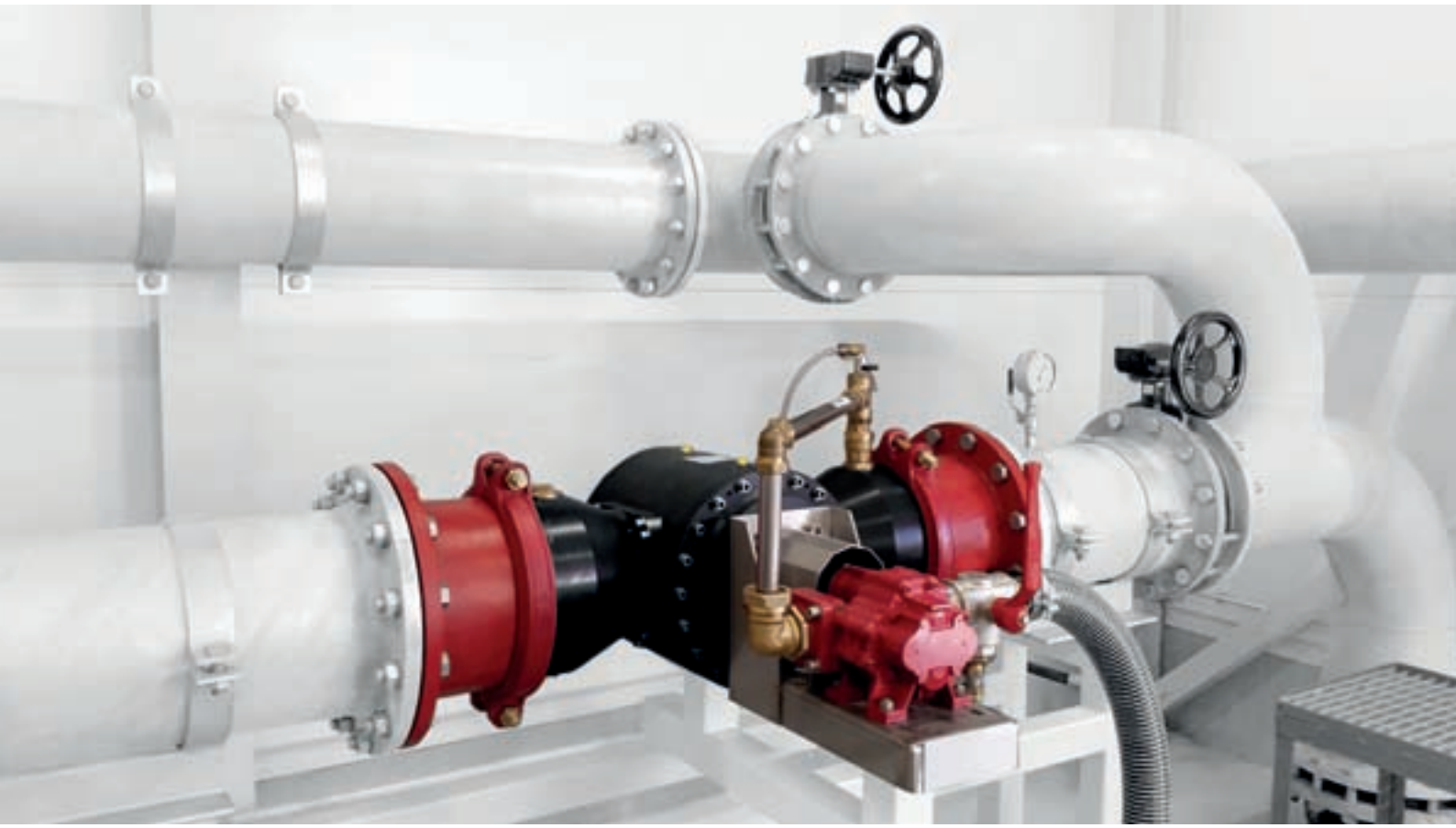

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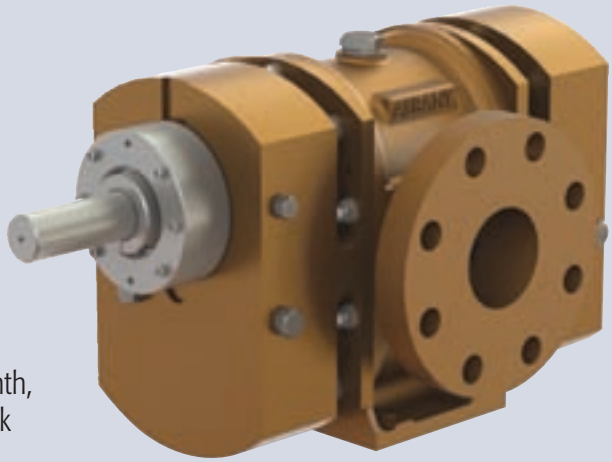

With new pumps and new foams reaching the market every month, choosing the right foam-concentrate pump can be a daunting task for engineers and fire safety officers, writes Geoff Maxted.

Geoff Maxted is a director at Albany Pumps

The gear pump has been historically the pump of choice for foam concentrates and it still takes the major share of the market, however both piston pumps and rotary pumps are now increasingly on offer and should also be considered.

The first question to be addressed is the type of pump needed: centrifugal or positive displacement? Both of these pumps work very differently.

The flow rate of a centrifugal pump at a constant speed will vary considerably with changes in discharge pressure, in contrast with a positive displacement pump where it varies very little. As a positive displacement pump's flow rate is proportional to its speed of rotation, it is the ideal choice for use with variable speed drives, including water-powered ones.

Another major difference between the two types of pumps is that a positive displacement pump's flow rate is not greatly affected by viscosity over a range up to and over 1,000 centistokes. A centrifugal pump's flow rate drops considerably as the viscosity increases, which means normally it is only used with liquids that have a viscosity below 500cSt.

In addition, in contrast with positive displacement pumps centrifugal pumps cannot self-prime; an additional consideration even if pumps on a foam system are usually started with a flooded suction.

It can be easily understood then why positive displacement pumps have been the pump of choice for foam concentrate applications.

Taking a closer look, the types of positive discharge pumps that are mainly used with foam concentrates are either reciprocating, piston-type pumps or rotary, gear-types pumps. By their very nature, reciprocating-type pumps provide a pulsing flow and require inlet and outlet flow-control valves. They are typically available with multiple heads to enable different percentage foams to be pumped. Rotary-type pumps are simpler and, depending on their pumping gear design, provide a relatively pulse-free flow.

Rotary pumps can either carry external or internal gears. The more widely used external-gear type comprises two gears meshing in a figure-8 shape; while internal-gear types carry one small gear with teeth on the outer diameter running in the inside of a larger gear ring with teeth on the inner diameter.

External type gear pumps come in two versions, those with external bearings and those with internal bearings. A benefit of the external versions is that their bearings are outside the pumping chamber, lubricated by oil or grease, so no consideration needs to be given to the nature of liquid to be pumped. A disadvantage is that if the bearings are a considerable distance apart, at either ends of the pump, shaft deflection can occur. While this is usually countered by liners fitted in the central part of the pumping chamber, the result is an increase in lifetime ownership costs as the parts wear out.

As external bearing-type gear pumps use timing gears to prevent the two metal pumping gears coming into contact, they are suitable for water as well as foam concentrates. On the downside, however, they require four shaft seals that may lead to high rates of foam seepage from the pump, something that does not sit well with many operators. Solutions are now available with short mechanical seals and a more compact design that reduces shaft deflection and therefore does not require liners.

Moving on to internal bearing-type gear pumps, these operate with bearings that are lubricated by the liquid and, consequently, are much more compact. Their minimal shaft deflection means no liners are required; timing gears are not needed on the internal bearings as the gear on the driving shaft drives through contact of the gear on the following shaft. As the bearings are lubricated by the liquid, however, the type of metal used on these gears has to be especially selected for the application.

Internal bearing type gear pumps use bushes that operate on either hydrodynamic or hydrostatic principles.

The hydrodynamic bush relies on a film of liquid that develops in the clearance between the bush and the rotating shaft. This liquid interface is self-renewing and, with the correct clearance, prevents bush and shaft making contact.

Top: Albany Pumps' GF 3.1 fire/foam pump is NFPA 20-compliant and is designed to handle liquids with a low viscosity. Below: positive displacement pumps have historically been the pump of choice for foam concentrate applications in industrial facilities.

The hydrodynamic bush's operation and life is dependent on three things: the viscosity of the pumped liquid; shaft rotation speed; and pump discharge pressure. The combination of higher viscosity, faster rotation and lower discharge pressure result in better performance of the bush, as well as longer life. Consequently, each pump model will have a minimum safe operating level at a certain speed, discharge pressure and foam-concentrate viscosity.

The hydrostatic bush is more precise in its design than the hydrodynamic bush; it incorporates channels through which the pumped liquid is forced under pressure to create a thin film between the bush and the rotating shaft, thus preventing friction.

The hydrostatic bush's operation is not as dependent on the criteria of viscosity, shaft rotation speed and discharge pressure as a hydrodynamic bush's operation. In fact, as the hydrostatic bush performs very well on liquids with a viscosity of 1cSt or less, water can be pumped.

The pumping of water has to be considered too because foam skids and other systems are tested on water for environmental and disposal reasons (and test foams which can be around 2cSt). To ensure good and reliable operational life, many operators conduct regular test runs using water, so pumps fitted with hydrodynamic bearings must have test limitations listed by the pump manufacturer in regard to minimum speed, maximum pressure and duration.

As a manufacturer, we receive many enquiries that only state the foam percentage to be used, which leads to additional requests for foam make and type so that data sheets can be examined to ascertain both the viscosity of the liquid and whether it is Newtonian or non-Newtonian.

The next common question we receive is whether a lower-priced hydrodynamic pump can meet operational requirements. If the pump under consideration has a fixed speed and the viscosity of the liquid to be pumped is lower than the manufacturer's recommended figure, then a larger pump should be examined. Its larger bearings will be more effective and they will additionally have a lighter loading, as the pumping gears will have to be reduced in length to achieve the required flow rate. If this still does not satisfy the requirements, then a more costly hydrostatic version has to be considered.

The hydrostatic version has a number of advantages over the hydrodynamic version, such as not requiring test limitations and the fact that it is not as affected by viscosity, which means there is less variation between test performance figures for water and foam concentrate.

Most manufacturers of the hydrostatic version will also manufacture pumping gears made of engineered thermoplastic, which results in smaller internal clearances than with metal gears, reducing the internal slip ie the flow of pumped liquid from the pressured side of the pump back internally through the clearances to the low-pressure side.

Seeing as positive displacement pumps have to discharge the liquid that they pull in – they won't 'paddle' like a centrifugal pump – a relief valve must be included in their design. While some may be supplied with an integral relief valve – a preference of fire truck manufacturers – it is worth noting that NFPA 20 stipulates that stationary systems must have a pipeline relief valve fitted with a relief line that is piped back to the foam tank. On stationary fire skids there is also an increasing requirement for approval by the likes of FM, UL, VdS and LPC, which includes the foam concentrate pump.

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Fuel for thought

The differences in performance between AFFF and fluorine-free foam on flammable liquid fires have been comparatively evaluated in over 80 fire tests conducted by Auxquimia. Javier Castro summarises the main findings.

Javier Castro is general manager at Auxquimia

Extensive fire testing has revealed that the difference in performance between aqueous film-forming foam and fluorine-free foam can be significant depending on the type of fuel.

From an environmental point of view, today's debates revolve around setting lower levels of PFOA, following the ban of PFOS, which now has a maximum limit of 10 parts per million. PFOA is not a raw material used in foam concentrate formulations, but rather a by-product or impurity that originates in the manufacturing process of fluorinated raw materials.

The first step towards its reduction was a voluntary EPA programme agreed amongst manufacturers of raw materials, in which they committed to eliminate fluorinated molecules with eight carbon atoms (C8) and to substitute them with six carbon atoms (C6). This significantly reduces the PFOA content in foam since the content of PFOA in C6 products is practically non-existent. However, this important breakthrough hasn't gone far enough for regulators such as the European Chemicals Agency, who intend to push acceptable PFOA limits to the realms of parts per billion (25ppb in the latest ECHA proposal), levels which are below the detection capabilities of most specialised laboratories.

Due to these regulatory pressures, foam concentrates without fluorinated components in their formulations have been introduced to the market as an alternative solution to aqueous film-forming foam and alcohol-resistant aqueous film-forming foam.

Fluorinated ingredients have several essential functions in formulation: the reduction of surface tension, which is required to enable film-forming; the provision of good oleophobicity, which is key to avoid foam contamination in forceful applications on hydrocarbons; a better heat resistance; and a better resistance on polar solvent fires, with alcohol-resistant foams.

It seems obvious that if we take this key element out of formulations, foam concentrates performance will be affected. Nevertheless, manufacturers are currently investing strongly in research and development to try and offer the best achievable solution to the end user, with a minimal environmental impact that is aligned with proposed environmental regulations.

So at what stage of the journey are we at now? Have fluorine-free foam concentrates been able to achieve the same fire performance as AFFFs?

