

# INDUSTRIAL **FIRE** JOURNAL

FOR PROFESSIONALS PROTECTING LIVES, ASSETS AND INFRASTRUCTURE WORLDWIDE

Third quarter 2016 issue no.105

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## What's in your water?

Erin Brockovich spearheads contamination lawsuit



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**"SEAC considers that fluorine-free foams can be taken into account on a long-term basis but cannot be relied on for the coming years for such a critical use."**

Committee for Socio-economic Analysis (SEAC), Draft Opinion, on an Annex XV dossier proposing restriction on PFOA, its salts and PFOA-related substances, 10 September 2015, p14.



Published Quarterly by

**hemmingfire.com**

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rest of world £50.00 or  
US\$80.00 (incl. p&p).

Send all subscriptions, changes of address  
and correspondence to address above.

Industrial Fire Journal, ISSN 0964 - 9719  
(USPS 021-884), is published quarterly March, May,  
September, December, by Hemming Information  
Services, a division of Hemming Group Ltd,  
8 The Old Yarn Mills, Sherborne, Dorset DT9 3RQ, UK.  
The US annual subscription price is \$80.  
Airfreight and mailing in the USA by agent named  
Worldnet Shipping Inc, 156-15, 146th Avenue, 2nd  
Floor, Jamaica, NY 11434, USA.  
Periodicals postage paid at Jamaica NY 11431.  
US Postmaster: Send address changes to Industrial Fire  
Journal, Worldnet Shipping Inc, 156-15, 146th Avenue,  
2nd Floor, Jamaica, NY 11434, USA  
Subscription records are maintained at Hemming  
Information Services, a division of Hemming Group Ltd,  
32 Vauxhall Bridge Road, London, SW1V 2SS, UK.  
Air Business Ltd is acting as our mailing agent.

#### Design & Artwork by

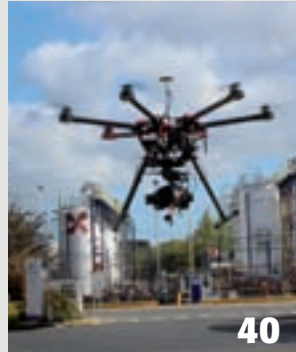
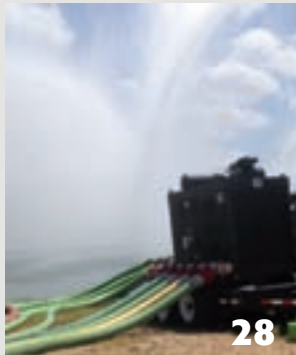
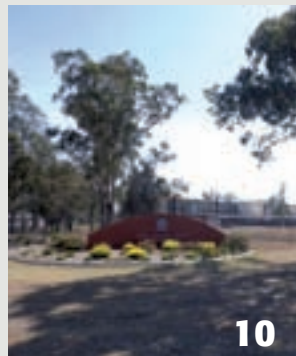
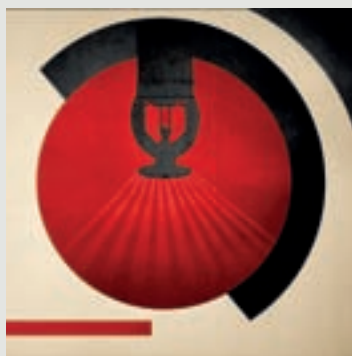
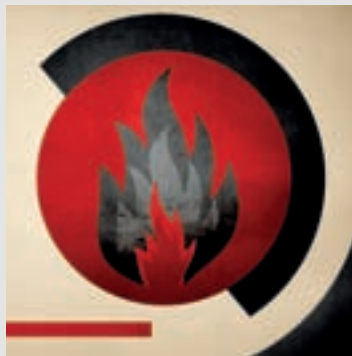
Graphic Examples, Sherborne.

#### Printed in England by

Latimer Trend & Co Ltd, Plymouth, UK.

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INDUSTRIAL FIRE JOURNAL are not necessarily those  
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Industrial Fire Journal (ISSN 0964-9719)



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Front cover artwork: Darren Small.

INDUSTRIAL  
FIRE JOURNAL

FIRE & RESCUE

FIRETRADE

FIRETRADE



## Comment

*The Australian Federal environmental health authorities must think that Australian citizens are made of sterner stuff than their US and European counterparts. In June they raised accepted levels of PFOS and PFOA in drinking water to almost 80 times higher than the US*

*EPA's, and around 50 times higher than those accepted by the German Federal Environment Agency.*

*The discrepancy hasn't been lost on famous environmentalist crusader Erin Brockovich, who has recently been spending some time in Australia adding her support to residents of Oakey. These Queensland residents are preparing a class action lawsuit against the Australian Department of Defence for the historical contamination of groundwater by foam used in fire fighting training at the nearby army base (see page 10), allegedly placing local residents at risk of serious health problems by failing to act on knowledge of that contamination.*

*The fact that several similar cases are unfolding in Australia should by no means lead to finger-pointing and assumptions that such things aren't happening elsewhere. In the US Dupont has been found liable for a man's testicular cancer (see below) to the tune of US\$5.6 million – and hundreds of similar lawsuits are expected to follow.*

*It appears that as the science behind the effects of PFOA and PFOS on human health sharpens, so do the teeth behind the 'polluter pays' principle.*

Jose Maria Sanchez de Muniain, Editor

## DUPONT FOUND GUILTY

Dupont is to pay US\$5.6 million in compensatory and punitive damages after a jury in Columbus, Ohio found the company liable for a man's testicular cancer.

During the trial David Freeman claimed that Dupont had knowingly dumped perfluorooctanoic acid (PFOA) – also known as C8 – into the Ohio River.

Freeman lived in Little Hocking, Ohio, which was served by the largest rural water system in Washington County. Little Hocking Water Association last year settled its lawsuit against Dupont for polluting its well fields.

Freeman had alleged that Dupont was aware of the potential toxicity of C8 as early as 1954 and that its own researchers knew that it was toxic by at least 1961. Plaintiffs argued that the company didn't inform the public of the hazards of C8 until 2012, when it was forced by regulators to fund a comprehensive study that found probable links between C8 exposure and certain kinds of cancer.

This is among the first lawsuits to go to trial from around 3,500 other personal-injury lawsuits set up in 2013 that allege Dupont dumped the chemical into the Ohio River from its Washington Works plant near Parkersburg, West Virginia.

Last year a jury awarded \$1.6 million in compensatory damages to kidney-cancer survivor Carla Bartlett who sued over the contamination.

While Dupont was the named defendant, a recent spin-off of its performance chemicals segment, Chemours, will cover its liability. Chemours said that it would appeal the verdict.

Two further test cases are planned this year related to kidney cancer and, from April 2017, the process will begin for a further 260 cancer suits. These will be tried at the rate of 40 per year and judges are currently being recruited to try them in federal courthouses in Columbus, St. Clairsville, Ohio and Wheeling, West Virginia.

## JAHEZIYA TRAINING AGREEMENT



Tawazun Safety, Security, and Disaster management City (Jaheziya) and Abu Dhabi Gas Development Company (Al Hosn Gas) have signed a memorandum of agreement to cooperate and identify business opportunities in HSE and fire training.

The MOA was signed at Al Hosn Gas headquarter by HE Ali Mohamed Al Ahbabi, Jaheziya Chairman and Saif Ahmed Alghefli, Al Hosn Gas chief executive officer, in the presence of Jaheziya managing director Jamal Al Shamsi.

The training programme is estimated to be worth AED12 million and covers fire and rescue, HSE and emergency response/preparedness for 2,000 Al Hosn Gas staff.



## WORLD'S FIRST OFFICE BUILDING PRODUCED BY A 3D PRINTER OPENS IN DUBAI

The 250m<sup>2</sup> 'office of the future' was built by a 3D printer measuring 6m high, 36m long and 12m wide, and erected near the Emirates Towers in Dubai. Siemens supplied fire protection technology for detection, alarms and control, including multi-sensor detectors that can adapt to changing environments, analyse signals for false alarms and protect against hazards such as the presence of carbon monoxide. The 'office of the future' concept includes a Siemens video surveillance system with high-definition cameras and web-enabled access via apps and web clients, and an access control system based on biometrics and smart cards. The complete system, which uses the Siemens' Designo CC building management platform, can also be analysed, evaluated and diagnosed remotely.

## YOUNG TALENT AWARD

The International Water Mist Association has announced the winner of its Young Talent Award 2016.

Daniel Alexander Martin won the award for his master thesis, The Use of a Water Mist Curtain as a Radiation Shield.

A volunteer firefighter, Martin has now started to work for Jensen Hughes as an Associate Fire Protection Engineer at the company headquarters in Baltimore, USA. Martin will present his master thesis during the 16th International Water Mist Conference which takes place 21-22 September 2016. Next year's award will be presented to the best PhD thesis and entries should be submitted before 30 April 2017.





## US\$6.2 MILLION FOAM CONTRACT



The US Air Force has awarded a US\$6.2 million contract to replace fire fighting foam used in fire vehicles with an environmentally responsible foam to reduce the risk of possible contamination of soil and groundwater.

In August ICL Performance Products was awarded the contract for 1.5 million litres of Phos-Chek 3%, six-carbon chain aqueous film forming foam. All foam in fire vehicles and fire stations is expected to be replaced by the end of 2016.

"AFFF is used by civilian and military firefighters to extinguish fires in aircraft accidents and other emergencies where jet fuel and other petroleum-based flammable materials are present," said James Podolske Jr, the Air Force fire chief, adding: "The Air Force must continue to use AFFF in its defence operations to protect people, critical weapon systems and infrastructure, but we will do so in a more environmentally responsible way that also makes our operations safer for the public." The Air Force also recently awarded a contract to retrofit all aircraft rescue and firefighting vehicles with specialised equipment that will enable fire fighters to conduct fire vehicle operational checks and required annual foam tests without discharging any AFFF into the environment.

The Air Force is considering several courses of action to address the AFFF used in aircraft hangar fire suppression systems.

## WASTE FIRE RULES UNWELCOME

New strict requirements have been issued in the UK for all waste site operators handling combustible waste.

The regulatory body of waste and recycling sites has issued a number of fire prevention measures to minimise the likelihood of a fire happening; extinguish a fire within four hours; and minimise the spread of fire within the site and to neighbouring sites.

All operators are expected to have procedures in place to detect a fire and operators that store waste in a building must install a fire suppression system that enables a fire to be extinguished within four hours.

As reported in *Industrial Fire Journal* (Second quarter 2016 issue 104), the Environment Agency had for the last few months been considering the results of a consultation regarding version three of its Fire Prevention Plan, which was first issued in 2013.

A condition for securing the Environmental Permit necessary to operate, the FPP is a detailed document and management system used by site operators to effectively manage site fire risk and its impact on the environment.

The publication of the new FPP has not been welcomed by industry. The Wood Recyclers Association had argued that the proposed stack sizes of three to five metres would make it impractical for the country's waste wood supply chain to handle the country's 4.5 million tonnes of annual arisings. It estimated that it would require most sites to increase their footprints by a scale of 10-15 times.

During the consultation the waste industry had also taken issue with the proposed maximum acceptable burn time of three to four hours until extinguishment.

## SPRINKLERS IN WAREHOUSES

The Association of British Insurers is calling on the UK Government to make it compulsory for sprinklers to be installed in warehouses over 2,000m<sup>2</sup> as well as new schools and care homes.

Several major fire brigades as well as the Chief Fire Officers Association and a number of fire prevention bodies have added their support to the initiative.

Average insurance pay outs for commercial fires are now above US\$32,500 (£25,000) for the first time, a rise of 165% since 2004.

Commenting on the call by the ABI to make sprinklers compulsory in warehouses in the UK, Iain Cox, chair of the Business Sprinkler Alliance said: "Our research with the BRE and the CEBR found that, from warehouse fires alone, businesses lose over £230 million (US\$300 million) annually, in addition to nearly 1,000 jobs. This cannot continue and we urge the Government to update the regulations to ensure businesses can urgently prevent and protect against the devastating risk of fire."

BEN CARLSON / SHUTTERSTOCK.COM



The US Department of Transportation has awarded the Texas A&M Engineering Extension Service US\$500,000 to provide hazmat instructor training. Through the grant, TEEX has proposed delivery of 37 classes in 18 cities across nine states that are adjacent to major interstate shipping highways and trucking hubs.

TEEX will develop and provide a four-day course in hazardous materials instructor training to help companies meet their safety goals and reduce hazmat incidents caused by human error. The TEEX train-the-trainer program will focus on understanding the hazardous materials regulations and recognising and identifying hazardous materials that are to be shipped.

"These grants are part of our comprehensive approach to improving the safe transportation of hazardous material by highway, rail, water, and air," said US Transportation Secretary Foxx.

TEEX is one of six US organisations to receive funding for hazmat instructor training from the US DOT's Pipeline and Hazardous Materials Safety Administration. PHMSA develops and enforces regulations for the safe operation of 2.6 million miles of pipeline and nearly one million daily shipments of hazmat by land, sea, and air.

## Angus International Safety Group

has appointed Ashley Brown to the position of chief financial officer, reporting directly to the group's CEO Paul Williams. Ashley is a Fellow Member of the Association of Chartered Certified Accountants and holds an MBA from Oxford Brooks University.

His career has encompassed senior financial roles in global blue chip organisations and also VC/PE backed businesses. His most recent role was chief financial officer of Elster Metering where he had responsibility for finance, IT, legal and HR. Ashley will lead Angus International Safety Group's finance, IT and HR departments in the UK, USA and France.



## CSB ISSUES SAFETY ALERT

The US Chemical Safety Board has issued a safety alert that aims to prevent accidents similar to the fatal 2010 explosion and fire at the Tesoro Refinery in Anacortes, WA that fatally injured seven workers.

The CSB's investigation into the catastrophic failure of a 40-year-old heat exchanger at the Tesoro Refinery determined that the fatal explosion and fire had been caused by a damage mechanism known as high temperature hydrogen attack, or HTHA, which severely cracked and weakened the carbon steel heat exchanger over time, leading to a rupture.

The CSB's 2014 report concluded that the standard used by industry for determining vulnerability of equipment to HTHA was inadequate but, according to the CSB, updated guidance recently published by the American Petroleum Institute has failed to address important elements of its recommendations.

CSB chair Vanessa Allen Sutherland said: "In the absence of industry guidance that incorporates findings from the Tesoro Anacortes failure, the CSB is issuing a safety alert to provide additional direction for industry."

The Safety Alert advises industry to identify all carbon steel equipment in hydrogen service that has the potential to harm workers or communities due to catastrophic failure; verify actual operating conditions (hydrogen partial pressure and temperature) for the identified carbon steel equipment; replace carbon steel process equipment that operates above 204°C and greater than 50psia hydrogen partial pressure; and use inherently safer materials, such as steels with higher chromium and molybdenum content.



## SIMULATOR IN A BOX



Rosenbauer's Panther tactical simulator is now available as a mobile, stand-alone training system that can easily be transported between locations. The new simulator is housed in a ro-ro container swap body vehicle and only requires a 400V electricity supply for operation.

Two sections make up the unit, a simulator and an instructor room, both fitted air-conditioning units. The simulator room is an exact replica of the Panther cockpit with seat, steering wheel and joysticks in the same place. The steering has been designed to provide feedback on terrain, for instance as regards steering resistance and automatic redirection when emerging from bends. The view from the cockpit is projected on 140cm, ultra-high-definition monitors with two screens forming the front windshield. Two more screens represent the left and right lateral windows with integrated rear view mirrors, while a roof monitor shows the extinguishing arm and the roof monitor.

The US Army stationed in Germany is the first organisation to acquire the mobile Panther tactical simulator.

## Advanced protection for natural history

The world-famous Natural History Museum in London, and its more than five million annual visitors are being protected by intelligent fire panels from Advanced.

Often called the 'cathedral of nature' the Natural History Museum is renowned for its collections of dinosaurs and ornate architecture, and is widely recognised as the pre-eminent centre for natural history and related research. The Museum is the third most popular in the UK and houses an irreplaceable 80 million-strong collection.

At the heart of the active fire protection for the Museum is a network of 24 Mxpro 5, intelligent, multiprotocol panels from Advanced, plus remote control terminals, BMS interface and a bespoke PC-based graphical user interface. The network was designed, configured and commissioned by Pacific Security Systems.

Kirk Short of Pacific Security said: "We needed a system that is simple to operate, with the features the end user requires on a daily basis, while also offering backwards compatibility with some of the loop devices that are already installed at the site."

The Mxpro offers four protocols, Apollo, Argus, Hochiki and Nittan, and a completely open installer network, backed up by training and technical support.





## HAZMAT ID RESOLVED

A new handheld tool that can 'see' through containers to identify hazmat materials has been launched.

Resolve uses Cobalt's Spatially Offset Raman Spectroscopy technology to quickly identify hazardous and contraband materials inside unopened opaque containers such as coloured plastics, dark glass, paper, card, wrapping, sacks and fabrics. The system identifies substances from comprehensive libraries including explosives and precursors, toxic industrial chemicals, chemical warfare agents, narcotics and new psychoactive substances as well as household chemicals.

The previous generation of Raman detectors could not identify samples contained within operationally-relevant thick, opaque or coloured packaging which meant that a container needed to be disturbed so a sample could be collected.

To operate Resolve, the user chooses the container type and the system then determines which measurement mode to use; Through-Barrier, Surface Scan or Vial Holder. According to Cobalt, Through-Barrier measurements take about one minute or less, with no sample preparation or consumables needed. Surface Scan mode is for 'point-and-shoot' measurements where there is direct line-of-sight to the sample. Vial Holder mode can be used when a small sample has been taken. The system also has a 'non-contact' mode for measuring through barriers without touching the container.

Cobalt's through-barrier SORS technology is already deployed at airports across the EU, Asia and Australasia as the engine in Cobalt's Insight range of liquid explosive detection systems.



## THREE STRIKERS MAKE DEBUT IN CARDIFF

Three Oshkosh 6x6 Striker vehicles started service in June at Cardiff Airport, UK resulting in an intensive 12-week training programme for the airport fire team.

The Oshkosh Striker is able to carry 12,000 litres of water and 1,600 litres of foam, which enables the vehicle to produce over 6,000 litres of fire fighting foam every minute from a forward facing bumper monitor with a jet throw in excess of 90 metres. Also mounted on the roof of the vehicle is the Snuzzle extending turret, a multi-function, quick-attack tool that provides the capability to place suppression agents at the fire source without having to commit firefighters to the hazard zone. The three new Global Strikers were supplied in conjunction with Terberg DTS, the official UK and Republic of Ireland supplier for Oshkosh. Under the contract Terberg will carry out on-site maintenance, routine service and repair work.



## PANTHER TRIAL

The International Fire Training Centre in Durham Tees Valley Airport in the north east of England is carrying out a two-month trial of the latest Rosenbauer Panther fire truck.

The newest model can accelerate from 0 to 80km/h within 25 seconds and can carry 12,000l of water, 1,500l of foam and 250kg of powder. It is also fitted with the 16.5m Stinger high-reach extendable turret for close proximity fire fighting on aircraft undercarriages, engines and spill fires. The Stinger features a piercing tool that can penetrate aircraft fuselage and which is operated using a Flir thermal imaging camera. Subject to successful completion of the current trial, the Serco-owned IFTC plans to permanently station a Panther at its 81,000m<sup>2</sup> training site for use in exercises by next year.



## ATEX LIQUID INDICATOR

A liquid level indicator that non-invasively detects the level of fire suppression agent contained inside a cylinder is now available for use in potentially explosive environments.

The Portalevel Intrinsically Safe indicator manufactured by Coltraco Ultrasonics can be used to quickly ascertain the level of clean agents and gases such as CO<sub>2</sub>, FM 200, NOVEC 1230 and HFC 225 and 227 contained inside cylinders to an accuracy of +/-1.5mm.

As the unit uses ultrasonic technology to identify the interface between liquid and air in any single-skin container, it has none of the issues associated with radioactive liquid level indicators, which require dedicated training, storage and transportation. In addition, it replaces the traditional means of verifying liquid levels by dismantling of fire extinguishing systems and weighing of cylinders.

The Zone 1 Atex approval of the Portalevel Intrinsically Safe classifies that the equipment "provides a very high level of protection in continuously present explosive atmospheres" such as those in LNG/LPG carriers, military aerospace industry as well as power plants and petrochemical facilities.



## German insurer goes wireless

BG Bau Praxiszentrum, Germany's statutory accident insurer for the construction industry, has installed WES+ in its Nuremberg training centre as the only wireless fire alarm system in Europe to fully comply with EN 54.

The wireless alarm system is now on a four-storey mock construction site within the training facility, which is visited by 4-5,000 inspectors, clients, construction companies and health and safety bodies each year, giving visitors a practical, hands-on insight into how the system works.

WES+ comprises manual fire alarm call points that are installed so that the system is interlinked. If one of the call points is activated all four storeys at the training centre's construction site receives the same audible and visual alert signal, even if the 'fire' is contained to just one of them and a single call point is activated.





## 7-10 NOVEMBER 2016, ADIPEC, ABU DHABI NATIONAL EXHIBITION CENTRE, UAE

Oil and gas giants will be calling for greater industry collaboration at this year's Abu Dhabi International Petroleum Exhibition and Conference.

Speaking ahead of his participation in the ADIPEC Global Business Leaders' panel, Total CEO Patrick Pouyanné said industry stakeholders must work in unison towards the common goal of achieving a sustainable energy future: "The global energy landscape is witnessing a rapid change, influenced by economic challenges and efforts to reduce carbon emissions, which can be addressed by the emerging role of natural gas and renewables. All of this makes it crucial that industry players operate not only more efficiently, but also more closely, in a spirit of cooperation," Pouyanné said.

Confirmed senior-level speakers at ADIPEC include Dr Sultan Al Jaber, Group CEO of ADNOC, who will be presenting the opening ceremony keynote; Rex W Tillerson, chair and CEO of Exxonmobil, Patrick Pouyanné, CEO of Total; Bob Dudley, CEO of BP; Alexander Medvedev, deputy chair, management committee, Gazprom; Vicki A Hollub, president and CEO of Occidental Petroleum Corporation, Jeff Miller, president of Halliburton; and Paal Kibsgaard, chair and CEO of Schlumberger.

Moderating the global business leaders sessions will be celebrated journalist John Simpson, BBC world affairs editor, broadcaster, author and columnist, as well as oil guru Dr Daniel Yergin, vice chair of the industry consulting group IHS.

For more information visit [www.adipec.com](http://www.adipec.com).



## 16-17 NOVEMBER 2016, TANK STORAGE GERMANY, HAMBURG MESSE, GERMANY

Tank Storage Germany brings together over 80 suppliers and a dedicated audience of decision makers and senior buyers, all looking to attend the highly anticipated conference programme and source the latest in tank storage solutions.

Germany has a total storage capacity of over 70 million m<sup>3</sup>, yet with much of it being geared towards supporting the inland supply chain, the market dynamics are very different to those in the ARA (Amsterdam, Rotterdam and Antwerp). The two-day conference programme will provide visitors with an insight into the industry's critical issues, as well as debate the latest trends and market forecasts.

Leading experts from Oiltanking, Arcadis, Vopak, Deloitte and Tanquid will be taking to the stage to discuss all things storage, including refining, trade flows, investors, regulations, falling prices, innovative new technologies and energy efficiency.

Alongside the educational seminar sessions will be a packed exhibition hall, showcasing an array of international suppliers, including Actemium, Börger GmbH, Ivens NV, Siemens, Mueller-Behaelterbau, M+F Technologies, Ifl Technology GmbH and Remondis.

To find out more visit [www.tankstoragegermany.com](http://www.tankstoragegermany.com).