As few studies exist that compare AFFFs and FFFs under the same conditions, Auxquimia decided to carry one out. The study, based on over 80 fire tests, involved five AFFF-ARs and five FFF-ARs from different manufacturers, which were tested against four different fuels.

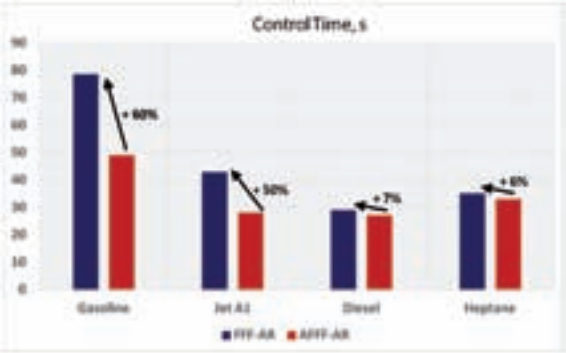
The primary aim was to identify the key differences between both types of foam in different scenarios and applications. The study did not intend to show the differences between the commercial brands but sought instead to discover the differences between both technologies.

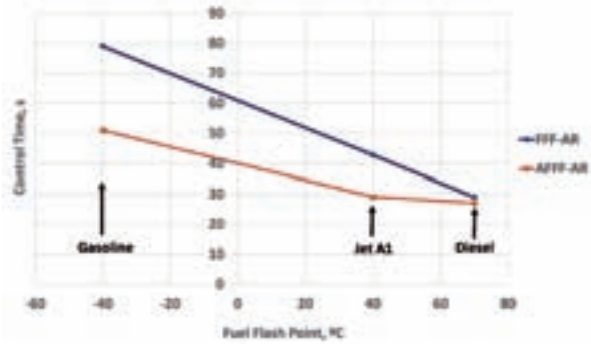
Although the test protocol did not replicate any official standards, all the tests were carried out under the same conditions.

The ten foam concentrates were tested using a pan 0.43m2, an application rate of 2.3l/min/m2, and with forceful application to the centre of the pan. The quality of the foam defined for this protocol was similar to a UNI 86 test nozzle. All foams were evaluated on gasoline, Jet A1 (aviation kerosene), diesel and heptane – fuels that are commonly used in most standards.

Extinguishment time and control time were recorded; control time was defined as the point when the fire covered just 10% of the surface during the foam application.

Above: fire testing pan used for the trial. Right: fire control is achieved when only 10% of the surface is still on fire.





Far left: differences observed in control times with different fuels and both types of foam concentrates. Near left: chart showing the differences in control when using fuels with different flash points.

The methodology was validated by comparing some of the results obtained in heptane and Jet A1 with data from EN-1568-3:2008 and ICAO level B.

When the foam concentrates were tested on heptane or diesel, FFF-AR took 6-7% longer to control the flames than AFFFs; but when tested on gasoline or Jet A1, the differences were much wider, going to control times of up to 50-60% longer.

If we establish a correlation in between fuel flash points and control times, we can clearly see that fires on fuels with lower flash points are more difficult to control; and even more so when using fluorine-free foams.

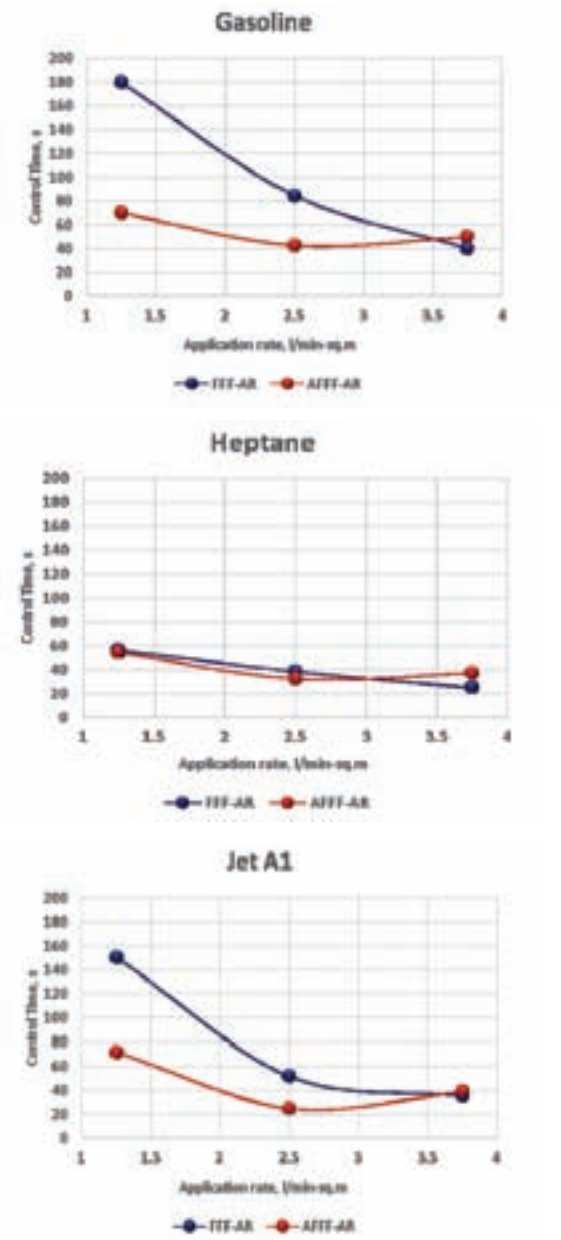
Extinguishment times were also measured but, since some the foam concentrates did not extinguish their fires, results were extracted only based on successful or not successful extinguishment. The results demonstrated clearly the difference in extinguishment performance: while all AFFF-ARs achieved successful extinguishment, the situation was not repeated with FFF-ARs. Significantly, none of the FFF-ARs achieved successful results with Jet A1 fuel in contrast with the successful performance obtained with all AFFFs.

Some tests were conducted with different application rates in order to explore the effect of application rate on control and extinguishment time. Application rate is the flow of foam

Below: result of fire extinguishment tests with both types of foam using different flammables.

	FFF					AFFF				
Test	1	2	3	4	5	1	2	3	4	5
Gas. 95O	YES	NO	NO	NO	Late	YES	YES	YES	YES	Late
Heptane	YES	NO	NO	YES	Late	YES	YES	YES	YES	YES
Jet A1	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Diesel	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Application rates affect performance in control.



solution applied divided by the fuel surface (l/min/m2).

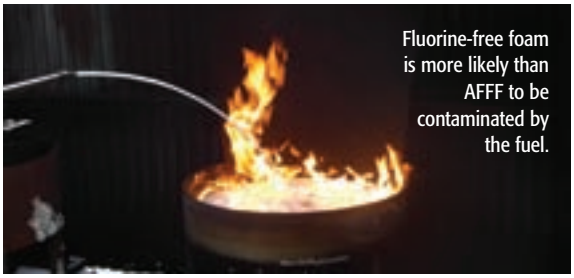
The reason behind this was to ascertain whether increasing application rates of FFF-ARs could compensate for their poorer performance to the extent that they could reach similar levels of performance as AFFF-ARs. Tests were conducted using gasoline, Jet A1 and heptane, at 1.25, 2.3 and 3.75l/min/m2.

By increasing application rates, the differences in performance for both types of products decreased and similar control times were observed.

However, at lower application rates, the differences

	l/min-m²	1,25	2,50	3,75
FFF	Gasoline	NO	YES/NO	YES/NO
	Heptane	YES	YES	YES
	Jet A-1	NO	NO	NO
AFFF	Gasoline	YES	YES	-
	Heptane	YES	YES	-
	Jet A-1	YES	YES	-

Application rates affect extinguishment performance.



Fluorine-free foam is more likely than AFFF to be contaminated by the fuel.

increased drastically, especially with gasoline and Jet A1.

We concluded that the critical application rate ie the minimum application rate needed to control or extinguish a fire, is higher in FFF-AR than with AFFF-AR. The conclusion was not the same in relation to extinguishment times, where a decrease or increase in application rate had no effect.

We believe there is an easy explanation for this seemingly contradictory observation. Once the quantity of foam applied is increased, the foam covers the fuel quicker, and that is the reason of a reduction in control time. However, as previously mentioned, the main characteristic of AFFF is good foam repellence against hydrocarbons when it is applied in a forceful application. It has been noted that due to the lack of this oil repellence property in FFF foams, even if the fuel is covered with foam and the fire controlled, the foam blanket still picks up some fuel and becomes contaminated, impeding a full rapid extinguishment.

Several physico-chemical properties such as pH, density, refractive index or viscosity are commonly analysed in fire-fighting foam concentrates. Only viscosity has a real impact on performance since the product has to be proportioned in water and a high-viscosity foam concentrate could make this difficult.

The viscosity of the ten foams was tested using methods based on EN-1568:2008. All of them had pseudo-plastic behaviour; FFF-AR's viscosity was between 35% and 80% higher than AFFF-AR's depending on shear rate conditions.

The spreading coefficient (SC) of the ten foams was also measured. SC is a parameter that is used to identify an AFFF, where an SC below 0 defines a non-AFFF foam.

SC is calculated based on foam solution surface tension, fuel surface tension and the interfacial tension between both. Since the fuel has an influence on SC, some foam concentrates may film-form on one fuel but not on another. The reference fuel used in the standard is cyclohexane.

The SC for all the products was calculated for all the fuels and it was found that for both types of products, the higher the SC the shorter the fire control time ie better film-forming means better fire performance. The correlation between film-forming and fire performance seems clear.

Based on the comparative data in the present study, it is not possible to conclude that both types of products are equivalent in performance; neither is it possible to conclude that fluorine-free foams are a valid alternative for all types of fire situations.

Formulations without fluorine have been improved over the last 10 years but they are still some way away from achieving the same effectiveness as AFFFs, which has been proven over the years worldwide in all types of emergency situations.

Our recommendations to the end users are therefore thus: before making a decision to change, analyse your risks and your equipment, then evaluate a potential solution's performance for your specific application. Failure to do this could jeopardise safety processes in certain emergencies. And it would be too late by then.

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Sprinklers and foam

What are the most important considerations for the installation of a sprinkler system that discharges foam? John Olav Ottesen writes.

John Olav Ottesen is managing director and founder of Dafo Fomtec

The use of a specially formulated film-forming foam that has been tested with the sprinkler system under consideration is among the key factors that will determine fire-fighting effectiveness.

During the past century, automatic sprinkler systems have been used with huge success for protection of all kinds of applications. Sprinkler systems are unique in the sense that they detect and fight the fire where it starts, and can scale up the fire-fighting automatically based on the size of the fire. The use of foam in sprinkler systems is an efficient way to protect against the hazards of fires in flammable liquids, but it requires a special kind of foam, developed and intended for use with sprinklers.

The effectiveness of the foam that fights the fire is a combination of the foam concentrate's properties and the properties of the discharge device; these properties are highly relevant and have a significant impact on fire extinguishing performance.

Standard sprinkler nozzles are not very efficient as a foaming device. Sprinkler nozzles generate low-expansion foam, with a typical expansion ratio of less than 5:1 and with a very short drainage time. Foam concentrates used with sprinklers must therefore be able to fight fires under these conditions.

As each sprinkler nozzle has different foaming characteristics and spray patterns, the only way to establish the effectiveness of a foam sprinkler system is to test each individual foam concentrate together with the specific sprinkler in question. Testing the foam concentrate together with the equipment is the idea behind test standards such as UL 162 and FM 5130. Using foam tested with normal foam branch pipe, such as described in EN 1568, does not provide evidence that it will work in a sprinkler system because the foaming properties of sprinkler systems are totally different.

UL sprinkler test using Dafo Fomtec's AFFF 3% M.

When tested on hydrocarbon fires, UL 162 and FM 5130 require that the foam blanket shall be deluged with water for five minutes before the burnback test is conducted, to establish the strength of the foam blanket. This aspect is not considered in standards such as EN 1568 or ISO 7203. Another aspect covered by the FM 5130 standard is the influence of the height of the system on its firefighting capability. Extensive testing shows that the effectiveness of foam sprinkler systems changes with installation height; FM 5130 requires testing of foam with sprinklers at minimum and maximum heights.

Design standards such as NFPA establish minimum application rates for foam sprinkler systems. These application rates are based on the requirement that the foam can function as intended when used with the selected discharge device. The only way to safeguard this is to test and document the effectiveness of the foam concentrate with the discharge device through approvals such as UL 162 or FM 5130.

The most effective foams for sprinkler systems are AFFF and AFFF AR foams, due to their oleophobic properties and the film formation that is unique to film-forming foams. High-quality film-forming foams are less affected by low expansion and do not lose their fire-fighting properties under such conditions. In addition, film-forming foams are less sensitive to the unique properties of different flammable liquids.

In view of the above considerations Dafo Fomtec has spent years developing and testing special foams intended for use in sprinkler systems. New products have been brought to the market, such as Fomtec AFFF 1% Ultra LT, Fomtec AFFF 3% S, Fomtec ARC 3x3 S and Fomtec AFFF 3% M. These products are multipurpose products and they have also been tested for use with foam makers and foam chambers. Fomtec AFFF 3% M is also MIL-F-24385 F, QPL-listed.