## 22-24 JANUARY 2017, INTERSEC, DUBAI INTERNATIONAL CONVENTION AND EXHIBITION CENTRE, UAE

With more than 1,280 exhibitors Intersec is the largest exhibition in its industry and with visitors from 127 countries also the most international event worldwide.

For the second year running the fire section of the trade show will feature the Safety Design in Buildings Pavilion, which will have a special focus on life safety design; building construction; fire protection; fire rated building materials; fire alarms; and smoke ventilation systems.

The GPEC General Police Equipment Exhibition & Conference will also run alongside Intersec, with a focus on police and special equipment, safety and rescue technology and communications, vehicles and traffic control, criminal science and forensic technology.

Messe Frankfurt will continue to expand its successful Techtextil brand in the growing technical-textile markets in the Middle East with the Techtextil Pavilion, which will present technical textiles for professional and protective clothing. Lastly, Intersec 2017 will once again present the concept of smart homes and building automation.

To register visit [www.intersecexpo.com](http://www.intersecexpo.com).



## NORDIC FIRE: CALL FOR ABSTRACTS

Almost 200 delegates attended the Nordic Fire and Safety Days conference held in June in Aalborg University in Copenhagen, Denmark.

The annual event included 70 presentations all with the overarching aim of building bridges between communities, explained conference chair Anne Dederichs: "The first bridge is to connect the research community with users in the local authorities and private sector; the second bridge is to share national projects on an international level. For example in Sweden there is currently a lot of funding into residential fires."

The topic of residential fires took a lion's share of the event this year but lively panel discussions on fire insulation also took place, amongst other subjects, following a keynote presentation by Birgitte Messerschmidt of Rockwool International. "We had delegates from the Faroe Islands where there are plans to join the islands with tunnels, so this was focussed upon," added Dederichs. Plans to connect Eysturoy and Streymoy as well as Streymoy and Sandoy are in place in what will be the most expensive construction project in Faroese history.

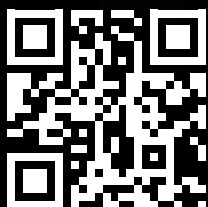
For future Nordic Fire conferences the event will be rotated between universities and countries in Scandinavia but in Spring 2017 it will again be held in Copenhagen. "We are now collecting ideas for key topics and lectures so submitted abstracts are welcome," said Dederichs.

To submit an abstract email Anne Dederichs: [Anne.Dederichs@sp.se](mailto:Anne.Dederichs@sp.se).



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# Residents to fight back

The scandal of the contamination of Oakey Army Aviation Centre in Queensland, Australia has attracted activist Erin Brockovich as local residents prepare to launch a class-action lawsuit. Lotte Debell reports.

**E**rin Brockovich is reported to have told Oakey residents that the contamination from the army base as a result of fire fighting drills carried out by the Australian Defence Force is the worst she has ever seen and she has encouraged them to stand together and fight for their town.

The US environmental campaigner, who famously won a case against Pacific Gas & Electric Company for groundwater contamination in Hinkley, California, was speaking at a meeting of residents on 2 August as an ambassador for Shine Lawyers. Shine has been acting for a number of Oakey residents since 2014, and is now putting together the class-action against the Australian Department of Defence, which looks set to be landmark case.

The contamination crisis has become increasingly political since residents were informed of the contamination in December 2012 following the discovery of toxic chemicals in the pool (waste water dams) at the Oakey Army Aviation Centre.

The chemicals involved are perfluorinated compounds, mainly PFOS (perfluorooctane sulfonate) and PFOA

(perfluorooctanoic acid), amongst many others, which are found in aqueous film-forming foams (AFFF) used in firefighting – the same chemicals that have been blamed for numerous adverse health impacts at the CFA Fiskville Fire Training College in Victoria (see *IFJ* Q2, issue 104). The foams containing these chemicals were in use by the Department of Defence at Oakey from the 1970s to 2005 and have caused contamination of soil, sediment, surface water and groundwater at the base and in surrounding properties. Properties near the base have been advised not to use bore water for drinking.

Residents have reported that further testing has revealed that levels of these chemicals are increasing, with several properties showing higher levels than two years ago, and that one property in particular has contamination levels 50% higher than in 2014.

Not only that, but the AECOM Environmental Site Assessment report published by Defence in July identified a contamination 'plume' that stretches up to 4.5km southwest of the base which will continue to be an issue for decades. Models carried out as part of the investigation found that, if no remediation is undertaken, the plume is expected to spread 2km in a similar direction over the next 100 years.

Defence has been heavily criticised for its handling of the crisis from numerous quarters, including by Queensland's Environment Minister Dr Steven Miles, who has been quoted as saying he is not surprised that residents feel the need to resort to the courts 'given the way Defence has handled this so far'. Earlier this year the Queensland State Government introduced a new policy that severely restricts but does not ban the use of AFFF (see page 12). However, Commonwealth land – and therefore Defence sites – lies outside its jurisdiction.

Much of the criticism levelled at the Australian Department of Defence centres on its failure to act on knowledge of the contamination for a number of years, and therefore continuing to put local residents at risk of serious health problems. At the time of writing, a report into the possible health effects of the contamination was yet to be published, but various international studies have linked PFOS and PFOA with a

Army Aviation Centre  
Oakey in Oakey,  
Queensland,  
Australia (photo:  
Shiftchange,  
Wikimedia Australia).  
Right: Erin Brockovich  
at the University of  
Sydney (photo: Eva  
Rinaldi).







number of illnesses, including kidney and testicular cancer, thyroid disease, pregnancy-induced hypertension and developmental issues – in the UK and the rest of Europe, PFOA is listed as a reproductive toxin – immune damage, ulcerative colitis and hypercholesterolemia.

However, Defence has repeatedly refused to accept that there is 'any consistent evidence' to prove that these chemicals cause cancer and other illnesses – a stance that has been described as 'out of touch with the global response' by Dr Mariann Lloyd-Smith, senior adviser from the National Toxins Network. It was also criticised in a recent senate report on the contamination, which found that it had known of the environmental and health risks of foams containing PFCs since 2003.

A report from its own consultants in 2003 warned Defence that these chemicals were present on its lands and that they were 'environmentally persistent, bioaccumulative and toxic to animals and humans'. The report also stated: 'both have been implicated with a variety of cancers and toxic health effects in humans that have had long term exposure to products containing PFOS/PFOA.'

Controversially, Australian Federal environmental health authorities have been accused of ignoring the latest international research and standards on the safe levels of PFOS and PFOA in drinking water and for daily intake when in June they set accepted levels of these chemicals at almost 80 times higher than a recent report from the US Environmental Protection Agency, and some 50 times higher than those currently accepted by the Drinking Water Commission of the German Federal Environment Agency.

In May, the US EPA set acceptable levels of PFOS and PFOA in drinking water as 0.07 micrograms per litre. The new Australian enHealth guidelines set these levels at 0.5 mcg/l for PFOS and 5 mcg/l for PFOA – more than 78 times higher than the US levels. The Australian paper *The Courier Mail* has reported that the levels being recorded at Oakey have reached up to 20 mcg/l for PFOS and 0.76 mcg/l for PFOA. Shine Lawyers, the firm acting for residents in the class action, say groundwater PFOS contamination levels may be as high as 50-500 mcg/l within the boundaries of the base itself.

In addition, initial blood tests of 75 Oakey residents for the senate report revealed average blood levels of these toxins at levels three times higher than Australians in general, with some recording levels up to 18 times higher. According to Shine, in some residents levels have reached up to 44 times higher. Erin

Brockovich told *The Courier Mail* that the Australia population has higher blood levels of these chemicals than she has seen in the US.

Oakey is not only site in Australia where contamination with PFOS and PFOA is a concern. The final report into the CFA Fiskville contamination scandal in Victoria was released earlier this year: residents near the Williamstown RAAF base in New South Wales are facing similar concerns to those in Oakey; and at least 16 other Defence sites are to come under urgent investigation out of a possible 100 cases. Investigations are also continuing at 36 civilian airports across the country, according to Air Services Australia. Most recently, RAAF Amberley, also in Queensland, has hit the headlines with the revelation that Defence knew of contamination there back in 2012, and it is possible that this may have spread beyond the base. Amberley has now been prioritised for investigation in 2017.



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# Foam management

Queensland's new operational policy for fire fighting foam contains highly restrictive environmental management requirements for AFFF.

**T**he Department of Environmental and Heritage Protection of the state of Queensland, Australia has published its long-awaited operational policy on the environmental management of fire fighting foam.

The new policy outlines the requirements for the handling, transport, storage, use, release, waste treatment, disposal and environmental protection measures around fire fighting foam in Queensland.

Minister for Environment and Heritage Protection and Minister for National Parks and the Great Barrier Reef, Dr Steven Miles said: "Queensland is adamant that fire fighting foams containing highly persistent organic pollutants including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) implicated in the contamination of the Oakey Defence base need to be phased out.

"The Government will require that any existing stocks of foams containing PFOS and PFOA are withdrawn from service at commercial and industrial premises, and similar products phased out and replaced, as soon as practicable with more sustainable alternatives."

Situated in the north-east of the country, Queensland is the second-largest state in Australia and is home to six World Heritage-listed preservation areas including the Great Barrier Reef.

According to a media statement by the Queensland Government, the impact of the ban will be felt by a small number of industry sectors in Queensland that continue to hold stocks of PFOS and PFOA foams for use in emergency situations, such as industrial ports and bulk fuel storage facilities.

Large stocks of PFOS foam are known to be held throughout Australia despite the current knowledge around PFOS's adverse effects. The policy document highlights an incident involving a one-tonne spill of PFOS-containing foam that occurred in Queensland into a body of water connected to the Great Barrier Reef Marine Park in January 2013.

The policy outlines that foams containing C6 can still be used for firefighting operations when they are the only viable option and if they meet a number of strict requirements. There can be no releases of C6 foams directly to the environment – for example uncontrolled drains or soakage pits – and all releases must be fully contained on site.

Significantly, only C6 foam that is 'purity-compliant' can now be deployed in the state. For foam concentrates to meet this requirement they must not contain more than 50 parts per million of PFOA and PFOA precursors, says the report. Companies that hold stock of foam above this limit must prepare a disposal plan for it in the few six months.

Although the new policy's comprehensive explanatory notes acknowledge that C6 foams are now widely available as alternatives to more bioaccumulative, longer-chain compounds, they point out that significant concerns are emerging about all PFCs – including short-chain compounds (ie C6 and below). A degradation endpoint compound for new-generation C6 foams is perfluorohexanoic acid, which is reported to be three to five times more acutely toxic than PFOA for some aquatic species.

In addition, the notes point out that there is still insufficient independent information publicly available on C6-based or C6-pure foams to conduct realistic environmental risk assessments due to major gaps in information.

The policy has not been welcomed by the fire industry. Fire Protection Association Australia has voiced concerns regarding the consultation and implementation process of the policy, in particular the lack of transitional mechanisms for existing users of now banned foams to move to fluorine-free alternatives. These concerns have been supported by the US-based Fire Fighting Foam Coalition, a not-for-profit industry association.

FPA Australia has also said that it was deeply concerned by the Queensland Government's view that potential environmental impacts alone should determine foam selection and use.

Matthew Wright, chief technical officer/deputy CEO of FPA Australia said the ban was a simplistic response to a complex issue and that it could be potentially dangerous. "Environmental impacts must be a key consideration in the selection and use of fire fighting foams, but this policy naively ignores the new generation of short chain  $\leq$ C6 fluorinated foams which are non-toxic and non bioaccumulative and simply draws an unrealistic line between fluorine-free and fluorinated foams as the deciding factor for selection," he said.

"If a foam is not effective for the hazard, the environmental impact will be magnified by the persistence and potential escalation of the fire event itself, damaging smoke, and potentially carcinogenic products and runoff regardless of whether the foam is fluorine free or not," added Wright.

The Environment Minister Dr Miles however has pointed out that Queensland Fire and Emergency Service has been using PFC-free firefighting foam since 2003. "Non-persistent firefighting foams are available, effective and certified for all major fire fighting applications. They can break down or biodegrade should they be released to the environment."

The Association is calling on the Queensland government to suspend implementation of the policy and to work with industry to develop alternative transitional arrangements.

*Download the full policy and comprehensive explanatory notes at [www.hemmingfire.com](http://www.hemmingfire.com)*

Aerial view of Upolu coral reef at the Great Barrier Reef near Cairns in Tropical North Queensland, Australia.  
Photo credit: Chameleonseye, Shutterstock.



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# Fluorochemicals

What is all the fuss about? Dr Roger A Klein explains.

**I**n May 2000 the 3M Company announced that on grounds of potential environmental and toxicological issues it was withdrawing from electrochemical fluorination using PFOS-based chemistry to produce a wide range of industrial fluorochemicals, including Scotchgard products and Lightwater and ATC fire-fighting foams.

Ever since then, environmental regulators and academic researchers as well as end-users and environmentalist pressure groups have all become increasingly concerned about widespread contamination of the biosphere with man-made fluorinated materials.

It is worth noting that historical human blood bank samples contain no detectable organic fluorine compounds prior to the chemical industry beginning fluorochemical production shortly after World War II.

Fully fluorinated organic substances – those with all their carbon-hydrogen (C-H) replaced by carbon-fluorine (C-F) bonds – are totally anthropogenic and do not occur in nature. A few examples of naturally occurring organo-fluorine compounds are known but these are only partially fluorinated, such as the monofluoroacetate excreted by the poisonous South African 'gifblaar' plant. Only 12 naturally occurring organo-fluorine compounds have so far been found and how these are biosynthesised remains a mystery[1]. Yet an estimated 20% of all pharmaceuticals and 30-40% of all agrochemicals are organo-fluorine compounds[2].

All organo-fluorine compounds are characterised by having one or more carbon-hydrogen bonds substituted by the carbon-fluorine bond C-F, one of the strongest and most stable in chemistry.

Molecular structures with all their carbon-hydrogen bonds replaced by carbon-fluorine bonds are referred to as 'perfluorinated'; these may be embedded in a larger structure

also containing C-H bonds in which case the term 'polyfluorinated' is often used. The abbreviation PFC generally refers to either per- or polyfluorinated materials, as many industrial polyfluorinated substances contain a perfluorinated portion within their structure.

The simplest perfluorinated chemicals in industry are CF<sub>4</sub> (tetrafluoromethane) and C<sub>2</sub>F<sub>6</sub> (hexafluoroethane), as produced during primary aluminium production, or CF<sub>3</sub>COOH (trifluoroacetic acid), widely used as an acid catalyst. Such highly chemically and physically stable perfluorinated compounds are characterised by extreme environmental persistence (ie atmospheric half-lives as long as around 50,000 years for CF<sub>4</sub>[3]) and long-range transport, appearing as contaminants of the oceans or the upper atmosphere.

Organo-halogens – which include all organo-fluorine compounds – have held an important place in fire engineering for many years as extinguishing agents, fire suppressants or flame retardants. Some of these applications have been discontinued or banned by international agreement. For example, halons were phased out and banned under the Montreal Protocol in 1989 because of serious concerns over depletion of the Antarctic polar ozone layer.

As well as being one of the very few treaties universally ratified by all 197 countries belonging to the United Nations, this was a prime example of global regulation being agreed before a scientific consensus was established – ie, a classic example of the Precautionary Principle being applied in practice (more on this later).

While flame retardants such as polybrominated diphenyl ethers or polybrominated biphenyls are either banned outright or severely restricted, fluorochemicals retain a central role in fire engineering practice.

Fluorosurfactants and fluoropolymers remain the cornerstone of highly successful and operationally effective AFFF (aqueous film-forming foam) formulations first introduced in the 1960s by the US Department of the Navy for Class B liquid fires.

Since the phasing out of PFOS-based AFFFs (which include alcohol-resistant versions as well as fluoroprotein variants) in the early 2000s on environmental grounds, modern AFFFs are almost always produced using fluorotelomer derivatives.

Fluorotelomers and perfluorocarboxylic acids are also used extensively for treating fabrics used in protective clothing, whether this is for outdoor activities such as for anoraks or footwear or for personal protective equipment (PPE) used by the emergency services or military.

During their manufacture feedstocks for these chemicals may be fractionally distilled to yield low or high molecular weight

Regional fire fighting exercise in Szeged, Algyo, Hungary. Fluorosurfactants remain the cornerstone of operationally effective AFFF (photo: jax973, Shutterstock).

Below: new blood levels of PFOS deemed as safe are down four/five-fold compared to those set in 2009 (photo: Gitagraph, Shutterstock).







fractions or cuts. The low molecular weight part – or fraction – has traditionally been used for producing derivatives for firefighting foam such as AFFF, fluoroprotein and film-forming fluoroprotein foam. This fraction has always had C6 as the major component, in addition to a mixture of chain lengths ranging from C4 through to C20. Originally the C6 and C8 components taken together represented around 80-90% of the total but, more recently, highly purified so-called 'pure' C6 raw material has become available as a result of pressures from regulators. The best currently available information in the public domain refers to around 99.7% of C6 chains with 0.3% made up of C4 as well as C8 and higher.

However, it has been found that reformulating AFFF-type fire fighting foams without significant amounts of C8 or higher carbon chains results in the degradation of foam performance, especially burn-back resistance. In addition, it has proven impossible to formulate functional FFFP without significant amounts of C8 and higher carbon chains present.

A similar phenomenon can be observed with textile treatments. The higher molecular weight fractions of the fluorotelomer perfluoroalkyl derivative are used for fabric and textile treatments to achieve oil and water repellency for a wide range of outdoor clothing, domestic textiles and furnishing fabrics as well as for PPE used by the emergency services, hospitals and military. This fraction usually consists of very few C4 and C6 chain lengths and mainly contains C8, C10 and higher chain-length molecules.

The reduction of the C8 derivatives has been found to adversely affect treated textile performance, especially for oil and chemical repellency.

These treatments are still in common use. A recent report on behalf of the German Federal Environment Agency[4], *Understanding the exposure pathways of per- and poly-fluoroalkyl substances via use of PFAS-containing products – risk estimation for man and environment*, has demonstrated that fluorotelomer-treated protective clothing used for leisure activities, such as all-weather outdoor jackets, contain significant quantities of

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extractable perfluoroalkyl carboxylic acids (PFCAs) consisting predominantly of PFOA (C8) and higher homologues.

Previous studies of the commercially available treatments for the domestic market for all-weather clothing, in the form of aerosol cans, have shown that some of these products contain high concentrations of fluorotelomer alcohols, or even PFCAs. There is therefore the potential for inhalation of the aerosol – a prime mechanism for internal whole-body contamination – followed by metabolic breakdown to PFCAs and damage to the liver. Other products tested, however, have very low or zero fluorocarbon content, a marketing opportunity not ignored by the manufacturer.

#### **Precursors giving rise to perfluorinated carboxylic acids (PFCAs)**

First suspected over 35 years ago, it is now accepted that all 8:2 fluorotelomer derivatives (whether in fire fighting foams or textile treatments) with the fluorotelomer C8F17CH2CH2 moiety, or higher homologues, can degrade to PFOA and other related PFCAs to varying degrees depending on conditions[5].

PFCAs with chain lengths >C8 are logarithmically more toxic and bio-accumulative than PFOA and the intermediate



breakdown products which include fluorotelomer saturated and unsaturated carboxylic acids, as well as ketones and aldehydes may be orders of magnitude more toxic to certain organisms than the same chain length PFCAs.

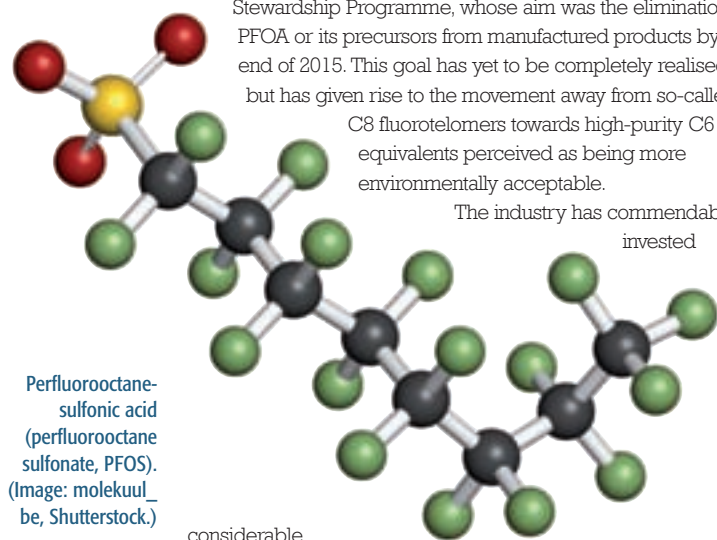
The C6 PFOA perfluorohexanoic acid produced from 6:2 fluorotelomers is less toxic or bio-accumulative than PFOA, as judged for regulatory purposes by the arbitrary trigger value criteria of the EU's chemical regulations (REACH). But this does not mean necessarily that it is completely non-toxic or bio-accumulative over long periods of time. Thus, any 8:2 fluorotelomer derivative when present even as an impurity can function as a precursor for PFOA, which is significant in relation to the European Chemical Agency's proposed restrictions on PFOA, its salts and precursors, in foam of 1 ppm as well as for legacy contamination.

### 2010/2015 PFOA Stewardship Programme and challenges for industry

Following on from a legal case, and initiated by the US Environmental Protection Agency, a number of fluorochemical manufacturers voluntarily subscribed to the 2010/2015 PFOA

Stewardship Programme, whose aim was the elimination of PFOA or its precursors from manufactured products by the end of 2015. This goal has yet to be completely realised but has given rise to the movement away from so-called C8 fluorotelomers towards high-purity C6 equivalents perceived as being more environmentally acceptable.

The industry has commendably invested



Perfluorooctane-sulfonic acid (perfluorooctane sulfonate, PFOS). (Image: molekule, Shutterstock.)

considerable resources over the last ten years in reducing C8 content and improving the C6 purity of fire fighting foam fluorochemical components as part of the PFOA Stewardship Program.

A fairly typical aqueous film-forming foam contains about 1% fluorine as fluorosurfactant in a concentrate as supplied to the end user. High-specification foams such as Milspec and 1% foams contain proportionately more fluorosurfactant or fluoropolymer than a 3% or a 6% foam. Thus a typical concentrate contains about 10,000 parts per million (ppm) of fluorochemical. In order to achieve the derogated limit of 1 ppm for PFOA or its precursors in fire fighting foam, as proposed by the European Chemicals Agency, the fluorotelomer components will need to be 99.99% pure in terms of C6 contaminated by C8 and higher homologues.

However, currently the best available purity of a feedstock on the market as declared in its safety data sheet is 99.7%. Achieving such very high purities industrially with a process that delivers a range of evenly spaced chain-length homologues (C4, C6, C8, C10, C12, C14 etc) is far from trivial, especially when production needs to be on a large and commercially viable scale. Fractional distillation aimed at producing such efficient separation of very similar compounds differing only in chain length is expensive and wasteful of costly starting material.

Furthermore, even if the fluorochemicals used were to be

100% C6, there remains the problem of increasing dispersion and exposure to perfluorohexanoic acid (PFHxA) with continued use.

### Regulatory pressures

Regulators as well as academic scientists worldwide have taken considerably greater interest in the potential impact of widespread environmental contamination by per- and poly-fluorinated alkyl substances in recent years compared to previously.

Concerns have been raised by the academic community in the form of the Madrid and Helsingør Statements. In addition the PFOA Stewardship Programme, Canada has introduced many restrictions on the use and importation of fluorochemicals. EU Directives put obligations on Member States to limit pollution of bodies of water by all possible means even for non-hazardous pollutants especially organohalogens, a catch-all that includes all fluorochemicals[6]. PFOS has been listed under the Stockholm Convention on POPs (persistent organic pollutants) and PFOA will probably follow.