When protecting high-risk applications where foam sprinklers are the selected system, the need for specifically formulated sprinkler foam is apparent. Using foam concentrates that are neither tested nor approved with sprinklers can compromise the effectiveness of the system. Where the protection of life, property and the environment against the hazards of fire is necessary, proper design, based on real test data, quality products and a sustainable philosophy, is a must.

The logical conclusion is to specify approved systems, using foams tested and approved with sprinklers, and to include containment of firewater runoff to ensure an environmentally sustainable system.

FLUORINE-FREE FOAM FOR HYDROCARBON HAZARDS

A biodegradable, fluorine-free foam concentrate that offers fast extinguishing action on hydrocarbon fires is available from Bioex.

Ecopol F3 HC is a new formulation of the company's Ecopol multi-purpose fluorine-free foam. It has been specially developed as a 3% concentrate that the company claims performs as well as, if not better than, the best aqueous film-forming foams.

Totally fluorine-free, it does not contain any fluorine derivatives, such as PFCs, or halogen derivatives, and is therefore not subject to current or forthcoming regulatory controls on products containing this type of chemical. It also breaks down quickly without any persistent bioaccumulative toxic residue.

Ecopol F3 HC can be used at 3% in direct application on hydrocarbon fires and Bioex claims that it provides long burn-back time equivalent to protein foams. It has been certified to EN1568-3, with a 1A performance classification for both fresh and sea water. It has also achieved the highest performance classification under LASTFIRE.

Furthermore, the adhesive nature of the foam and its slow drainage means that it offers durable adherence to vertical surfaces. It can also be used as a protective fire barrier for long-lasting cooling of storage containers or hydrocarbon tanks.

ADDITION TO US MILITARY QUALIFIED PRODUCT LIST

A new AFFF foam concentrate has passed the requirements of military specification MIL-F-24385F and has been added to the US military qualified product list.

Manufactured by Swedish company Dafo Fomtec, Fomtec AFFF 3% M has been under development since 2013 and had been previously approved to ICAO level C in June 2014. It is the first time one of the company's products has been listed on the QPL.

According to the manufacturer, who has a daughter company in the US, Fomtec Inc, the concentrate is also suitable for foam sprinklers and it will also soon be UL listed.

"Having a Milspec AFFF foam opens doors to new business opportunities, it also shows our commitment to quality products and our position as a leading company within the fire-fighting foam business," commented Fomtec managing director John Olav Ottesen.

All AFFF used by the US military must meet the requirements set forth in MIL-F-24385F, which is under the control of the Naval Sea Systems Command. The Naval Research Laboratory is the designated institution for certification evaluation for the Department of Defence's AFFF QPL. The criteria for passing the MIL-F-24385F are regarded as the toughest in the world and include a requirement that the concentrate be compatible/mixable with all other QPL-listed MIL-F-24385F products. In fire tests the foam must also be capable of suppressing a fire at 'half strength', or 1.5%, a requirement that was included to address concerns of proportioning accuracy.

Swapping foams?

There are a number of critical considerations when switching from the storage of fluorinated fire-fighting foam concentrate to non-fluorinated versions, writes Michael F Schunck.

Michael F Schunck serves as faculty adjunct in higher education facilities throughout Michigan, including Oakland Community College, Oakland University, Michigan State University and Madonna University

How well foam concentrates are stored is absolutely critical to the delivery of a quality foam blanket and a successful outcome in a fire situation. During the process of switching from fluorinated fire-fighting foams to non-fluorinated versions, there are a number issues that need consideration to ensure safe and effective storage, including whether or not new foams are to be stored in tanks that were previously dedicated to fluorinated products.

Let's start with the basics. As always, long-term storage of various types of foam concentrates mixed together is not recommended. Due to chemistry differences, it is possible that bubble formation or changes detrimental to appliances could occur under changing environmental conditions. Since conditions do vary, this practice is therefore discouraged as a general rule.

The material of foam storage tanks is also important and this can only be accurately assessed by the foam concentrate manufacturer. It is important to note that failure to install the correct tank materials could result in contamination and performance issues in the finished foam application.

Fluorinated foam concentrates are excellent fire-fighting foams, but are persistent and bio-accumulative and therefore can have negative environmental and health impacts. For a number of years these compounds used long-chain fluoro-surfactants, but in 2006 the US Environmental Protection Agency established a voluntary stewardship programme to reduce the use of these long-chain elements because of the toxicity issues.

Initially the substitution of long-chain with short-chain fluoro-surfactants resulted in a requirement of up to 40% more volume for meeting Underwriters Laboratory's UL 162 standards for fire fighting. Then came halogen-free foam concentrate; the creation of 'green' foams for fire fighting and hazardous material-vapour suppression appear to have satisfied both issues. The resulting product ensures both fire-fighting performance and environmental compatibility.

The initial question for storage sites is whether to replace old with new, or use existing up existing stocks first. Once the older fluorinated foam concentrates are gone, a number of elements require evaluation to ensure trouble-free storage and future foam application during an incident. These range from tank integrity and location to any volume enhancements required to accommodate plant expansion, pump capacity and transport lines, exterior seals, and automated monitoring.

Once storage tanks have been emptied and are free from all halogenated foam concentrates, a thorough interior tank cleaning and inspection should be undertaken. Not only will power-washing remove remaining contaminants from the older product, but it also affords a detailed inspection of the interior of the tank walls. All interior surfaces should be checked for corrosion and tank-course thickness, and if these measurements fall below standards, the damaged tank course shell should be replaced.

Don't forget to check the proper conical shape of the tank bottom as well as material thickness. Is the slope the same? Are there any indentations from load or pressure over the years? Advances in ultrasound technology now have the ability to evaluate tank wall thickness and pick up signs of corrosion or damage from outside the walls of the existing tank. This should eliminate the need for dangerous confined-space entry to evaluate the tank bottom interior. If deviations from the original design and construction of the tank are found, it should be serviced by a storage tank fabricator.

Once any necessary repairs have been made, consider the site. Storage tank location is critical to both loading and unloading. Have the plant facilities grown over the years? Is there a more centralised position to new fire hazards? Foam storage tank replacement may benefit a facility if the new tank is an equal distance from all fire hazards, as a long transfer of product risks being interrupted in an emergency situation.

Could the plumbing be better protected if placed underground? Is tank movement a possibility? Portable tanks could be moved to new platforms to accommodate site facilities, depending on projected growth and future plans.

Should foam storage tank volume be increased to match site and/or hazard growth? If the hazard risk has increased, you need to ensure that you have enough foam concentrate on hand to deliver to multiple tanks involved in a fire. In this situation, a change in tank location might be the answer.

Are upgrades required in the foam concentrate transfer plumbing? If the hazards have increased, are more or larger supply transfer lines from storage tanks to induction process required? Do these need to be adapted to take into account new roadways or other improvements? If new roadways are planned, make sure that your system does not need to be off-line while construction is taking place. This could take a system out of service for long periods and create extensive safety issues.

Loading areas should not be in the way of other plant operations. In case of a major fire situation, the storage tank loading area must be free from plant operation obstructions to ensure frequent replenishment of foam concentrate.

All of these things should be considered before final storage tank placement is decided upon, as once your storage tank is completed you will have to work around any problems in the

Foam concentrate stored in intermediate bulk containers at a facility in Europe.

event of an emergency. The goal is to implement a system that cannot fail even in a disaster situation.

Once these issues have been worked out, be sure to check for the appropriate exterior tank hatch seal material of the foam concentrate storage tank. This should be done on a bi-annual or annual basis from sample testing. According to the facility's standard operating procedure, a sample of stored concentrate should be taken from the bulk storage tank and sent to the foam manufacturer's lab for analysis. This procedure is designed to inform you of issues affecting the integrity of the exterior tank seal against environmental effects or contaminants.

Auto-monitoring leak detection is an excellent upgrade for future tank leakage or security issues. With automated leak detection in place, an operating facility can access real-time data analysis of tank integrity and respond quickly to minimise leaks and loss of foam concentrate. It is the most effective way to assess and manage problems as they occur.

When storing large volumes of foam concentrate, bulk storage accomplishes two main goals. Firstly, it eliminates the need for loading and transporting five-gallon containers by on-duty emergency personnel to the induction site. Secondly, the pump transfer, eduction, and application are immediate and unmanned, which yields a fast response and is safer for emergency responders. As flammables must have an automated foam application system in place anyway, an additional automated system for foam concentrate supply to the induction system makes sound sense.

Exterior ventilation and tank opening seals should be evaluated before the foam concentrate is loaded into the tank. Not having the proper seals on containers of foam concentrate is like leaving a tin of paint open. Foam manufacturers have a complete system for the proper sealing of foam-concentrate storage tanks. If yours does not, you should change manufacturer. NFPA 1901 has storage tank recommendations that will assist with this process.

There are four basic components that should be present in any foam storage tank system. Firstly, you are trying to achieve a minimal air-to-concentrate interface. This means always keeping a storage tanks as full as possible to minimise the possibility of 'skinning over' on the surface of the concentrate. 'Skinning over', or drying, negatively affects all appliances and the finished foam application.

Second is the inner protective screen. This shields the raw foam concentrate from particle contamination, which can occur whenever sampling or general human monitoring is carried out. The screen prevents objects of contamination from entering the concentrate tank and tainting the product.

The third key components of the storage tank system are the airtight hatches. These must be sealed with the appropriate seal material, such as Buna-N or an EDPM gasket composition. Check with the manufacturer for the proper gasket material.

Lastly, a pressure/vacuum relief device permanently affixed to the exterior of the airtight hatch cover is required. This enables the tank to adjust automatically to changes in pressure or vacuum when filling or withdrawing foam concentrate from the tank. This device should only allow air movement with natural pressure changes due to temperature. No direct openings to the atmosphere are allowed, such as overflow tubes or other open pathways to the environment.

Getting foam storage right is critical for successful emergency incident response; proper consideration and monitoring of foam storage is therefore essential.

Keeping it clean

The management of fire-fighting foam took centre stage during a three-day seminar organised by the Queensland Government discussing the practicalities surrounding the implementation of a new policy. *IFJ* reports from Brisbane.

Delegates at the recent foam management seminar in Queensland heard how a new, environmentally-neutral disposal method for fluorochemical waste that costs as little as US$1 per litre could revolutionise the way companies handle the disposal of fluorinated foam concentrates and contaminated soil and water.

This ground-breaking development was just one of many insightful presentations delivered at the seminar at the Brisbane Conference and Convention Centre, 21-23 February. It was organised by Nigel Holmes from the Queensland Department of Environment and Heritage Protection on the implementation of Queensland's Policy on the Management of Firefighting Foam, which came into force on 7 July 2016.

Keynote Speakers included His Honour Justice Brian Preston, Chief Judge, New South Wales Land and Environment Court; Dr Erika Houtz, Arcadis USA; and Martin Cornelsen, Cornelsen Umwelttechnologie, Essen Germany.

Five major themes emerged from the three-day seminar, which was opened by Dr Steven Miles, Minister for Environment and Heritage Protection of Queensland, and which was attended by almost 200 delegates. The first addressed the legal obligations and liabilities for end users and regulators, with significant implications for the lifetime costs of foam.

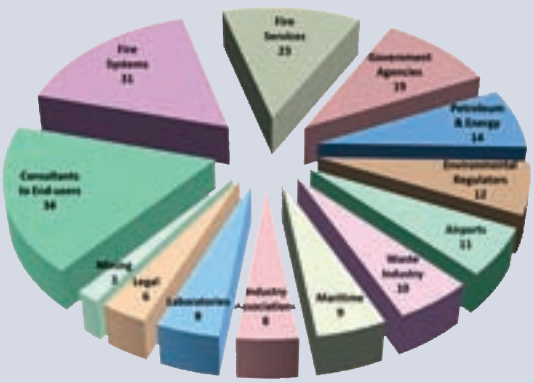
The second looked at modern analytical methods for uncovering the full range of potential end products of degradation for fluorinated foams, so-called 'dark matter', using the Total Oxidisable Precursor Assay developed by Houtz and Sedlak.

The third theme covered the development of suitable disposal methods for fluorinated waste streams, such as firewater runoff or unused fire-fighting foam considered as regulated industrial waste.

Developments in remediation technologies for contaminated soil and groundwater was the fourth key content stream. Finally, the fifth stream addressed the overarching need to carry out a suitable assessment of environmental risk when using fire-fighting foam operationally or during training, and maintenance procedures including the adequacy of the information typically available in Safety Data Sheets.

The session that seemed to leave a lasting impression on most delegates focussed on the legal obligations and liabilities of both end users and regulators. Justice Preston introduced the session with a detailed explanation of the background and application of the Precautionary Principle and environmentally sustainable development in courts in Australia and around the world. These form three of the Principles (§5, §7 and §15) of the Rio Declaration on Environment and Development 1992, to which almost all UN members were signatories. Both end users and regulators are legally obliged, as part of environmental law in Australia as well as in many other jurisdictions, to apply the Precautionary Principle if certain precedents are met. Indeed, there are cases where ministerial decisions have been ruled fatally flawed by the Courts for not considering the Precautionary Principle.

The key elements of the Precautionary Principle outlined by Justice Preston included: the spatial scale of the threat – for example local or international; the magnitude of possible impacts on both natural and human systems; the perceived value of the threatened environment; the temporal scale of



Nearly 200 delegates attended from a wide range of sectors. Top: The Story Bridge over the Brisbane River (picture Shanti Hesse/Shutterstock.com).

possible impacts in terms of both the timing and the longevity – or persistence – of the impacts; the complexity and connectivity of the possible impacts; the manageability of possible impacts, having regard to the availability of means and the acceptability of means; the level of public concern, and the rationality of evidentiary basis for public concern, and the reversibility of the possible impacts and, if reversible, the time frame for reversing the impacts, as well as the difficulty and expense of reversing them.

As Roger Klein highlighted in his presentation on the holistic assessment of environmental risk for fire-fighting foams, a balance must always be struck between operational imperatives, ie bringing the fire under control and protecting human life and health, and the need to minimise the environmental impact of fire-fighting operations both in the short and long term. Application of the Precautionary Principle, as outlined by Justice Preston, points to the need for strategic planning using standard operating procedures aimed at containing all firewater runoff especially if it contains fluorinated material, ie the foam is an AFFF, FFFP or FP product. This should also be followed by collection and disposal as a regulated industrial waste.

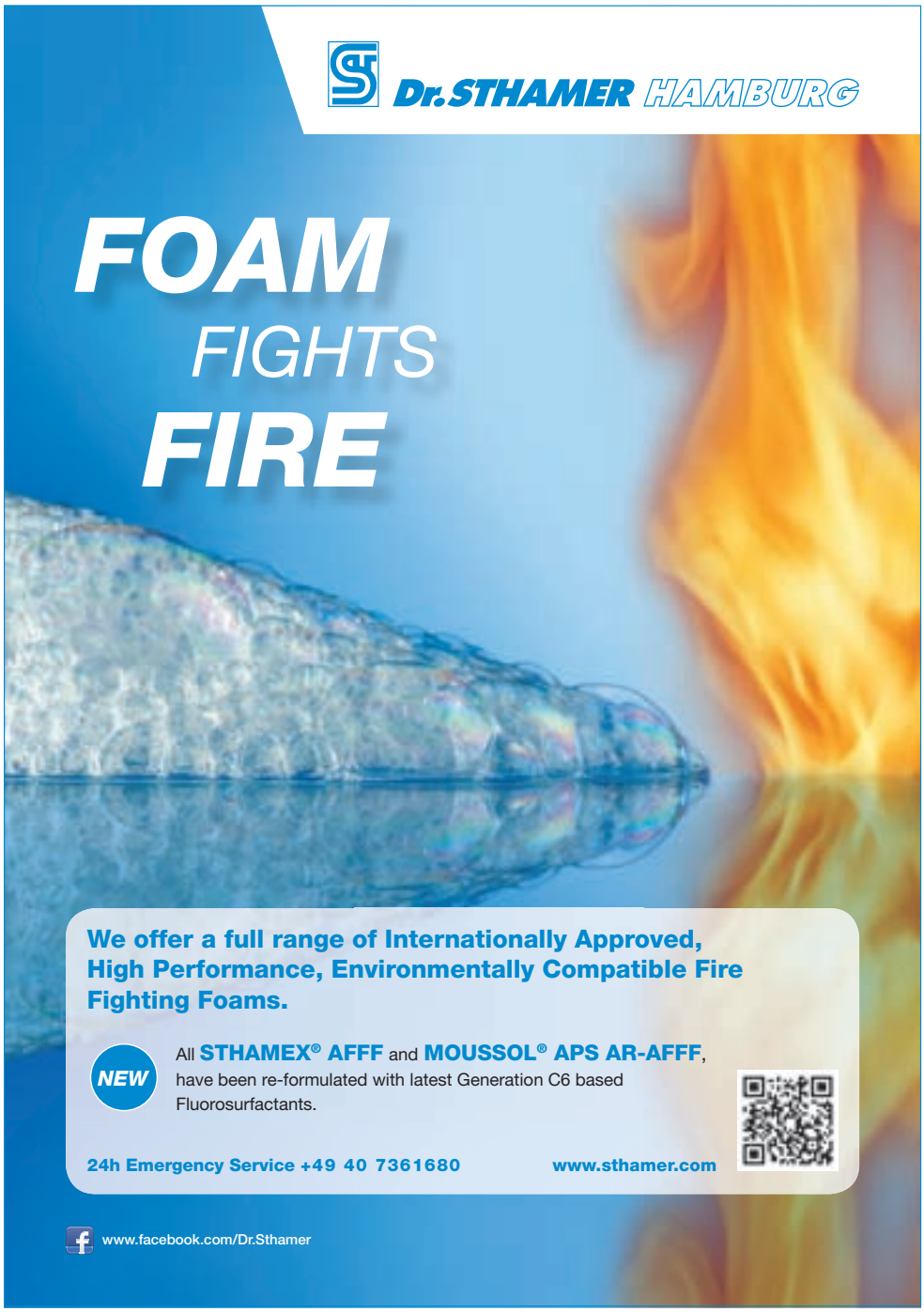
Such a requirement forms one of the key features of the Queensland Policy as described at the seminar by Nigel Holmes and his colleagues from the Department of Environment & Heritage Protection. Fluorinated foams satisfy most of the required trigger conditions for invoking the precautionary principle.

The lifetime costs associated with fire-fighting foam were summarised by Roger Klein. These include original purchasing costs; any change in equipment or standard operating procedures; legal liability in criminal and civil courts including class actions, breach of license conditions and loss of operating license; decontamination and remediation costs for on-site and off-site pollution; waste disposal of unused foam concentrates, firewater runoff and contaminated soils; analytical plus consultancy and legal fees; as well as political collateral damage such as loss of reputation and brand image. As pointed out in this presentation many of these costs far outweigh the original cost of the foam concentrate and can be avoided or minimised by appropriate procurement procedures and use of due diligence when carrying out an initial assessment of risk.

Rory Ross and Peter Shannon of Shine Lawyers, an internationally known environmental legal practice associated with Erin Brockovich, shook up many of the delegates with their presentation. Using a mythical case study, they highlighted the considerable liability under Public and Civil Law that can be incurred from contaminating the environment – even without the intention of doing so. Keir Bielecke of Insurance Council of Australia closed the legal session by stressing that a separate insurance policy

Parameters	Class B persistent			Class B non-persistent		Class A
	AFFF	FP	FFFP	FB	High Expansion	
Spatial Extent	World	World	World	Local	Local	Local
Magnitude	Moderate	Moderate	Moderate	Local	Local	Local
Perceived Value	High (E&H)	High (E&H)	High (E&H)	Moderate (E only)	Moderate (E only)	Moderate (E only)
Temporal Scale	Extreme	Extreme	Extreme	Short	Short	Short
Complexity	Moderate	Moderate	Moderate	Low	Low	Low
Manageability of impacts	Poor	Poor	Poor	Moderate	Moderate	Good
Reversibility	Poor	Poor	Poor	Very Good	Very Good	Good
	Evidence of persistent adverse effects			Properties well known		

Triggers for the Precautionary Principle.



was required to cover environmental liability for owners and occupiers of premises.

The key issues with runoff from fluorinated foam were discussed from a regulator's point of view. These were the extreme environmental persistence of perfluorinated end-point degradation products; scientific uncertainty as to their toxicity and potential for bioaccumulation; long-range transport; proven contamination of groundwater and drinking water supplies; difficulties in managing environmental impacts as well as reversing effects or remediation of contaminated soil and water; and political and public concern.

In order to carry out a suitable and sufficient assessment of environmental risk the end user requires access to 'suitable and sufficient' information. Both Nigel Homes (Queensland DEHP) and Jimmy Seow (Western Australia DER) highlighted the requirements for specific information and the current deficiencies in what was available. Unfortunately, with some notable exceptions, the information provided by foam manufacturers and suppliers in Section 12 of most product Safety Data Sheets is woefully inadequate, and the let-out clause 'no data available' is over used. In addition, warnings from feedstock manufacturers not to release material to the environment are ignored and not passed on to the end user. Lastly, there is lack of consistency in how BOD (biochemical oxygen demand) and COD (chemical oxygen demand) values as well as acute and chronic toxicities are reported in the SDS. It was stressed by the speakers that this lack of information represented a significant risk for the end user and therefore should be treated with suspicion.

It was also emphasised that the Queensland policy makes absolutely clear what is required as a minimum in terms of BOD or COD information and which species should be used for reporting acute aquatic toxicity. BOD (5-day) and BOD (28-day) values should be quoted for the foam concentrate supplied and not for individual components, the latter being largely irrelevant given the potential for synergistic effects.

BOD5 reflects the acute oxygen stress to which the receiving body of water will be subjected; BOD28 gives a measure of degradation over a four-week period. Claims that fluorinated foams are 'readily biodegradable' are highly misleading because they take no account of the chemical stability of the fluorochemicals present. Confusion and misunderstanding are partly due to measures of degradability that are based on the percentage of COD represented by BOD28. However, standard analytical procedures for determining COD using acid dichromate fail to detect highly stable fluorochemical components in the formulation, thus yielding an artificially high estimate for degradation based on BOD/COD ratio.

Acute aquatic toxicities should be determined using standard protocols and species, preferably the most sensitive. The point was clearly made that in general the acute oxygen stress far outweighs the significance of acute aquatic toxicity at usual dilutions and range of toxicities. Moreover, acute aquatic toxicities are determined using standard protocols at an oxygen saturation of 65%. In a real life-situation, oxygen saturation levels would be much lower than this, making these toxicity values meaningless.

Aquatic organisms are very sensitive to dissolved oxygen levels, as explained in detail in the Queensland DEHP Explanatory Notes to the Policy. Acute oxygen stress, as indicated by BOD5, is the primary kill mechanism associated with pollution.

Moreover, when short-term and long-term BOD values are compared using a large database of commercially available fire-fighting foams, there is almost nothing to choose between AFFF-type foams and non-persistent fluorine-free foams. If anything, fluorine-free foams have short-term BOD values – ie BOD5 or BOD10 values – slightly lower than those for AFFFs on average, as shown in the data below left (courtesy of Nigel Holmes, Queensland DEHP), indicating marginally less acute oxygen stress.

On the other hand, some AFFFs on the market have BOD5 values that far exceed those for the fluorine-free foams as well as, of course, fluorinated materials that degrade to highly persistent perfluorinated end-products, indicating that these particular foams might not be the best choice for an environmentally or hydrologically sensitive environment.

As explained by Nigel Holmes, a key part of the Queensland Policy includes measures to control the release of all fluorinated AFFF foam waste to the environment by containment and correct disposal as regulated industrial waste through a licensed contractor.

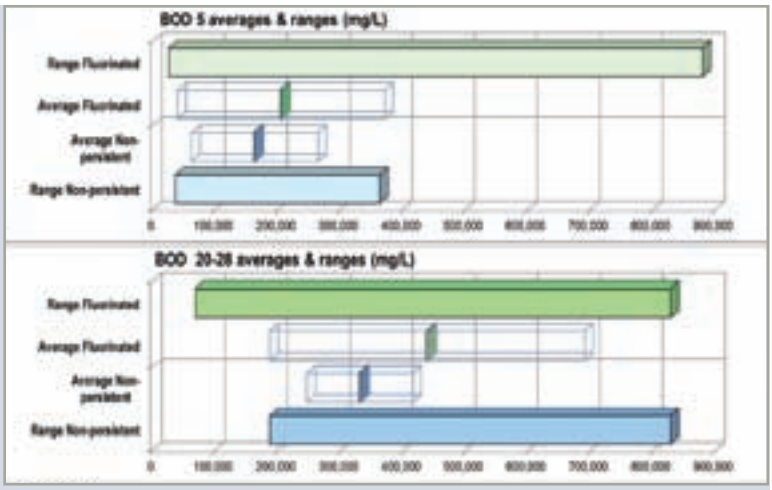
PFOS-containing foams have been banned in Queensland and must be removed from inventories and disposed of properly. These requirements for containment of waste also include the modern, so-called pure C6 foams, which may continue to be used so long as the content of PFOA or PFOA precursors does not exceed 50ppm. This level is achievable using the purest C6 fluorochemical feedstock available with a purity of 99.7%.

It was stressed during the presentations that the Queensland Policy is not a ban on the use of AFFF and especially modern purer C6 products, contrary to ill-informed claims by some in the industry, but rather a requirement to control runoff to the environment by containment.

At large petrochemical, chemical process plant and tank farm sites, containment should be part of an engineered solution, including bunding and isolated drainage systems for example, at the strategic planning and construction stage as part of reducing overall risk.