PFOA is considered a substance of very high concern under REACH, and PFHxA is undergoing the initial stages of a risk management options analysis initiated by the German authorities. All use or storage of PFOS in fire fighting foam has been banned within the EU as of June 2011. The European Chemical Agency is currently going through the final stages of formalising very stringent restrictions on the amount of PFOA, its salts or precursors, in products allowed on the market with some time-limited transitional derogations for fire fighting foams and emergency services/military PPE.

Acceptable levels of PFOS and PFOA in human blood, drinking water, and bodies of water, set by national and international bodies, have been decreasing since the early 2000s. On 19 May this year the US EPA published in its Health Advisory a level of 0.07 microgram/litre (70 ppt) for the concentration of PFOS in drinking water. Also in May the Human Biomonitoring Commission of the German Federal Environment Agency published new values, where there is no risk for adverse health effects, of 5 ng PFOS/ml and 2 ng PFOA/ml in human blood.

The European Union 2013/39/EU sets an environmental quality standard of 0.65 ng PFOS/litre (inland surface waters) or 0.13 ng PFOS/litre (other surface waters) for annual average concentration.

It is worth noting the fact that the new blood levels deemed as safe, which are down by 4-5 fold compared to those set in 2009, are already exceeded by many national population averages. This indicates a pressing need to control human exposure to fluorochemicals. Moreover, evidence to a recent Victorian Parliamentary Inquiry into a legacy, contaminated site in Australia with claims that 2,000 ng PFOS/ml human blood, or even higher, is a 'safe level' look increasingly suspect when considered alongside the levels set by regulatory authorities elsewhere.

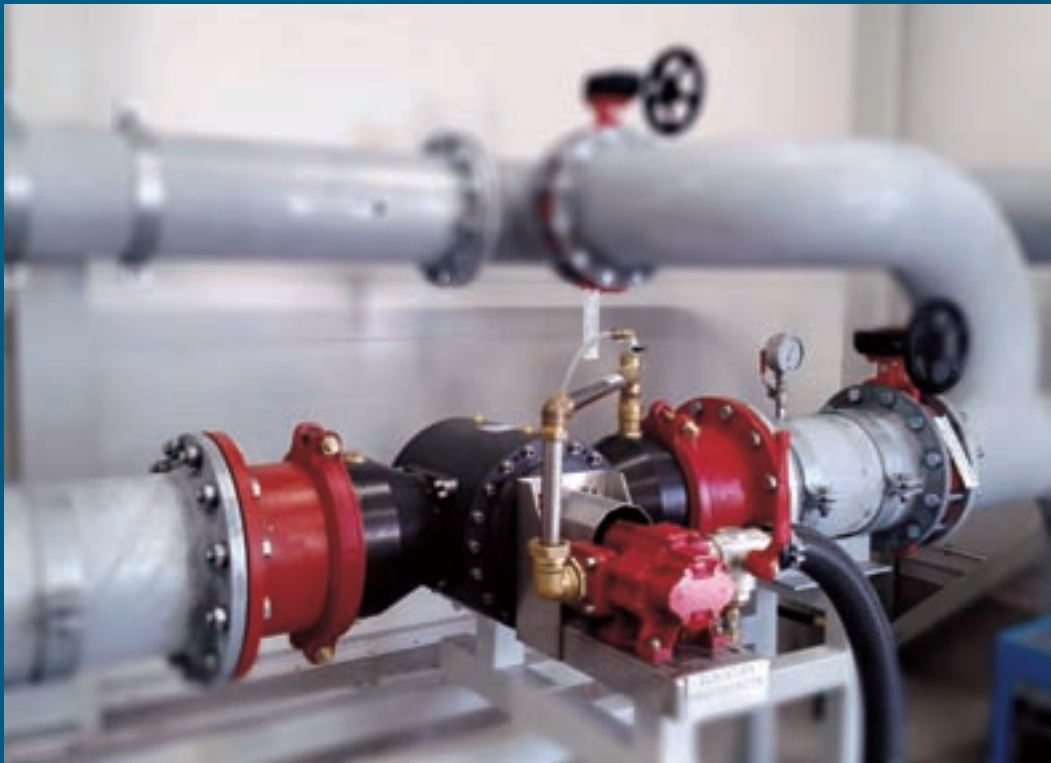
### Environmental contamination with fluorochemicals

In the early 2000s it was soon realised that PFOS could be found worldwide as a pollutant in geographical locations and animal species for which there was no direct contamination pathway.

Subsequently many other fluorochemical species have been found worldwide at isolated locations and in isolated species such as polar bears, penguins and seals in the polar regions, far from any obvious source of contaminant, such as manufacturing facilities or centres of population.

All perfluorinated end-products arising from the breakdown





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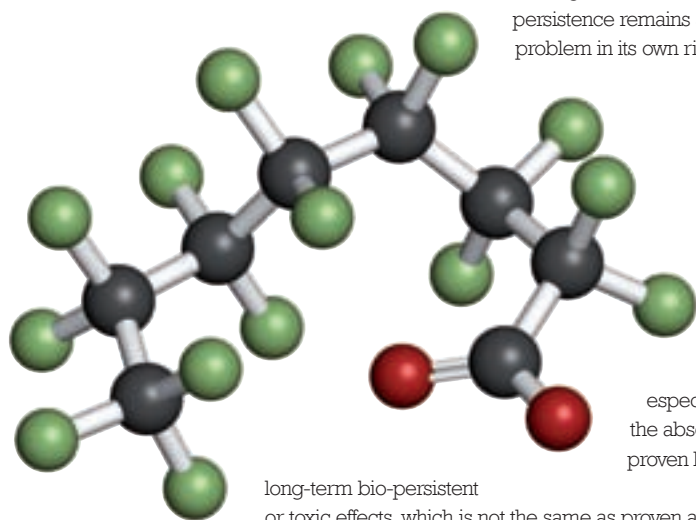
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of fluorochemicals (i) are all highly environmentally persistent with extended half-lives sufficient to constitute an inter-generational legacy on a potentially 'geological' time-scale; (ii) are subject to long-range-transport (LRT) through atmospheric or oceanic mechanisms – global transit times can be as short as 7-10 days; (iii) may have the potential for bioaccumulation and bio-magnification (ie trophic magnification, eg shellfish up to top predators such as man and sharks) up the food chain with very high concentrations being found in certain species or organs, such as gull eggs; (iv) may have as yet unknown long-term toxicity for various species or be linked to human health effects.

For regulators environmental persistence remains a problem in its own right,



especially in the absence of proven lack of

long-term bio-persistent or toxic effects, which is not the same as proven absence of lack of long-term bio-persistence and toxic effects.

Moreover, substances that produce PBT-classified substances on degradation, such as C8 PFCA precursors, must themselves be classified as PBT under the REACH Regulations.

Since the majority of PFOS use and manufacture has ceased especially in western developed countries, population average blood concentrations have decreased more or less in a linear fashion. The same is not true for PFOA, where the concentration, after an initial decrease, has plateaued out, suggesting the continued existence of sources for this contaminant.

Perfluorooctanoic acid (PFOA, perfluorooctanoate) carcinogenic pollutant molecule (image: molekkuul\_be, Shutterstock).

### Health effects, toxicology, animal studies

Claims by certain sections of the industry as well as Government that there is no scientifically, generally accepted proven link between exposure to fluorochemicals such as PFOS and PFOA and consequent human health effects, is disingenuous, based on ignorance at best and at worst a wilful misrepresentation of the scientific literature and quite contrary to conclusions drawn by – and evidence accepted by – key regulatory bodies.

Even before the announcement that PFOS chemistry was being phased out in May 2000, there were indications in the literature based on animal experiments and some human epidemiological studies that exposure to PFOS and PFOA exposure could be linked to disorders in liver function, endocrine metabolism, pregnancy and survival of the new born, some neoplasms such as testicular and kidney cancer, and the immune response.

There are now comprehensive reviews available of potential human health effects caused by PFOS and PFOA that have been carried out by regulatory authorities as part of their hazard assessment procedures or on behalf of courts, that summarise what is known about association with particular diseases.

Studies have shown that certain PFAS have well-founded and statistically significant associations with:

- developmental delays in the foetus and child, including

possible changes in growth, learning, and behaviour;

- decreased fertility and changes to the body's natural hormones;
- increased cholesterol;
- changes to the immune system;
- increased uric acid levels;
- changes in liver enzymes;
- prostate, kidney, and testicular cancer.

However, the medical results are not clear-cut and conclusive but are instead based on probability, which has lead to denials of any effects on health by some.

Lawyers that act for organisations being sued for causing specific human disease require absolute certainty in attributing cause and effect. Unfortunately that is not how science works and public health and environmental decisions have to be taken on the balance of probability. Where public health and safety are concerned, decisions must factor in the Precautionary Principle.

It is, of course, essential to be looking at the right target organ and not just the big 'C'. For too many non-specialists, 'health effects' are equated with the development of a cancer presumed to have been caused by exposure to the particular toxic chemical. But most of the studies involving human health (at current population levels of exposure) highlight effects associated with suppression of the immune response, especially in children undergoing vaccination, or with pregnancy such as fertility, fecundity or birth weight.

### Precautionary Principle

The Precautionary Principle has been embedded in international, national, commonwealth, state and territories' law as an obligation on decision makers ever since the Rio Declaration on the Environment in 1992. Failure to observe the Precautionary Principle has even resulted in a court declaring a Minister's decision 'fatally flawed'.

Some ten years ago in the case *Telstra Corporation Limited v Hornsby Shire Council*[7], the Chief Judge of the NSW Land and Environment Court, His Honour Mr Justice Preston, gave a detailed and seminal analysis outlining the principles of Ecologically Sustainable Development, especially where it related to the Precautionary Principle.

Preston CJ made it clear that application of the precautionary principle and the need to take precautionary measures would be triggered by two conditions being met:

- a threat of serious or irreversible environmental damage;
- scientific uncertainty as to the nature and scope of the threat of environmental damage.

When both of these conditions have been met, precautionary measures should then be taken but must be proportionate to the level of the threat.

Factors which Preston CJ suggested could be considered in assessing the seriousness or irreversibility of environmental damage include:

- the spatial scale of the threat;
- the magnitude of possible impacts, on both natural and human systems;
- the perceived value of the threatened environment;
- the temporal scale of possible impacts, in terms of both the timing and the duration;
- the manageability of possible impacts, having regard to the availability and acceptability of the means;
- the level of public concern, and the rationality of scientific or other evidentiary basis for the public concern, and;
- the reversibility of the possible impacts and, if reversible, the time frame for reversing the impacts, and the difficulty and expense of reversing the impacts.



A firefighter in full protective gear is fighting a large fire in an industrial setting. The firefighter is wearing a silver heat-reflective suit, a helmet with a face shield, and yellow boots. They are holding a hose and spraying water onto a large fire that is burning brightly. The background shows industrial structures and scaffolding.

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Clearly fluorochemical contamination ticks most if not all of these boxes: worldwide occurrence, long-range transport, highly valued environments, extreme persistence in the environment, unknown long-term health effects, difficulty of managing impacts or reversing them, and finally the level of public concern and effect on livelihoods.

When both conditions necessary for triggering the precautionary principle are satisfied, there is a shift of the burden of proof.

The decision maker must assume that the threat of serious or irreversible environmental damage is no longer uncertain but is a reality, albeit potential, and the burden of showing that this threat does not in fact exist or is negligible effectively reverts to the proponent of the project. This can be expressed in terms of the following inequality: the lack of evidence of harm is not evidence of lack of harm.

Preston CJ stated: "The function of the precautionary principle is, therefore, to require the decision-maker to assume that there is, or will be, a serious or irreversible threat of environmental damage and to take this into account, notwithstanding that there is a degree of scientific uncertainty about whether the threat really exists..." Lawyers defend cases against polluters by insisting on absolute proof rather than facing up to the reality of causation being more likely than not. Associations between adverse health effects or actual disease and individual or classes of PFCs flagged up as 'probable links' means that these are 'more likely than not', ie greater than 50%. Thus these chemicals may possibly cause disease directly but, more importantly, may influence

the development of disease only indirectly.

In summary, there are sufficient indications of an association or probable link between exposure to PFOS and PFOA at current population average levels with human health effects to trigger application of the Precautionary Principle and lead to a conservative approach aimed at limiting further exposure in the future to this class of compounds and hopefully thus reducing population levels.

## ABOUT THE AUTHOR

Roger Klein has 40 years' experience working with Fire Departments nationally and internationally. Originally trained as a medical doctor as well as a physical chemist his professional interests have been in biological and theoretical chemistry. In his work with the fire service his areas of expertise include hazmat, PPE, incident command and control procedures, risk assessment and the environmental impact of fire service operations. His involvement in risk assessment dates from the early 1990s. He was asked to draft the first version of the guidance document for the emergency services by the UK Home Office Fire Service Inspectorate, forming the basis for the subsequent work on the Fire Service Manual covering risk assessment. Post 9/11 he was asked to provide input to the McKinsey Report into FDNY operations at Ground Zero on command and control issues. He is currently affiliated research faculty at the Christian Regenhard Center for Emergency Response Studies, John Jay College of Criminal Justice, CUNY New York, a Member of the UK Institution of Fire Engineers and a Fellow of the Royal Society of Chemistry and the International Union of Pure and Applied Chemistry.

# Pollution containment

Many operators are still surprised by the fact that the most likely environmental damage caused by fire at an industrial site is the water that is used to fight it – but there are solutions, writes Phil Collins.

**I**n the early stages of a fire, thousands of litres of water are discharged into the environment every minute. The surface water runoff created will pick up the pollutants and contaminants of whatever burning or hazardous substances are present, and if a site is not fully contained they will escape into the environment. There is even the potential worst-case scenario of fire water and heavy rainfall combining to overwhelm a containment area and end up in a river or sewer, leading to crippling cleanup costs for the industrial operator. While many companies believe that they are fully insured under their standard material damage liability policy, it may not fully cover them for the remediation costs required by a regulator.

The fire at the Jayplas plastics and paper recycling plant in Smethwick, UK, in June 2013 was the largest ever dealt with by the West Midlands Fire Service and involved 100,000 tonnes of plastic recycling material. In the first 12 hours of operations, 14 million litres of fire water were needed and water was pumped from the nearby Birmingham Canal.

After the Buncefield disaster in 2005, the UK Health and Safety Executive found that protective bunding had many flaws that caused large volumes of fuel, foam and fire fighting water to leave the site. The site's last line of water pollution defence – so-called tertiary containment – was practically non-existent, amounting only to the site's surface drainage

systems which were not designed to cope with any large-scale releases.

Any industrial operator that is keen to act sustainably should be able to evidence how surface water is discharging to the environment and how it would be contained during an incident. However, many may unknowingly risk water pollution incidents by relying on inadequate containment systems or not knowing how flood water or surface water runoff would be directed on and off their site.

Drains are usually gravity- or pump-fed, taking surface or foul water away from a building. If a spill or fire occurs, the drainage network will be a main pathway for pollution. If the drains are blocked, cracked, unidentified or incorrectly connected there is little chance of preventing a pollution escape.

Hydraulic modelling techniques can map the surface water pathways on and off a site and are especially useful for companies with complex drainage and spill containment requirements. Surface water flows and pathways can be modelled and the performance of any proposed containment design tested in the computer model prior to installation. The end result is a consultative document that can be presented to the environmental regulator or fire service as evidence of robust pollution containment. An insurance underwriter may even be



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persuaded to discount premiums based on this evidence.

To provide water pollution containment, most companies start by installing isolation valves in the outlets to surface water drainage to prevent flood or fire water escaping from the site, and to contain it until it can be safely removed. Bunds or physical barriers can also be installed to contain spills around hazardous areas such as oil or chemical tanks.

Penstock valves are often installed and it is important to use the correct design, as there are many types of penstock valves, not all of which with the ability to seal low-pressure flows fully. If a site is looking to contain pollution then the valve must contain the entire flow.

Penstocks are closed by the force of the head of water rising in the drain but, if the pressure is insufficient, then polluted water could still trickle through the opening and out into the environment.

The development of drop-seal valve technology has led to watertight, failsafe solutions such as the Hydro Brake isolator pollution containment valve, which can aid compliance with environmental protection regulations. Its mechanically-locking failsafe design ensures that, once activated, the valve remains fully closed and sealed until it is safely unlocked by an operator. Manufactured from stainless steel, it is factory pressure-tested to ensure zero leakage to up to 0.5 bar.

On more complex sites, operators need ensure that in the case of a fire incident, even with valves installed, the surface water drainage won't back up, overtop bunds or other storage measures, and flow out of the site.

All on-site containment systems need to be regularly tested, serviced and maintained. Pressure testing of drainage containment systems may be advisable to ensure shut-off systems are water tight in the event of a pollution emergency.

Many high-risk sites use tertiary containment systems whereby the sealing of drains allows the filling of a tertiary bund area. However, if the drains or valves don't seal, the

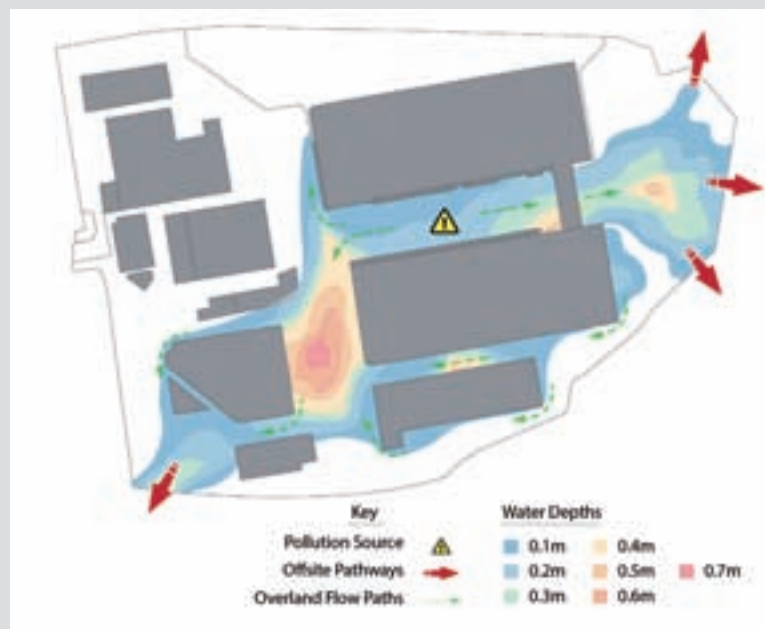
bund system is unlikely to fill.

In the event of a fire the runoff water may need to be held for several days or weeks, which can only be achieved if the system is fit for purpose and operational.

In addition to permanent containment systems, it is possible to deploy temporary or reactive systems to deal with a spill, such as spill kits, drain covers and portable bladders but again, it's important to fully consider the reliability of the technology, the correct disposal of the waste and that personnel are correctly trained.

*Phil Collins is national water pollution manager for Hydro International's stormwater division for UK and Ireland.*

**2D overland flow map of pollution and flooding.**



# Rim seal fire



In May around 100 delegates congregated in the Jaheziya Fire Training Ground in the town of Mussafah, south-west of Abu Dhabi to witness the live demonstration of a fire extinguishing technology rarely seen in action – a rim seal fire extinguishing system.

**T**he protection system was developed by Saval nearly 50 years ago to counteract fires that can occur in floating roof tanks when air and stored product vapour mix as a result of a damaged rim seal. Ignition of the hazardous mixture can occur due to static electricity or lightning, resulting in a fire that can be hidden by the tank wall itself, but which will lead to a large-scale incident.

The system consists of a circular pressurised pipe running along the rim seal with a number of regularly spaced glass bulb-activated nozzles. The pipe is connected to a pressurised storage vessel containing the environmentally friendly extinguishing gas trifluoriodomethane (CF<sub>3</sub>I) and nitrogen. This gas has a 30-year shelf life even in the high temperatures of the ME region.

When a glass bulb is broken the gas is released through the sprayers directly onto the fire, which is extinguished in seconds by negative catalytic action. In this process, the CF molecules quickly bond with the oxygen and make it unavailable for use as a fuel. After extinguishing, in only a few seconds, a calculated 'gas overkill' prevents re-ignition by cooling the rim seal area.

As opposed to conventional fire extinguishing systems that normally require a separate panel for activation of the extinguishing action, the CFI system is designed to detect and extinguish without any additional power source or valve activation and only a signalling panel is provided. "And nine times out of ten by the time it alarms the fire is already out," explained Fulco de Vries, business unit director for oil and gas at Saval. "We have had fires on tanks which our systems have successfully extinguished, but it is something we can't monitor and take live footage of. This was a unique opportunity to bring in fire chiefs, specialists and HSE managers from the region and demonstrate how the system on their tanks would operate when there is a fire, using a real section of a rim seal. That is very powerful."

The 6m-long demonstration unit consisted of a typical cross-section of a floating roof storage tank that had been shipped for the demonstration from the Netherlands. The unit simulates a 2m-long rupture in the rubber rim seal that leads to the hazard between the tank wall and the floating pontoon. The demonstration fuel was petrol that had been provided by one of Saval's local customers. After being poured along the rim seal the remaining petrol was ignited in a container beneath the unit, with the resulting fire quickly becoming aggressive and releasing copious amounts of black smoke.

The process from ignition to extinguishment took less than a minute. "At first the extinguishing cloud was white but when it came into contact with the heat the chemical reaction resulted in purple smoke, indicating extinguishment was in action," said de Vries.

The demonstration was successful in spite of adverse wind conditions of 5m/s that were strong enough to blow over all the decorative flags that had been set up for the day throughout the 75,000m<sup>2</sup> campus. "The wind wasn't a concern because the system has been tested and certified with VdS under much heavier conditions. Obviously in the real world it can be very windy so this was a good simulation of what can happen," commented de Vries.

In addition to the rim seal protection system, delegates also had the opportunity to view a new foam proportioner in action, the Turbinator, which was launched last year by Saval's sister company Knowsley.

The proportioner comprises a water-powered motor and a mechanically coupled foam-concentrate pump, both of which work on a positive displacement principle. For every revolution of the water motor and the foam pump, a fixed volume of water and foam concentrate are delivered, regardless of the operating pressure. The more water that flows through the water motor, the more foam is added, and vice versa. Available in 1% and 3% proportioning rates, the unit can be used as a mobile proportioner or installed in vertical or horizontal piping.

The design of the system means that the foam water mix delivered at the nozzle will always be correct, regardless of the water flow rate. This feature was demonstrated at Jaheziya's live training ground, where delegates watched foam delivered via different devices including bund pourers, monitors and hand-held lines – and even all three simultaneously. "One of the delegates, who operates a power plant, was highly impressed by the simplicity of the system. Some of his tanks are not protected and he was considering mounting a proportioner on a fire truck. He was especially amazed by its simplicity and smooth, quiet operation," remarked de Vries.

The Turbinator is in use in fixed and mobile systems both onshore and offshore and is equally suitable for mounting within fire trucks.

*The demonstration day was so well received that Saval and Knowsley are planning to organise further events in key Gulf regions as well as in Asia. For more information about further demonstrations contact: [systems@saval.nl](mailto:systems@saval.nl).*

Saval's CFI system was put to the test using a 6m-long demonstration unit transported from the Netherlands especially for the occasion.



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# Mutual aid

An international research project has been launched by Kappetijn Safety Specialists and JOIFF looking into different mutual-aid models for large-scale incidents in high-risk industries.