Discharge of fluorinated foams onto open ground should be avoided, especially near waterways or near to drinking water aquifers. In most cases, fluorine-free foams are perfectly adequate for such situations, for example, tanker spills on roads or wharfing and fuelling facilities. The presentation from Niall Ramsden, LASTFIRE coordinator, underlined the importance of considering environmental impact when doing a holistic risk assessment. He pointed out that in most incidents involving large tank fires, life safety was not an issue and that a 'let it burn' solution might be the best solution from an environmental perspective, if not from a political or fire service culture's point of view.

Innovative solutions can play a role in reducing the risk of environmental pollution. Airports are high on the list of sites of significant PFC contamination, historically caused by training or



Comparison of BOD5 and BOD20-28 for around 70 fluorinated and non-persistent foams. Standard deviation shown in outline, relative to average values. Source: Queensland Policy Explanatory Notes.

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Event moderator Anne-Maree McInerney, founder of Models of Success and Sustainability, and Dr Steven Miles, Minister for Environment and Heritage Protection of Queensland.

maintenance procedures. Training areas should have an impermeable concrete apron with isolated drainage and collection of waste for subsequent disposal. Regular testing of airside crash tenders using foam, where necessary or required by local rules or international regulations, can be carried out using a containment facility such as that at Düsseldorf International Airport, resembling a farm silage pit.

Erika Houtz, Arcadis USA spoke at length about the use of the Total Oxidisable Precursor Analysis method for uncovering so-called 'dark matter'. This term has been adopted to cover the recently identified extensive range of perfluorinated end-products of degradation arising from fire-fighting foam.

The method has the advantages that a knowledge of commercially sensitive formulations is not required. In addition, the analytical oxidative procedure produces end-point perfluorinated species that closely mimic environmental breakdown. The TOPA method is a key tool for a regulator analysing fluorinated waste streams such as firewater runoff or legacy concentrates, as well as for determining the purity of C6-compliant AFFFs. TOPA is also useful for end users in checking contamination levels in foam stocks or foam delivery equipment and assisting with compliance issues.

A number of analytical consultancies gave updates on the commercial development of the TOPA method for use by regulators and foam end users. These contributions included presentations from Bob Symons of Eurofins/MGT Laboratories and Marc Centner of Environmental ALS.

Over recent years, airports have featured as major sources of both legacy PFC contamination and ongoing incidents from accidental discharge of hangar foam fire suppression systems. As recently as 10 April, some six weeks after the Queensland seminar, a hangar foam deluge system accidentally discharged 22,000 litres of foam, some of which ran into a local waterway, Myrtle Creek, and then the Brisbane River. A similar incident had occurred at Toronto Pearson Airport more than 15 years ago contaminating Etobicoke Creek and the Great Lakes. An historical perspective of site contamination and legacy issues, especially serious for airports, was presented by Ian Ross of Arcadis.

Martin of Cornelsen Umwelttechnologie and Ravi Naidu of CRC Care both spoke about current technologies for remediating contaminated sites. Cornelsen described Perfluorad, a technology that is designed to greatly improve the absorptive capabilities and lifetime of granulated activated charcoal for the removal of fluorinated waste products from water. This technology, which is available as a portable ro-ro container unit, is especially useful for remediating contaminated groundwater. It has been successfully applied in Germany's PFC contamination of the Moehnetal and Ruhr Valley water-catchment area, and also in the case of legacy airport contamination with fire-fighting foam (Düsseldorf and Nürnberg airports) resulting from fire training and aircraft incidents.

Naidu described methods being developed by CRC Care for remediating both contaminated soil and water with a proprietary modified montmorillite clay/mineral mixture. Matcare was developed on behalf of the Australian Department of Defence for remediating AFFF-contaminated sites by absorbing PFCs as part of mobile treatment units. A test kit suitable for field use has also been developed, Astkcare, capable of detecting residual anionic surfactants such as fluorotelomer sulfonates from degraded AFFF in samples that can be used by unskilled operators.

Correct disposal of fluorinated waste, whether unused foam concentrate, firewater runoff or contaminated soil, as regulated industrial waste using a licensed waste disposal facility forms a key part of the Queensland Policy. Robert Schiller of Geocycle, Cement Australia presented what is arguably the best practice currently available for disposing of fluorinated waste technology that can then be used for both solid and liquid waste.

The method was originally developed for handling fluorine-containing waste from the aluminium smelting industry containing up to as much as 10% fluorine by weight.

The method involves feeding the fluorinated waste into rotary cement klinker kilns that operate at extremely high temperatures – between 1,000-1,500°C. This is sufficient to mineralise all organic fluorine compounds to calcium fluoride because calcium carbonate, ie limestone, is also present. The beauty of this method, apart from it being the cheapest available, is that it is environmentally completely neutral. The calcium fluoride produced is identical to the mineral source of the fluorine originally used to produce the fluorochemicals. It does not even need to be removed from the klinker before it is used in the manufacture of cement.

Moreover, it is significantly cheaper than previously available methods of high-temperature incineration. Traditional methods are extremely expensive and not capable of handling large quantities of waste. Using this method costs have come down from something around US$17-20 per litre/kg to less than US$1 per litre/kg. This makes the disposal of an IBC of foam concentrate (1,000l), for example, a much smaller element of the lifetime cost of fire-fighting foam – a matter of great interest to end users who need to find a practical and cost-effective way of dealing with fluorochemical waste.

Geocycle is currently working on increasing capacity of the klinker kiln technology to deal with around 100-tonne waste charges as well as obtaining regulatory approval for licensing this disposal method.

The other major topic discussed in detail by Nigel Holmes and his colleagues from the Queensland DEHP was the timescale for compliance with the new Policy.

During both the consultation process and after the Policy had come into force, industry had complained that the three-year transition period specified for coming into full compliance was too short for large installations such as refineries or tank farms. It was made clear by the Department, both during the seminar but also in the Explanatory Notes that accompanied the published Policy document, that reasoned arguments for an extended timescale would be considered on a case-by-case basis if presented with a strategic plan containing realistic timings. This plan would then be incorporated into the site license conditions and become legally enforceable.

Tip of the iceberg?

Controversy around the fire-fighting foam spillage at Brisbane Airport's Qantas hangar in April coupled with a rise in lawsuits related to water contamination have worrying implications for foam users, writes Lotte Debell.

Qantas is looking for foams that do not contain PFAS (Mehdi Photos/ Shutterstock).

Contamination lawsuits by local communities against manufacturers of per- and poly-fluoroalkyl substances may not be new, but the growing evidence of similar contamination around military bases could have repercussions for the industrial fire sector in regard to the use and improper disposal of aqueous film-forming foams (AFFF).

These chemicals have been linked to, amongst other things, various cancers, thyroid disease, pregnancy and reproductive issues, and damage to the immune system. In February 2017 Dupont and Chemours agreed to pay US$670.7m to settle 3,550 lawsuits stemming from PFOA contamination of air and water in Ohio and West Virginia from its Washington Works plant in West Virginia.

Cases of contamination by PFOA and PFOS continue to come to light in the US, where the Department of Defence is currently carrying out testing at hundreds of military sites. As of November 2016, more than 350 active and inactive sites had been found to have one or more areas of concern related to contamination by the use of AFFF in fire-fighting training.

These include Joint Base McGuire-Dix-Lakehurst, where levels 20 to thousands of times higher than recommended levels have recently been found in ground, surface and drinking water on and around the New Jersey base.

Another is Peterson Air Force Base in El Paso County, Colorado, where residents in nearby Security, Widefield and Fountain came together to launch class action lawsuits against foam manufacturers in September 2016. So far, three have been filed. Hannon Law has filed one suit seeking medical monitoring and another for compensation for property damage. Yet another was filed by McDivitt Law Firm. All the suits name well-known foam manufacturers and suppliers.

However, perhaps the most significant from the standpoint of legal activity is in Pennsylvania. The Pennsylvania contamination initially came to light in December 2014 when testing in Horsham, Warrington and Warminster in Bucks and Montgomery Counties by the Environmental Protection Agency discovered the presence of PFOS and PFOA in public drinking water.

The contamination is thought to be the result of use of AFFF foams since the 1970s at two inactive naval bases in Warminster and Willow Grove, and Horsham Air Guard Station, which is still active. The military has been investigating contamination by PFCs at these locations since 2011. Eight public wells were initially closed, and 80 private wells were subsequently found to be contaminated. To date, 200 private wells and 22 public wells serving around 100,000 people in the area have been closed as a result of contamination.

Weitz and Luxenberg, the law firm for which environmental activist Erin Brockovich is a consultant, filed the first of a number of class actions against foam manufacturers over the contamination. The firm's representative Robin Greenwald said: "For years, residents living near military bases in eastern Pennsylvania were unknowingly exposed to dangerous chemicals in their drinking water. With this lawsuit, we are fighting to ensure that the companies who manufactured and marketed products containing these chemicals – and put their profits ahead of public health in the process – are brought to justice for their wrongdoing."

This suit has been followed by a number of others. Five law firms, including Weitz and Luxenberg, have now combined their suits into a single class action seeking more than US$5 million in damages from the defendants, who are foam manufacturers and suppliers. The suit alleges that the companies' products were defective, that they had 'known or should have known' the dangers of the products, and further that they failed to recall them or issues warnings even after their toxicity was established.

Many of the same law firms are involved in a separate mass tort for personal injury on behalf of almost 500 local residents. The plaintiffs are seeking damages "as a result of their suffering from injuries/diseases they believe are caused by ingestion, etc. of water polluted with the chemicals PFOA and PFOS", according to Creedon & Feliciani, one of the firms involved.

The first lawsuit in this case was not against foam manufacturers, however. In August 2016, Williams Cuker Berezofsky filed a suit against the US Navy on behalf of a family living a few hundred metres from the Horsham Air Guard Station. It alleged that the Navy failed to dispose of foams properly, or prevent the spread of toxic chemicals into water supplies and the ingestion of these chemicals by the local population.

The suit is seeking blood testing and health assessments for all residents of Horsham, Warminster and Warrington. In June 2016 the Navy refused to fund blood tests for around 70,000 residents on the basis that the presence of these chemicals in the blood could not be definitively linked to health impacts.

The Navy has come under fire for this decision. Philadelphia Governor Tom Wolf wrote to both the Navy and the Air Force requesting that they pay for testing. Other local lawmakers have also publicly criticised the decision, including Senator Bob Casey who wrote to the Department of Defense, Centers for Disease Control and Prevention, and the Environmental Protection Agency. In his letter Casey argued: "If (the military) will not pursue blood testing without a broader scientific study of health effects, then a study is warranted. It should fund a joint DOD-CDC-EPA health study that will give the affected communities some clarity on the impact this exposure has had on their health."

The pressure for more research has been ramped up by a House budget bill introduced in March which would require the US Defence Department to submit a report to Congress within four months detailing the contamination of drinking water by fire-fighting foams on and around its bases. It would also require the development of a plan to notify at-risk communities.

It's not just the US that has issues of contamination at military bases. There are similar cases in Australia, most notably at Williamtown in New South Wales and Oakey in Queensland, where residents are coming together to file class actions against the Australian Department of Defence as a result of contamination of local communities by PFOA and PFOS.

As of May 2017, in addition to Williamtown and Oakey, there are currently 18 Defence sites in the country undergoing or scheduled to undergo environmental investigation for contamination by PFAS. Thus far, the federal government has committed to investing AUS$55 million (US $41 million) from the Defence budget to manage, contain and remediate PFAS contamination at military bases. This includes an epidemiological study that will look at potential patterns, causes and health effects in communities exposed to elevated levels of PFAS.

A recent move to lower the safe levels of these chemicals for daily intake and in drinking water may impact any health studies, however. The federal government was criticised last year for adopting safe levels of PFOA and PFOS at almost 80 times higher than the latest recommendations from the US EPA. In June 2016, enHealth set interim safe levels in drinking water at 0.5 mcg/l for PFOS and 5 mcg/l for PFOA.

Following new guidance developed by Food Standards Australia New Zealand in April, the Australian Government has now adopted safe levels of PFOS equivalent to the US recommendations of 0.07 mcg/l. Safe levels of PFOA have also been lowered to 0.56 mcg/l, eight times higher than the US guidelines. Health advice remains unchanged, however, with the Australian Government maintaining that there is still 'no consistent evidence' that exposure to these chemicals is harmful to human health.

Firefighters from the 87th Civil Engineer Squadron extinguish flames during a live-fire exercise at Joint Base McGuire-Dix-Lakehurst, NJ (US Air Force photo by Russ Meseroll).

The new lower safe levels could have implications for investigations in contaminated areas, and for the lawsuits. They also call into question research and advice from Defence regarding risks to residents. The department's response to the contamination crisis has largely been driven by the levels set by enHealth and these formed the basis of its 4,000-page risk assessment.

Shine Lawyers, which is representing Oakey residents in a pending class action against Defence, said the new lower levels validated their clients' concerns and undermined the conclusions of the Human Health Risk Assessment conducted at Oakey.

In response, Defence is assessing the implications of the FSANZ guidance values 'as a priority', and will work with its independent environmental consultants "to revise and update relevant reports developed as part of the environmental investigations".

The department added: "Current and future Defence investigations and assessments… will now adopt the FSANZ guidance values in place of the enHealth interim values."

Controversy has also erupted in Australia over the failure of the relevant authorities to alert the public to an accidental foam spillage from a Brisbane Airport Qantas hangar in April 2017. Around 22,000 litres of foam containing PFOA leaked from a faulty sprinkler, some of it into local waterways, but it was three days before the public was alerted. An investigation to determine the cause of the spillage has been launched.

Qantas has since announced that it is looking at alternative foams that do not contains PFAS and would meet the new guidelines brought in by the Queensland Government in July 2016 restricting the use of these foams. As the airport is on Commonwealth land, it is outside the scope of the Queensland regulation.

In a statement on 20 April 2017, Queensland Environment Minister Steven Miles called on the federal government to replicate the Queensland ban of foams containing PFOA and PFOS at Commonwealth sites in the state. He also stated that Jim Reeves, director general of the Queensland Environment Department, had written to the CEO of Qantas requesting a review of the airline's use of PFOA foams nationally.

"What I want to know is why one of the country's largest and most reputable companies is still using fire-fighting foams containing PFOS and PFOA right here on our doorstep," said Miles. He went on to outline the steps taken by Queensland following the ban of these chemicals last summer. Around 800 operators have been contacted with a survey of foam stocks, and around half have submitted responses (see issue 107, Q1 2017 of *IFJ*). "Of those responses, approximately 20% identified they had banned stocks and have either replaced them, or are in process of replacing them with a suitable alternative," said Miles.

In response to the Brisbane Airport incident, the Australian federal government has said that it is now looking at options for phasing out the use of foams containing PFOA and PFOS. It had previously resisted such calls.

Federal Infrastructure Minister Darren Chester said in a statement: "The Government is considering management options for PFOS and PFOA transitional removal from use, improved management and appropriate disposal of PFOS-containing fire-fighting foams at all facilities in Australia, consistent with the listing of the chemical under the Stockholm Convention on Persistent Organic Pollutants." Whether industrial facilities with a history of usage or improper disposal of PFOS and PFOA-containing fire-fighting foams decide to acknowledge the potential environmental problem by actively conducting water and soil sampling remains to be seen.

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Hot on health

Firefighters' blood gets stickier and is 66% more likely to clot after exposure to fire and high temperature, reports Lotte Debell.

Sudden cardiac death is the leading cause of death among on-duty firefighters. In the US, heart disease has consistently accounted for around 45% of on-duty deaths since the 1970s. In 2015, according to the NFPA, 35 of the 68 firefighters who died on duty died from heart attacks. That's 51%. In 2011, this figure was 59%.

The critical question is 'why?'. That the percentage of on-duty cardiac deaths has remained relatively stable over such a long period – a time in which so much of a firefighter's job has changed, from types of incidents attended down to the PPE they wear – suggests that the reason is fundamental to the activity of fighting fires.

Approximately half of all on-duty firefighter deaths each year in the US are the result of heart attacks. ©Shutterstock.

A 2007 Harvard study published in the *New England Journal of Medicine* linked the prevalence of on-duty deaths to the 'physical and toxic factors' related to the job. In fact, researchers found that firefighters are 12 to 136 times more likely to die of heart disease when putting out a fire.

This research piqued the interest of a research team at the University of Edinburgh, Scotland, which recently conducted trials with firefighters from the Scottish Fire and Rescue Service to try to find out what it is about fire suppression, principally, that presents such a risk to firefighters.

They found that a series of physiological changes take place within the body when firefighters are exposed to a combination of intense heat and physical exertion, which could explain why they are more susceptible to heart attacks during, and immediately after, fighting fires.

Amanda Hunter, part of the British Heart Foundation-funded research team, explains that a series of studies based on potential occupational risk factors were designed. Nineteen non-smoking, healthy firefighters were recruited to participate in these studies, which used sophisticated physiological monitoring techniques.

One study involved fire-simulation training. Researchers measured blood vessel function and blood clotting and discovered that the firefighters' blood became stickier with 66% more clot-forming as compared to a control exposure. Their blood vessels also failed to relax in response to medication following the fire simulation exposure.

"We believe two main things are causing these physiological changes – dehydration and a rise in core body temperature. The dehydration is a result of how hard the firefighters are working, the external heat, and their PPE preventing heat escaping. On average, our firefighters lost 0.5kg in a 20-minute period as a result of fluid losses. That

same period saw their core temperatures rise by 1°C, a huge physiological change.

"When core body temperature starts to deviate from normal, important bodily processes can start to go wrong. We saw subtle markers of inflammation – an increase in the white blood cell count, higher lactates, and increased glucose levels – that reflect this."

These weren't just short-term changes. Further tests at the research facility after the fire simulation showed that the changes persisted for up to two to four hours. The firefighters also demonstrated evidence of 'minor injury' to the heart muscle as a result of exposure to fire situations.

The researchers measured levels of a protein called troponin, which is released by the heart when it is starved of oxygen for any period of time. The presence of this protein – in much higher levels than were detected in the study – is one of the first ways of determining whether someone has had a heart attack.

"We measured troponin before and immediately after the fire simulation, and we saw an increase among participants that wasn't there on control days," explains Hunter. "The levels were well within what would be regarded as a normal range, and remained elevated twenty-four hours after the event. This elevation suggests that there is a form of injury to the heart muscle, albeit very minor, and we do not know exactly why."

Although these tests were conducted during a training exercise, firefighters undergoing annual breathing apparatus training firefighters often do two of these exercises in one day. This is arguably less strenuous than a real-life fire suppression scenario that might require commanders to commit the same firefighters again and again over a short period of time.

"If firefighters go into a fire multiple times, and they are not taking the necessary steps in between – getting out of their PPE, rehydrating, and cooling down – you can see how this could create the perfect storm in a susceptible person," says Hunter. "Firefighters with undiagnosed risk factors for heart attacks such a high blood pressure, high blood cholesterol, and diabetes would be the most susceptible."

While the results might seem disturbing, understanding what is happening to cause this increased risk is fundamental to managing it. And Hunter says that the researchers believe there is real potential to reverse the changes.

One way is by taking a more precise approach to rehydration after exposure to fire suppression. "During the trial we weighed the firefighters before and after the fire simulation to show the fluid loss. Therefore, if we know a firefighter has lost 0.5kg, they need to rehydrate by consuming at least 500mg of fluid."

Likewise, firefighters need to make a real effort to bring their core temperature down quickly. "If left to come down by itself, their core temperature remains elevated for three to four hours, during which time the inflammatory response is likely to be ongoing within the body. This could explain the lag period of firefighters having heart attacks hours after a fire suppression scenario."

Taking steps to cool down after coming out of a fire is something all firefighters should be doing anyway, and each fire service will have procedures in place. This research highlights the need to ensure these procedures are enforced, and that firefighters take responsibility for their own wellbeing by getting assessed for previously undiagnosed risk factors for heart disease – because it could save their lives.

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Lower your heat stress

Strategies to manage the risk of heat stress should consider everything from PPE selection to cool-down procedures, reports Lotte Debell.

Many things play a role in heat stress – the length of time a firefighter spends in a fire, for example, or how often they return to it. Another is PPE. Turnout gear is increasingly effective at protecting against heat and flame, yet it is also a factor in heat stress because it places a physiological strain on wearers. Since PPE is absolutely vital, it's a case of balancing the risks and benefits.

In the UK, less than 10% of fire service call-outs involve a fire. Mostly, firefighters attend other incidents such as road accidents or flooding. This raises the question of what they should be wearing. Traditionally, the same structural kit would be worn to all incidents, but there is a recognition that this adds an unnecessary burden on firefighters responding to other types of emergencies.

What are the options? Layered systems, such as Layerflex from Bristol Uniforms, offer the flexibility of a garment system that includes a mid-layer jacket, top coat, and overtrousers. Together these provide the necessary protection for structural fires, while for operations such as wildland firefighting and technical rescue, the lighter, cooler mid-layer jacket can be worn with overtrousers.

Alternatively, fire services can opt for specific kit for specific tasks, selecting the lightest options for each but potentially purchasing more garments. Xenon from Ballyclare, for example, offers both layered and task-specific garments for structural, rescue/wildland and USAR.

Garment fit is also important. "Kit that is too big adds unnecessary weight," warns Roger Startin, joint MD of Bristol Uniforms. "Kit that is too small can compromise thermal protection by reducing air gaps and cause discomfort."

Weight too has an impact. Bristol's technical manager Ivan Rich believes that restrictions on the weight of PPE may appear in upcoming revisions to European standard EN 469 that governs protective clothing for firefighters. This process is also likely to include recommendations to help combat heat stress, such as guidelines on the maximum time firefighters wearing PPE can be exposed to certain temperatures.

Helping to reduce garment weight are lightweight, specialised outer shell fabrics that combine protection from heat, flamelick and flashover with air permeability and breathability. Weight can also be reduced through garment design by removing bulk where possible, particularly around joints, as Ballyclare demonstrated with its Xenon range.

The development of Xenon saw Ballyclare combine new technologies and design techniques to produce its lightest, most breathable garments yet. In part, this is down to the use of Parallon, a new multi-barrier lining system from WL Gore that replaces the traditional moisture management membrane and thermal layer in turnout gear.

Parallon offers lower resistance to the transmission of sweat vapour through garments, which helps reduce the physical strain of working and minimise potential core temperature rises. Ballyclare's fire and technical director Richard Ballheimer calls it 'a real breakthrough' in breathability.

Parallon is also used by Bristol Uniforms in its Xflex and Layerflex ranges.

What firefighters wear under PPE is just as important. Current standards don't cover base layers, but the next-to-skin layer could be a vital weapon in the fight against heat stress.

'The skin is the largest organ in the human body,' says Andy Caughey from Armadillo Merino, which specialises in base layers for high-risk industries. "This layer is critical for sensory perception and a firefighter's wellbeing, comfort, and ability to perform. Yet professionals in high-risk environments often wear inferior products next to their skin that can negatively impact performance. At worst, they are dangerous."

Firefighters have moved away from cotton base layers, which have poor moisture management, but in some cases these have been replaced with the type of high-performance synthetic garment common in sportswear.

Above: layered PPE solutions combine full structural protection with the flexibility of lighter garments for operations such as wildland firefighting or technical rescue (picture: Bristol Uniforms).

The bodyworn sensors on Equivital's Black Ghost monitoring system.

One reason is the so-called 'moisture wicking' performance of such garments. Moisture management is critical for firefighters, but sportswear is not the answer, says Caughey.

"Sweat is part of the body's natural cooling process. It is not dangerous unless the sweat accumulates against the body. Synthetic sportswear is made with hollow, extruded fibres which are not effective in managing sweat when worn as part of a firefighter's ensemble, and can lead to steam burns."

For a sportsperson soaked in sweat, a single-layer synthetic that doesn't absorb moisture enables faster evaporation. "For firefighters in multiple layers, there is no evaporation. The resulting moisture build up is uncomfortable and dangerous."

This is not the only danger, however. Fibres such as nylon, polyester, and polypropylene melt at around 160°C. If a firefighter is caught in a flashover, the fabric can melt into the skin causing terrible, lifelong injuries. This does not apply to specialist FR synthetics. But while these won't melt, warns Caughey, they may not provide the required level of moisture management and thermal regulation.

But one fibre does, and that's merino wool. Armadillo Merino specialises in merino base layers because of wool's inherent properties: natural FR resistance up to 600°C without the addition of chemicals; non-melting; no static discharge; superb moisture management and thermal regulation.

"Wool absorbs up to 35% of its weight in moisture before it feels wet," says Caughey. "It starts to thermo-regulate before you sweat, helping to maintain a stable core temperature. A study at the University of Otago [New Zealand] showed that merino can actually delay the onset of sweating by up to 50% – a huge saving in moisture loss and calorie burn."

Another study in 2013 at the University of Guelph-Humber in Canada put four base layers to the test through live fire evolutions: Nomex, merino wool, an FR synthetic, and cotton. 67% of participants chose Armadillo Merino as their first choice, and 100% chose it as their first or second choice.

What firefighters wear, however, is only part of the story. It is what is happening internally that is most critical.

"We can all tolerate different temperatures," says Matthew Evans from Equivital, which provides mobile physiological monitoring solutions. "The best way to understand who is at risk, and when, is to monitor individual firefighters' physiological status during an incident and in training."

That is the goal Equivital is working towards. The company is about to embark on a study with three UK fire and rescue services using its Black Ghost remote-monitoring system in training scenarios.

The UK's current approach to heat-related risk in training, says Evans, is to ask a set of questions and make an assessment based on their answers. "As this is very subjective, some FRS are using timpanic temperature measurements before and after training, but these do not give the true picture. Access to real-time data would improve safety and the long-term health and effectiveness of firefighters."

The Black Ghost trials will see firefighters wear monitoring sensors that transmit data to the incident commander. "The system uses two algorithms to interpret the raw medical data," explains Evans. "The first is the Physiological Welfare Index, a straightforward traffic-light index of how each firefighter is doing, using data such as heart rate and respiration."