**L**arge petrochemical industries face large challenges where safety is concerned. They have to abide by strict governmental regulations (Seveso/COMAH) and must provide specialist fire fighting capabilities to overcome large-scale fire scenarios. It is unusual for a single company to be able to offer all the necessary materials, personnel, education and training to comply with all these requirements, which is why various collaborations have been springing up internationally under the collective term of 'mutual aid'.

The experiences and lessons gained from collective fire fighting and emergency services collaborations are the subject of an international research project being undertaken by Kappetijn Safety Specialists in partnership with JOIFF.

History has many examples of large industrial fires and incidents that demonstrate the need for cooperation in preparation for and response to large-scale accidents such as the 2005 giant fire on the tank terminal premises of Buncefield, near London; the fire at the chemical company Chemiepack in the Dutch harbour of Moerdijk in 2011; and even more recently the fire in the tank terminal of Andhra Pradesh.

Invariably, the lessons learned from such major incidents

are that individual companies are not equipped with the necessary materials to control such fire scenarios and the governmental fire brigades are similarly unprepared in knowledge and capacity. Joining forces is necessary therefore to ensure the fire safety at chemical companies and tank terminals and guarantee a quick deployment of the necessary fire fighting materials during calamities.

More and more large industrial clusters are discovering the power of mutual aid, with initiatives now existing even on a national scale – CIMA in Houston and SMC in Sweden are good examples. However, in many other places organisations are still searching for possible cooperative solutions, a process that this research aims to facilitate. A vast amount of knowledge and skill exists in the world of industrial fire fighting, but it needs first to be unlocked to benefit the collective. This is what this investigation aims to do with the support of JOIFF.

## Mutual aid and PPP

Collective industrial fire brigades come in different shapes and sizes as regards organisation and operational method. The type of collaboration that best fits a cluster of high-risk companies depends on a number of factors, including the local situation, the risk profile of the companies, the credible and normative scenarios, the financial framework and national rules and regulations. But it also depends on the ambitions of the local leadership: what do they want to organise – and thus manage – collectively? There is no good or bad system, but here is a quick sketch of the various models.

Industrial mutual aid consists of multiple companies in an industrial cluster cooperating to maintain a robust fire fighting organisation with specialist vehicles, equipment and materials for fire and spill suppression.

The model appears in different variations. Some companies may invest in a collective organisation with an independent governing body, while others may supply financial means while the actual provision of the specialist services are

Three Williams Battler monitors flowing at 30,000 litres per minute each during a training exercise at Ceyhan Terminal in Turkey.  
Right: LNG training facility at Texas A&M University's Emergency Service Training Institute.





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performed by one of the member companies. A third option is outsourcing the suppression services entirely to a private supplier of fire fighting services.

There is a fourth model and one that is perhaps not yet as valued as it should be: public-private partnership (PPP). Under PPP, industry and government cooperate in safeguarding an effective collective corporate or joint fire fighting organisation. In this way, both corporate and governmental interests are met. A PPP for industrial safety is sometimes regarded with suspicion by critics, who point out that governmental and industrial interests are too far apart to constructively cooperate in one collective firefighting organization. Practice, however, is refuting that argument. Successful PPP fire fighting organisations are working in many different places, proving that government and business can easily and successfully cooperate provided there is a framework of agreements with a clear division of responsibilities and tasks.

### Examples from the Netherlands

As a small and densely populated country with various seaports and a number of large industrial clusters, the Netherlands has acquired its fair share of experience with collective corporate fire fighting organisations based on mutual aid and PPP. Governmental bodies and businesses both acknowledge the collective need for robust industrial fire fighting organisations to ensure public safety and industrial continuity and have therefore joined forces in a number of industry-rich regions.

The Port of Rotterdam's industrial area has since 1998 been home to the 'Joint Fire Brigade', which comprises the governmental fire brigade of Rotterdam-Rijnmond Safety Authority and over 60 high-risk member companies.

While a segment of these high-risk companies – which include refineries – used to have an industrial fire brigade, many others were not as well prepared where fire safety was concerned. Similarly, Rotterdam's municipal fire brigade was equally unprepared for large-scale industrial fires. When the government outlined its strict requirements based on Seveso/COMAH regulations around response and credible fire scenarios, it soon became apparent that to provide a number of individual fire fighting teams would be a tremendous waste of money in the case of a relatively small cluster of high-risk companies. Consequently the local authority and businesses joined forces in a communal arrangement that provided the foundation for a joint fire fighting corps. This corps is responsible for incident control both on-site at the member companies and in the public domain. In addition to offering basic local and industrial fire services, a separate arrangement is in place with a pool of specialist equipment for



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large-scale tank fire fighting.

A more recent PPP fire fighting organisation has been active in the port since 2013, specifically in the industrial area of Moerdijk and involving approximately 20 Seveso companies. It came into being following an incident in 2011, when a sizeable fire raged in Chemiepack's facility. The company did not have a corporate fire brigade and the municipal fire brigade proved unprepared and unequipped for such an incident. The public-private partnership model here consists of a financial contribution from the high-risk companies in the area to a special unit of the municipal fire brigade, which takes care of any similar incidents.

Then there is the Port of Amsterdam' mutual aid system (AMAS), a PPP model aimed at large-scale tank fire fighting with heavy pumps and extinguishing materials. Companies facilitate the budget for two complete sets of equipment consisting of pumps, monitors, hoses and connectors for tank fire fighting. The operational deployment is carried out by the municipal fire fighting departments of Amsterdam-Amstelland and Kennemerland, which both border the port. Amsterdam-Schiphol Airport and its fuel supplier AFS are also partners in this arrangement.

Examples of Dutch mutual aid without a local authority component also exist. The province of Limburg is home to the industrial complex of Sitech (850 hectares with production facilities for bulk and fine chemistry), where an active collective corporate fire brigade serves multiple companies, including Lanxess, OCI and Sabic. Examples of fire provision outsourcing can also be found at Chemie Park Delfzijl in the north of the Netherlands and the Kijfhoek railyard. Both locations fall under the Seveso guideline and are required to maintain an industrial fire fighting organisation on site. Here, the first line of defense falls onto Falck as a result of the municipal fire brigade being unable to be present within the mandated times of arrival. Both locations are looking into the possibility of a public-private partnership with local authorities.

### Current research

The four different models from the Netherlands demonstrate the possibilities when companies start working together in a mutual aid construct or join forces with the local authority. But there might be other models from which local authorities and industry can learn. Indeed, information and insights have already been shared in Sohar (Oman), Antwerp (Belgium), Essex (England) and MSC (Sweden). Kappetijn Safety Specialists aims to map out the current state of mutual aid and PPP worldwide, going beyond providing an inventory of organisations and their locations but also setting out the organisational setup, governance structures, tasks, methods and finance models.

The types of questions the research aims to answer include: is collaboration limited to operational incident control? Is there also cooperation in other fields like promotion and safety briefing, risk control, education and training? How effective are the various models in their respective surroundings? Are the newly found collaborative formulas also applicable in other areas?

The goal of this investigation is to share knowledge and exchange experiences to become stronger and improve fire safety in industry on an international level. Industrial fire fighting is highly specialist in terms of knowledge, competency, materials and equipment, which is why professionals should join their forces across borders. We want to facilitate that by making the results of the investigation available through JOIFF, as an international and independent interest group for industrial fire care and hazard management.

We hope that many companies and cooperative organisations will be willing to participate in the investigation and provide an insight into their own mutual aid experiences.

*To take part in the research contact Kees Kappetijn on [k.kappetijn@kappetijn.eu](mailto:k.kappetijn@kappetijn.eu) or Philip Stohr on [p.stohr@kappetijn.eu](mailto:p.stohr@kappetijn.eu).*



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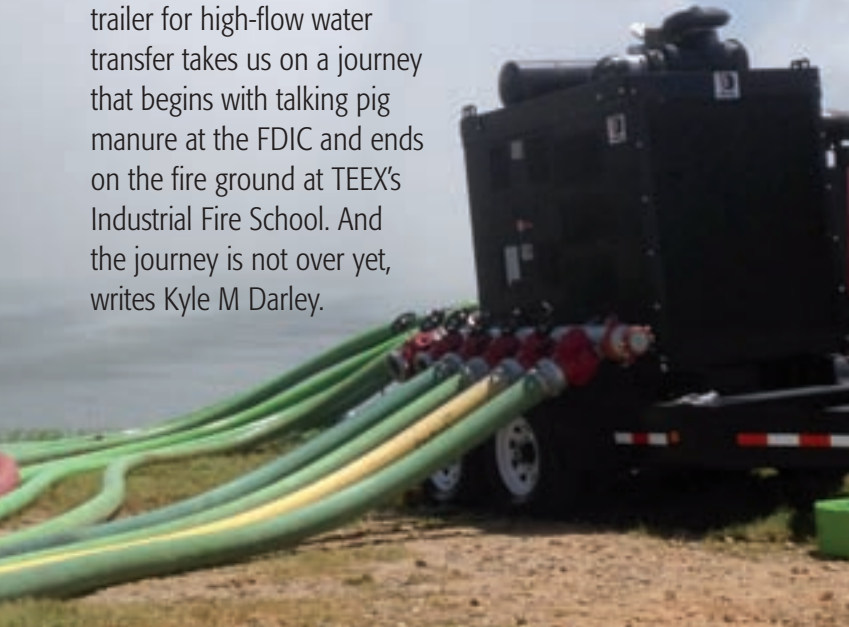
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# From concept to delivery

The designer of Darley's ZSE trailer for high-flow water transfer takes us on a journey that begins with talking pig manure at the FDIC and ends on the fire ground at TEEEX's Industrial Fire School. And the journey is not over yet, writes Kyle M Darley.



The ZSE trailer includes the Evolution pump controller which enables remote monitoring and control.

**T**he ZSE trailer unit was initially conceptualised in 2012 on the show floor of FDIC in a conversation with Charles Genthner, the late owner of Key Hose. The conversation started out with small talk and quickly moved to the new (at the time) ZSM, the first of the Z-series of pumps, and various applications that would require flows in excess of 11,300 litres per minute such as pumping manure in pig farms. The conversation led to the idea of an engine-driven Z pump and then to the oil and gas industry, a market that at the time was booming. Charlie and I were joined in conversation by Tobey Mathews, VP of Key Hose, and I soon realised that there was a great opportunity for the Darley Company to provide a solution here, in the shape of the ZS trailer unit.

The next step was designing a product that the market

would accept and Tobey helped me connect the dots with a company that had an established reputation in the oil and gas industry, Davis Pipe and Supply. Together, we developed the concept of a remote operable trailer unit and the details of the concept finally came into place in December of 2013. The goal was to bring the product to market in May of 2014.

In April of 2014 we showed the product to the fire market at FDIC. Its highlight was the R-Evolution control panel, nicely accented by our largest flowing pump, the ZS.

The R-Evolution control panel allows an operator to run the pump remotely with any device that has an internet connection.

Along with the remote capabilities the control package has a smart alarm system that notifies a remote operator of any operating conditions that are signs of imminent failure – an extremely critical feature when there are thousands of miles between an operator and the pump. From a development stand point, this had been a major hurdle to overcome and it took over 100 hours to validate the system in our test room.

In hindsight, operating a pump remotely over a long distance is similar to standing in a soundproof box with access to nothing but the control panel. I remember leaving the office late in the evening and remotely monitoring and controlling the pump performance from my laptop and/or cellphone. The first couple of times I was a little bit concerned as to what would happen. I was working closely with two of our night-shift test technicians, Carl Mohr and Hesston Hughes, and I would send them a text message to let them know I was going to change the performance. A confirmation message would give me the green light to proceed, followed by another one describing the data being seen in our test facility. This allowed me to confirm that the real-time displays on the remote monitoring web portal were accurately displaying the operating condition.

Throughout this process we encountered our fair share of challenges, mostly in the design and development of the control logic, but the team at Darley has well over a thousand of years of collective pump experience and we were able to draw from a wealth of knowledge.