The second is the Heat Stress Index. "HSI takes the raw physiological data from a specific point in time and gives an estimate of heat strain on a scale of 1-12, and a predicted level of heat strain in 15 minutes if they continue at the same level of work in the same environment. This enables the proactive cycling of firefighters before they get into trouble."

The inherent properties of Armadillo Merino's base layers include natural FR resistance up to 600°C without the addition of any chemicals, no melting or dripping, no static discharge, and superb moisture management and thermal regulation. © Mitchell Images

The data also helps to record a baseline physiology for each firefighter, which allows more intelligent assessment of heat strain and other indicators. "This enables FRS to optimise work/rest cycles on an individual basis," says Evans. "Some firefighters will need shorter rest periods, and others longer."

The trial is only looking at Black Ghost within a training environment, but the ultimate aim, says Evans, is to translate its use into real fire scenarios. Monitoring must not lead to complacency, however, or replace basic good practice. "Just because our system shows that a firefighter's HSI hasn't gone into the danger zone, it doesn't mean they're not hot," says Evans. "All firefighters coming out of a fire need to do what they have been trained to do to cool down."

Post-fire cool-down procedures remain as vital as ever. As Richard Ballheimer notes, PPE retains heat. If garments are not properly vented and a firefighter goes back into a fire, the latent heat increases the risk of heat stress. Manufacturer's guidance states that when it is safe to do so, PPE should be removed entirely. Procedures to assist with cooling should also be properly implemented.

PPE should be propertly vented on exiting a fire and removed entirely when it is safe to do so, according to guidance from Ballyclare. © Eddie Howland

Vertical challenge

Active fire prevention for the world's largest high-bay freezer warehouse, by Katharina Bengsch.

Katharina Bengsch is editor (marketing) at Wagner

An oxygen-reduction fire prevention system has been installed for the protection of three areas containing 35m-high shelving with a total volume of over 1 million m3 – a world first.

Warehouses, data centres and archives are heavily dependent on efficient and reliable fire protection because even small failures can lead to grave consequences. However, the increasing level of automation technology and digitalisation is increasing the risk of fire: potential cable smouldering, overheating in pump motors or technical defects with refrigeration and air conditioning systems can cause a fire. Large amounts of easily flammable packaging materials like paper, cardboard or film increase the risk even further. In warehouse and logistics operations, the high density of goods stored in high shelves with narrow spaces can make it easier for a fire to spread to adjacent pallet spaces. The smart approach could therefore perhaps be described as altering the environment to such an extent that a fire is physically unable to start in the first place.

Preferred Freezer Services' warehouse is the first building in the US to be protected by Wagner's Oxyreduct technology.

In 1994, Wagner became the first company in Germany to introduce nitrogen as an extinguishing gas, which was closely followed by the development of an oxygen reduction system that minimises the risk of a fire breaking out in the first place. This system generates nitrogen from ambient air and continuously feeds it into the protected area in a controlled manner, keeping the oxygen level below the ignition threshold at all times.

Such a system was selected for the world's largest high-bay freezer warehouse, which was constructed for Preferred Freezer Services in the city of Richland, Washington State, around 300km east of Portland. Commissioned in July 2015, the warehouse stores and unloads around ±900,000 tonnes of frozen food per year – primarily French fries – with an order volume of over US$100 million.

The construction style of the deep-freeze high-bay warehouse is unusual for the USA; in a country not suffering from a lack of space, high-bay warehouses are relatively rare. The logistics specialist chose that design because automated logistics processes for goods storage and distribution were considered as the most efficient solution. However, warehouses of this size and height present special challenges for fire protection.

Conventional sprinkler technology, which is still the norm in the US, would have been pushed to their limits by the requirements of the facility: three protected areas with a total volume of over 1 million m3, 35m-high shelving systems and 117,000 pallet storage spaces.

The extensive lengths of pipelines and numerous sprinkler heads of conventional sprinkler systems would not only cost a great deal, but would also be difficult and costly to install and maintain – especially considering that, with rack storage facilities over 35m high, there would be no guarantee that the extinguishing water would actually reach the fire.

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Moreover, according to estimates, a great deal of the losses incurred in warehouses are not the result of the fire itself, but of the installed fire protection equipment, for example burst sprinkler-system water pipes or leaking sprinkler heads. Regardless of the cause (defects or fires), water damage in a deep freeze storage facility of this size would likely result in downtime and operational difficulties.

The active fire prevention system installed in Preferred Freezer Services' freezer facility uses the latest Pressure Swing Adsorption technology to obtain nitrogen from the air at near ambient temperature. This nitrogen is then introduced in a controlled manner to lower the level of oxygen in the environment to below the ignition threshold of the materials contained therein.

The level of oxygen was determined on the basis of fire tests that took into account the ignition thresholds of the stored goods packaged in dispatch-ready cartons as well as the low -23°C ambient temperature of the warehouse. The results of these fire tests were approved by Germany's independent organisation of property insurers, VdS.

The system has been set to lower oxygen concentration levels to 16.1% by volume; sensors in the oxygen control system monitor the protected area to ensure that the nitrogen injection is controlled and that the oxygen concentration is continuously maintained at the specified level.

For Wagner, the installation of the system in Preferred Freezer Services's warehouse was unique. It was the company's first installation of a nitrogen-generation system for a US customer, and one that was also based on American Society of Mechanical Engineers' standards.

Beam it up

The many challenges faced by fire detection specifiers and installers in the effective protection of warehouses can often be met with the help of beam detection, writes Warren Moyle.

Warren Moyle is senior product support engineer at Apollo Fire Detectors

An auto-aligning beam detector with a low-level mounted controller and a single 2C+E cable proved to be the best option for a 3,300m2 warehouse used for storing sensitive financial information.

There are many factors to take into consideration when it comes to ensuring that warehouse environments are adequately protected from the threat of fire. Most notable is the typically large size of warehouses and, consequently, the significant volumes of air; these lead not only to smoke dilution but also allow the potential for smoke to form into layers, delaying its detection. By their very nature, warehouses are also home to diverse ranges of goods meaning that a 'one-size-fits-all' approach is not appropriate.

An example of these challenges was encountered by Southern Alarm, who recently took over the maintenance and installation of an existing fire detection system at a warehouse. Built in 2007, with a total footprint of 3,300m2 and an above-standard height of more than 10.5m, Southern's first service visit revealed not only that the warehouse had insufficient point detector coverage but, with its excessive height, the system was non-compliant with the regulations.

A single beam detector can detect smoke over an area up to 1,500m^2.

The warehouse provides storage for large volumes of confidential paper records and books kept on racking; further, some of this is held on mobile shelving on a false floor. Keen to recommend the best solution to protect the highly flammable contents and to safeguard staff and visitors to the site, Southern considered both aspirating detection and beam detection. It was immediately apparent that aspirating detection was not an option for two reasons: firstly, the false floor would not bear the load of a platform lift and, secondly, the cost was prohibitive compared to a beam detection solution. For this warehouse installation, Southern specified Apollo's intelligent auto-aligning beam detector range with its 100m extension kit and universal brackets.

Darrell Pryor, from Southern Alarm Systems, explains the technical reasoning behind the specification: "The key factor in selecting the Apollo auto-aligning beam detectors above other similar products was that the controller and, consequently, the loop wiring is all mounted at low level with the motorised head wired radially from the controller in one 2C+E cable. This meant that there was no requirement for any 4C+E cable to complete the installation. Additionally, there was no need for either additional interfaces or for an additional power supply, as the unit is loop-powered. On that basis, the beam detectors were the obvious choice."

Beam detectors are often the most cost-effective solution for protecting large open spaces because one single unit installed on a wall can detect smoke over an area up to 1,500m2. To provide the warehouse with effective fire detection, Southern installed three beam systems in total, protecting the large space with its high ceiling and providing peace of mind to the client due to the system's compliance with BS5839-1:2013. Feedback from the two project engineers has been highly positive; with a combined 40 years' experience in the industry; they were particularly pleased with the laser-assisted alignment feature and commented that the set-up and menu structure couldn't have been easier. Going forward, Southern has already recommended the same range of beam detectors to a different client for use in another warehouse.

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Stand F170

The latest fire statistics show that the number of false alarms in the UK are continuing to decline – is it time to celebrate?

The latest fire statistics published by the Home Office show a continuing decline in false alarms in the six previous years, but also a levelling off in the downward trend.

False alarms due to apparatus such as smoke, heat or flame detectors account for nearly 70% of all false alarms, as well as 27% of the 529,000 incidents attended by UK fire and rescue services each year.

The total amount of false alarms caused by smoke detection, heat detection and flame detection systems declined for the period 2015/16 compared to the previous year by nearly 6,000 incidents. However, false alarms caused by sprinkler systems rose, due to an increase in incidences of faulty and damaged systems, as well as incorrect positioning and the use of unsuitable equipment. The number of false alarms caused by contaminants including steam, chemicals/aerosols, smoke cloak and thrips (a type of insect) also declined. Dust incidents, which accounts for around half of false alarms caused by contaminants, declined from 11,232 to 10,541.

This period also saw a decline in the number of fires in industrial premises, a category that includes manufacturing, processing, laboratory, public utilities, vehicle repair and warehouses/bulk storage. Interestingly, the number of fires in industrial premises has decreased by nearly a third compared to the period 2009/10, a decline seen also in the number of fires in offices and retail premises.

The overall reduction in false alarms by nearly 1,500 incidents from the previous year has been welcomed by the fire industry, which typically ascribes the downwards trend to a combination of regulation, increasingly sophisticated detection systems and a professional approach to systems management. However, according to Paul Pope, head of system integration and technical support at Apollo Fire Detectors, more remains to be done. "One key area in which Apollo feels there is far greater potential to drive down false alarm incidents is in improving the management of fire detection systems by site owners and/or maintenance contractors.

"By routinely checking that systems are operating properly, and addressing any subsequent maintenance issues, false alarm incidents can be further reduced. Hand in hand with this is the crucial issue of replacing detectors and devices which have reached the end of their manufacturer-recommended lifespan; this will undoubtedly increase a system's reliability," says Pope.

False alarms caused could be further reduced, suggests Pope, if system designers also took into account the differing detection and response strategy requirements for both occupied and unoccupied buildings. "An occupied building has the potential for life to be endangered by real fires and, while it is more susceptible to false alarms caused by human actions, it also supposes the possibility that early warning, pre-alarm conditions can be acted on.

"Occupied buildings may also have personnel on-hand to make an assessment about the validity of an activation, deal with and/or assess an emergency and act on fault and maintenance conditions as they occur. "An unoccupied building, on the other hand, does not risk human casualties directly and has potentially fewer false alarm phenomena but may not include any on-site verification of abnormal conditions such as faults and fires, however the main purpose of the fire system is the protection of property.

"Having the correct verification/response strategy and detection system in place will lead to fewer false alarms by ensuring that a system is fit-for-purpose in regard to the appropriate detection sensitivity settings, correct detector type and detector siting."

Seeing RED

The looming deadline of an EU directive coming into force this month is causing problems for manufacturers of radio-transmitting fire equipment, writes Jose Sanchez de Muniain.

A newly implemented step in the process of publishing standards in the Official Journal of the EU is being blamed for driving up the costs of compliance with a new directive coming into force in June this year.

The new Radio Equipment Directive (RED) applies to equipment that transmits or receives radio waves for communications or radio-determination, regardless of its primary function eg a connected device such as a smoke detector that uses an embedded radio module for communications. A wide range of products fall under the scope of RED, including anything with GPS, Bluetooth, radio-frequency identification or radio local-area network.

The RED has been brought in partly in response to the expected proliferation of the Internet of Things, where thousands of items will be connected and will be communicating between themselves.

The main changes of RED include; no lower limit to the radio frequency spectrum which, under the RTTE Directive, covered a range between 9kHz and 3,000GHz; no voltage limits for radio equipment; provision for universal chargers to address wastage; the inclusion of all radio receivers, including TV and radio equipment; and all equipment to be able to be connected to a public telecommunications network even if that is not its intended purpose.

First published in 2014, RED has been a long time coming: manufacturers who did not comply with the previous version of the directive, the Radio & Telecommunication Terminal Equipment Directive or Low-Voltage Directive, had until June last year to comply. However, manufacturers who did already comply with the previous version, repealed in 2016, were given until 13 June this

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Euralarm fears that installers face losing staff as a result of compliance issues with the new Radio Equipment Directive.

year to comply with the new Directive.

Harmonised standards published by the European Telecommunications Standards Institute (ETSI) are the preferred method for demonstrating compliance with European radio regulations. In practice, a manufacturer can cite the harmonised standard and then declare the product as compliant with the Directive, as long as said standard is also cited in the Official Journal of the European Union. Published every day, the OJ is the EU's official gazette of record and contains legislation including regulations, directives, decisions and recommendations.

The alternative to self-declaration via following a cited harmonised standard is to invest in a technical file that demonstrates compliance with the Directive – an expensive route to follow as it also requires a so-called Type Examination from a Notified Body, which is dependent on limited availability of test laboratories and certification agencies.

According to Euralarm, a trade association representing the electronic fire and security industry in Europe, the average cost of testing a radio-containing product via the Notified Body route ranges from €6,000 to €32,000 (US$6,700-36,000) per product. It estimates that with 2,000 product lines sold by European businesses across Europe, this would equate to approximatively €12 million to €64 million (US$13.5-72 million) in testing costs. "New products could therefore be 'off the market' from six to twelve months as a result. Loss of revenue could potentially be up to 50% for some companies resulting in significant losses. Figures could be in excess of €0.6 billion (US$0.37 billion) across the European supply chain," said a Euralarm communication.

In addition, Euralarm points out that there are up to 75,000 installations of wireless systems per month across the EU, equating to 3,750 engineers installing wireless systems every working day. Installing companies may be faced with either redeploying or losing staff.

The European Commission is producing a RED Guide that is expected to be published shortly.

The association has been lobbying ETSI and the European Commission over the challenges arising from the delay in the production, publication and citation of the harmonised standards. "We have been lobbying the Commission and other key stakeholders for many months now to secure a delay in the implementation of the RED based on the lack of standards and available test facilities to test products. So for us – the ideal outcome – would be for the Commission to realise the damage this causes our security and fire industries with lack of development and production time for manufacturers. Let's not forget this has knock-on effects on installers and end consumers!" said a Euralarm spokesperson to *IFJ*.

In response to the confusion surrounding the issues, the ETSI held a webinar in May hosted by director of spectrum and equipment regulations Michael Sharpe. He admitted that the European Commission's original requirement to produce the harmonised standards by March 2016 had not been realistic. "We said at the time this wasn't going to be possible. But, under the requirements of the Directive, the timescales of the Directive itself were such that we had to meet the requirements of the Directive. So we accepted the mandate knowing we could not meet it. We do the best we can."

The delays in production of the standards have been aggravated, explained Sharpe, by a change of procedure between publication of a standard by ETSI and publication of that standard in in the Official Journal. This new checking mechanism was implemented in 2015. "Previously the Commission would review standards and things were published pretty much as were…. and from that point [2015] onwards the Commission started checking and reviewing [everything] before going in the Journal. That is why we are in this situation. That is why there is a delay between ETSI published [standard] and citation in OJ. Now the Commission provides very detailed comments, and in most cases now requires modification as a result of those comments," said Sharpe. The new process means that it can take six months between ETSI publication and official citation in the OJ.

Four standards will be delivered by ETSI by the end of June; another 16 are expected by the end of 2017 and another 22 for 2018, said Sharpe. Some popular standards have, however, already been published in the Official Journal, such as the EN 300 200 and 330 Series, which covers short range devices in the 25MHz to 1,000MHz and 9kHz to 25MHz ranges, respectively.

The question of the options available for manufacturers relying on standards that have not been published in OJ was also addressed by Sharpe. "If a standard is published [by ETSI] it still represents the state of the art as developed by experts and endorsed by national standards organisations. That is a good basis to build up a technical file and then if for EMC (Directive)… it gives you a good basis to go to market directly. If radio or 3.3 standard you have to go to Notified Body but have firm [foundation] to go on. If the standard is in draft form … you can download those. There is a higher risk but still a firm basis for tech file."

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SUPPRESSION NEWS IN BRIEF

Strong actuation achieved

A new device that actuates with increased force the release of extinguishing agent from storage containers has been launched.
The device, suitably named the Increased Force Electric Actuator, has been especially designed by TLX Technologies for fixed gaseous suppression systems that have high system pressures and thus require higher actuation forces than standard components.
The standard solenoids and actuators from TLX deliver around 5.5kg of force but the latest addition delivers around four times that amount.
The new actuator contains an internal supervisory mechanism that ensures it has been properly installed on the appropriate discharge valve of the extinguishing agent storage container. According to the manufacturer, the integration of the supervision mechanism eliminates the need for additional components, connections and wire paths; resulting in a streamlined, NFPA-compliant solution that provides supervision of both the releasing device's proper placement as well as electric connection to the fire panel. In addition, the actuator provides high latching forces with ultra-force response and can be reset for future use.
The actuator can also be tailored to a particular system's operating requirements and size; interfacing options include connection, thread and pipe size; and stroke requirements and pin stick-out can be customised. An optional manual actuation assembly and/or reset tool attachment is also available.
As per all the devices supplied by TLX, the actuator meets the required UL and NFPA wiring codes and standards, including NFPA 2001, UL 864, UL 2166, UL 2127 and FM 5600.

Lightweight protection for bus engines

A range of small and lightweight bus fire protection systems certified to UNECE (United Nations Economic Commission for Europe) R107 has been launched by global fire suppression manufacturer Firetrace. Starting at just 4.5kg and with only four nozzles, the systems have a smaller footprint for faster installation in bus engine compartments. Larger 9kg and 10kg versions area available for extended options in cylinder placement and discharge network design. The new systems have also achieved certification at -40°C, which is preferred by bus manufacturers.

Larger flow from electric pump

Larger flows are now possible with the Hi-Fog electric pump unit from Marioff as the unit has been upgraded to allow for the housing of up to eight electric motors in a single pump skid. This is ideal for customers in marine and industrial applications as it offers the option to protect premises with additional water flow without installing multiple pump units.
The upgraded EPU pump unit skid will have an additional tower of electric motors but will use the same control cabinet as the original Hi-Fog EPU.

Sensitive touch for hard drives

A new acoustic nozzle from Tyco Fire Protection Products protects sensitive hard disk drives and data in the event of a fire suppression discharge. Designed specifically for use in data centres and server rooms, the acoustic nozzle significantly reduces the sound output of the nozzle and therefore the risk of damage to critical equipment as a result of sound exposure and vibrations. It is effective for use in both 60- and 120-second discharge options and can be retrofitted to existing installations.
Tyco has developed a white paper on the impact of sound on computer hard disks following a research study with Michigan Tech University. This details performance testing, guidance, and recommendations to help reduce sound exposure. It can be accessed at: http://hygood.com/Literature/Sound-White-Paper-Data-Center-web.pdf

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Delamination caused by incorrect surface preparation.

Shared visions

An industry group looking to raise standards in passive fire protection held a meeting in the US to share its vision of increasing safety and asset integrity.

The Passive Fire Protection Network held its US inaugural meeting in Houston, Texas, to introduce its vision of increasing the overall level of competency and knowledge within the field of passive fire protection (PFP) by developing guidelines and delivering training based on the knowledge and experience of its members.

The technical meeting introduced PFP Net to the US hydrocarbon fire protection sector and presented the key findings from the UK's first meeting last year, including the group's aims for 2017.

PFP Net was launched in September 2016 as a result of the identified need to introduce standardisation within the passive fire protection industry. It aims to establish a dedicated organisation that will enable a partnership between all those involved in the use, installation, inspection and manufacture of PFP systems. PFP Net will identify the current problems and the future needs, and then systematically resolve them as a collective industry response.

The industry group was founded by MMI Engineering, a technical consulting firm that had encountered multiple instances where PFP had been applied incorrectly, compromising both safety and asset integrity.

The US launch was attended by over 50 organisations; to date the following companies have signed up as members: Total, Shell, HSE, Woodside, Hempel, Technip FMC, Perenco, Alfred Miller Contracting, Esterline, PPG, Trelleborg, Conoco Phillips, Isolatek International, Morgan Advanced Materials, Promat, Advanced Insulation, Exova, Jotun Paints, Sherwin Williams and Typhoon Performance Products.

Simon Thurlbeck, MMI practice lead in fire protection, commented: "We knew we were facing a challenge when we decided to launch the group within the current business climate, however we were confident that the industry would recognise the need for PFP Net and the benefits of membership. The group will provide guidance, training and eventually accreditation – increasing understanding and competency across the whole area of PFP, leading to a reduction in the risk of costly problems, with the potential for significant immediate and longer term cost-savings. Members will have direct input into this process, as by serving on sub-committees, or by becoming developers or deliverers of the guidance and training, their opinions and knowledge will be included in all output."

For more information visit www.pfpnet.com.

SAFE IN THE BOX

An enclosure system has been launched that protects complex industrial equipment against extreme heat.

The passive fire protection enclosure system is designed to protect equipment such as risers, valves, pipework and flanges from the heat of a hydrocarbon and jet fire for up to three hours

The Jet Fire Pro-XP enclosure system from Advanced Industrial Solutions is a solid box-like structure coated with a flexible intumescent coating.

The enclosure can be produced in any design configuration for the protection of complex shaped industrial joints, flanges and valves – which are notoriously difficult equipment to coat effectively with traditional methods of PFP.

The new rigid system is a protection option that can be quickly installed for safety critical industrial equipment, such as shutdown valves.

According to AIS, the rigid PFP product has taken18 months of research and development to bring to market. During final testing, several configurations of the prototype were subjected to temperatures of up to 1,250ºC. The prototype

continued to withstand this extreme heat for three hours, exceeding typical specifications of 120 minutes, whilst still maintaining its integrity.

The testing, witnessed by Lloyds Register and DNV-GL, meets international safety standards ISO22899, UL1709 and BS476.

AIS is now investing in the development of further rigid PFP products for a wide range of industrial sectors including the nuclear and defence industries, in addition to oil, gas and petrochemical markets.

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Access denied

Germany has been accused of contravening European law through the introduction of additional national approvals for CE-marked construction products.

The European Association for Passive Fire Protection has branded the move, which includes passive fire protection, as a clear barrier to trade and says it infringes the EU's Construction Product Regulation No 305/2011.

In its present form, the German Regulation (Verwaltungsvorschrift) does not allow the use of certain CE-marked construction products without an additional national document. This links use in a building directly to the product via the application of European testing and classification standards.

By declaring product-related requirements that already incorporate usage requirements as building-related requirements, the German authorities are introducing a range of potential installation and job-site related problems, says the EAPFP.

The association goes on to argue that the additional approvals are a barrier to trade when applied to construction products that have declared all the required performances for the use of the product in the Declaration of Performance, or in the European Technical Assessment.

In this case, says the EAPFP, the additional approvals infringe the Construction Product Regulation (EU) No 305/2011, Article 8, para 4, which states, "A Member State shall not prohibit or impede, within its territory or under its responsibility, the making available on the market or the use of construction products bearing the CE marking, when the declared performances correspond to the requirements for such use in that Member State."

According to the EAPFP's position, the free movement of construction products and the use of such products is key to further growth in the construction sector as a whole, and fire protective products in particular.

"National barriers, potentially explainable and justifiable from historic perspectives, and related to short-term objectives, are detrimental in the long term to our market sector, and thus for the economies of European Member States," said EAPFP President Joric Witlox.

"EAPFP supports the CE-mark as the only mark that assesses product characteristics, allowing access to the market," said Witlox.

Joric Witlox, president of the European Association for Passive Fire Protection.

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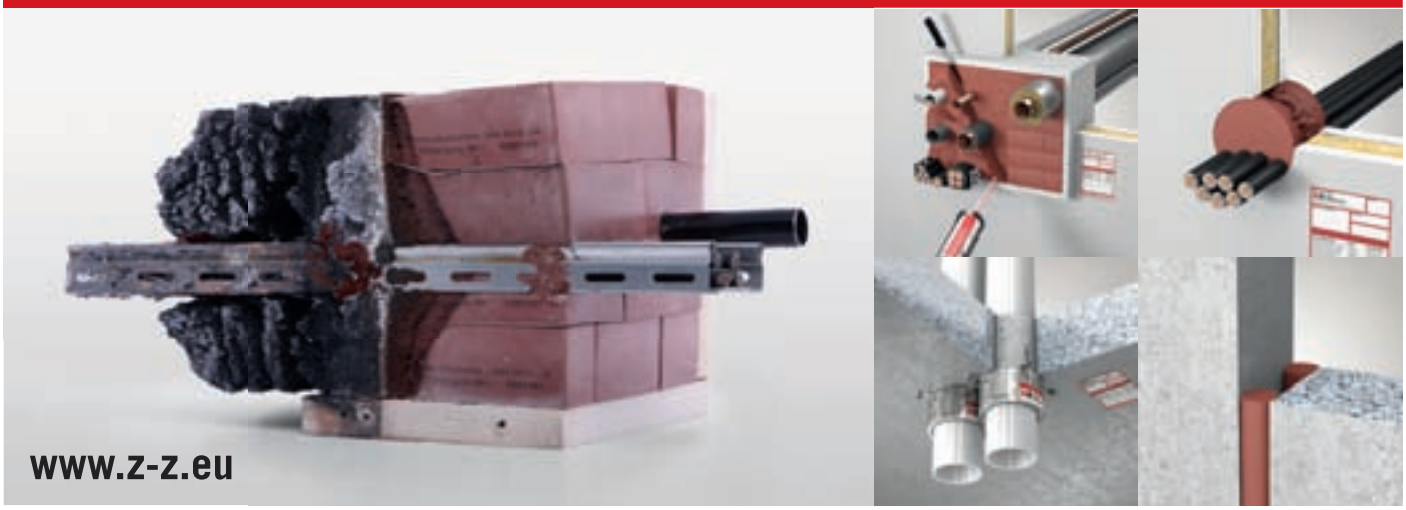
- Joint seals with movement capability

References:

Medicine Management Transport Industry



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