The product was delivered to Davis Pipe and Supply in May of 2014, a time when the oil and gas industry was still producing at record levels. During demonstrations people that had never run a pump in their life were able to walk up to the pump and operate it with very few questions. Others that did have pump operating experience commented that the smart alarm system helped them to better operate a pump system.

As the product gained market awareness we had high hopes for success, but about that time the oil and gas industry took a turn for the worst, declining at a rate well beyond what I had anticipated. Fortunately there were other applications that required high-volume water transfer.

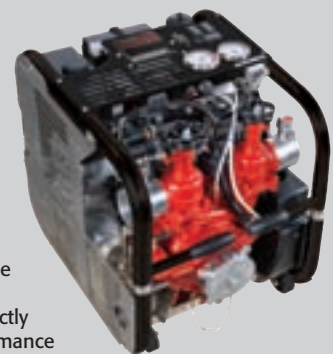
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The display screen of the Ultraview control module features user-friendly icons for quick and easy understanding of the system status, plain text warnings and on-screen calibration tutorials. Diagnostics and system schematics are also incorporated. Also on display will be the new KP pump with an instrument panel featuring Smartfoam – the latest electronic control and information display for foam proportioning operations. Smartfoam also uses Ultraview technology to provide high performance discharge side foam proportioning in the range 0.1% to 9.9%, where the operator presses one button for precise delivery.

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Working with Allen Huelsebusch, co-owner of ADH Fire Equipment Service and industrial product specialist at Pierce and Siddons-Martin Emergency Group, we were able to come up with a plan.

Allen turned us to the idea of creating a trailer that was set up solely for water supply in the industrial fire market. Our new product goal was to deliver a trailer to Allen to be used for feeding high-volume pumpers at the TEEEX Industrial Fire School held at Texas A&M.

The new trailer would be developed with three 15cm suction inlets and six 13cm Stroz connections on the discharge side of the pump. The real challenge was getting everything to come together in the short time period that we had.

The idea of taking the trailer to TEEEX had been discussed around mid April 2015 and we needed to get the product designed and built in time to deliver in the first week of July. It was a little bit of a crunch to say the least.

We had to make some quick decisions. We decided to go with the Darley auto governor that is supplied by our friends at FRC. The manifolds were designed in stainless steel: the trailer, engine, and pump package all remained the same as in the initial design.

When the day came to ship the trailer we were still in the final stages of testing and I recall the freight driver waiting in the parking lot for the performance test to be completed. In my opinion, we were cutting it pretty close. If anything had gone wrong in testing we wouldn't have been able to deliver the pump in time.

The pump made the journey safely to College Station where it was set up to feed a beautifully built Pierce industrial pumper.

The TEEEX industrial school was my first real experience of relay pumping from a trailer unit to a fire truck and I had the luxury to experience the night burn training, where I learned some of the details of tactical fire suppression in the industrial fire market. I then understood why a 13,000 lpm pump might not be big enough to satisfy the market forever and that a fire often couldn't be put out but the structure that surrounded it must be cooled so it didn't collapse.

Today the ZSE industrial trailer unit is being developed to be built in a more suitable fashion for practical water delivery in the industrial fire market. Plumbing options, monitors, foam systems, hose racks, tool boxes and a lot of other items are being designed to be available to customers as options. We are also working on developing another control offering to help simplify operation of the pump system.

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*Kyle M Darley is design engineer at WS Darley and Co.*



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# Keeping hazmat simple

Considerations for setting up a hazmat decontamination process, by Mike Schunk.

**T**here are many points to consider when coordinating a hazardous materials response team for an industrial facility. What kind of equipment to use? Who will respond to the incident? What model will return operations back to normal in the quickest time? How to store the resulting waste in the short term? How to motivate hazmat responders? What are the safety considerations?

A decon process must be simple and thorough for everyone and this should be paramount in the design of the hazmat response system. The fact there are workers that are not designated and specifically employed for hazardous waste operations will influence the operational procedures because, like in any other profession, the more frequently a task is performed the better it is carried out. Simple decon procedures are safe decon procedures, so systems that require less training while achieving full decontamination will serve infrequent responders best.

Decontamination safety showers are the system of choice for hazmat responders on industrial sites and they are usually found

Mobile shower and decontamination system (photo: Swingtec).



throughout a plant at key locations where workers who become accidentally contaminated by spills or processes can quickly wash off toxic contamination. All these showers should drain into plant chemical holding tanks for later removal by a hazardous waste management company. Draining diluted hazardous materials into storm drains or other municipal waste systems is a clear violation of environmental laws. Plants with systems that do not drain into a proper chemical storage tank separated from non-hazardous waste streams must be reconfigured before safety showers can be used for hazmat decontamination.

Planning the waste storage from a hazardous materials incident is important and a facility that does not have an EPA 90-day, short-term storage license has only 96 hours from the onset of the initial incident to package and dispose of all spill waste through a licensed EPA hazardous waste company. The use of these companies tends to be the norm as these licenses frequently cause local site ordinance issues with the surrounding neighborhood. Maintaining a good relationship with the local hazardous waste transportation contractor is always beneficial because, from experience, it is better to see a friendly face at 0300 hours than an adversary during a hazmat incident.

Location is the usual limitation for the practical use of safety showers, where the distance between the spill and the shower can be too great for the response team. Equipment-wise, a potential solution is to adapt a safety shower for mobile use. At an industrial site we came across a well-executed example of one, comprising a Haws metal safety shower mounted on a pallet-sized spill-containment skid which could be transported throughout the facility. The installation even included back-flow drains for use outside the plant structure in inclement weather. The system consisted of the shower unit itself, a water intake line and a discharge line to empty the containment pallet when full (eg during a prolonged incident). It also included a portable pump to transfer the drain water into drums when full. Very slick.

Keeping it simple results in an efficient, low-cost, versatile system that is simple enough to be used everyone, including untrained new employees and plant guests. However it does require strong leadership.

There are two options for choosing the employees designated for hazmat. Using outside contractors means that the planning required by an industrial facility will be minimal. The facility's concern will be confined to providing access and an appropriate response time, with the latter depending on location – which may not fit well into the back-to-normal-business timeframe. This is the primary reason that many facilities choose the second option of using on-site facility responders.

On-site facility responders bring their challenges too. They are usually and primarily site workers with daily tasks to complete, which could cause production problems when called to an incident. In addition, many facilities are reluctant to send these employees off-site for training due to the issues associated with their temporary replacement. Over the course of time it is not unusual for facilities to begin considering appropriate hazmat training and refresher courses a lower priority than their staff's onsite presence.

Employees that are exclusively tasked with handling plant emergencies may be a solution, but here a number of issues also arise. In which facility are they located at the time of the emergency? What is their response time to the site of the incident? All these questions require evaluation prior to the designation of responders. Narrowing down operational priorities will determine who will best suit a company's needs.

While getting back to business as normal is understandably a primary concern for business management, for a truly sustainable result the primary focus must be on the safety of the operations that solve all the issues resulting from the incident.



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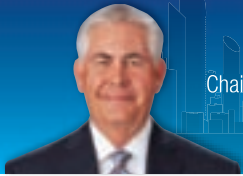
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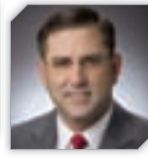
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Once a team has successfully mitigated the incident, all plant and ancillary equipment connected to or nearby the incident site should be checked. Something that many managers do not initially appreciate is that downtime during an incident provides a good opportunity to correct minor issues. It is much more cost-efficient than having to shutdown again for a small maintenance task and the benefits of making the overall business operation more profitable in the long run need to be emphasised. These benefits should be recognised as being linked to the emergency response team. That the sustainability of the hazmat team increases the bottom line is good to remember when the response team is in need of something.

The motivation of a response team's working culture is critical to its success. If the workers are volunteering to perform these tasks (as most are), an appropriate incentive must be available to maintain their interest. This does not have to take the form of additional remuneration and it is up to the team leader to figure out what the team wants. Whether it be shift preference or better recognition, its implementation and development will strengthen the team's interest and solidify its performance. The best way to research and strengthen this bond/goal is to host frequent team meetings where important worker issues can be remedied and which demonstrate continued corporate interest in the team.

An excellent source for putting together a blueprint for decontamination response and planning is to be found in OSHA's standard for toxic and hazardous substances, 29 CFR 1910.1200(q) (2) (vii). This is the gold standard and should serve as the master template at all facilities in all countries throughout the globe. It should be followed because it not only consolidates response practices but it also affords safe and – crucially – flexible concepts, including guidance for working with

mutual-aid organisations in large-scale incidents. Considering the current political/terrorist climate, it would be comforting to know that all responders at a facility could work cooperatively even during large problems.

In conclusion, all hazmat tasks must be carried out with the proper equipment and, regardless of the decontamination format selected, the minimum safety considerations should always include respiratory protection; CPC (chemical protective clothing) ensemble; and proper equipment (decontamination system). Providing the correct hazmat and decon equipment should be regarded along the same lines as providing mechanical equipment to render physical labour safe. When this concept is successfully transferred to a hazmat response team its performance invariably increases.

## ABOUT THE AUTHOR

Michael F Schunck (also known as 'Hazmat Mike') serves as faculty adjunct in higher education facilities throughout Michigan, including Oakland Community College, Oakland University, Michigan State University and Madonna University.

Schunck was featured as a presenter at the First State Hazardous Materials Convention at Crystal Mountain, which covered dry decontamination, LEPC planning and methamphetamine clandestine drug lab response. He has authored various articles focussing on philosophy, environmental technology, hazmat, bio-weapons and terrorist response. You can follow Schunck's blog on: [www.hazmatmike.com](http://www.hazmatmike.com).



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# How much do you pay for yours?

To encourage the UK Fire Service to purchase its equipment collaboratively the Home Office has published fire and rescue procurement data. The publicly available data makes for some interesting reading, reports Ann-Marie Knecht.

**T**he results of the procurement survey issued to 45 Fire and Rescue Services is one of the first steps by the Home Office to reform the sector and make it more transparent and more accountable to the public. It is part of wider UK Government reform announced in May 2016 focussing on diversity, efficiency and transparency.

It is expected that Fire Authorities will use the data to compare with others how much they spend on essential items, thereby ensuring that they are achieving the best possible value.

The survey, which ran 1-23 June, required Fire and Rescue Services to provide details regarding 25 commonly procured items of PPE and equipment including helmets, fire tunics, trousers, BA sets, cylinders and fire appliances. The information required covered cost, quantity, date purchased, supplier, and whether the purchase had been made jointly or as part of a collaborative framework.

Some authorities use a shared service agreement for the procurement and management of their PPE. The survey found that Gloucestershire paid most per firefighter per annum for this service at US\$666 (£507.85), while Bedfordshire paid the least at US\$570 (£434.85). The items of personal protective equipment included in these fully managed services varied depending on

the terms of the agreement, as did the level of service – for example, maintenance, replacement and laundering of items.

The survey revealed that the average price of a fire helmet in the UK is US\$212 (£162). However, in Oxfordshire firefighters pay the most at a cost of US\$331 (£252.53), while in Cumbria they pay the least by procuring helmets at US\$177 (£135).

On average authorities spend around US\$554 (£422.56) for a fire jacket and trousers. The Fire and Rescue Services that pay the most for their kit are Cambridgeshire at US\$759 (£579.41) and Greater Manchester at US\$721 (£549.95), while firefighters in Wiltshire don fire garments that cost only US\$426 (£325).

Most FRS pay around US\$973 (£741.79) for a BA set, excluding cylinder, but the survey revealed that Cornwall pays US\$1,907 (£1,504.19), with West Yorkshire close behind at US\$1,786 (£1,361.54). Lincolnshire, however, has managed to procure BA sets for less than a third of Cornwall's budget at just US\$547 (£417) per set.

For some types of equipment, such as medium-sized pumping appliances, there is a significant difference between authorities. This, states the Home Office, is because the operational requirements of each fire and rescue authority impact upon equipment choice and therefore cost, as each FRS must determine which class of rescue pumping appliance is appropriate for them.

On average, a UK fire service pays around US\$241,431 (£184,000) for a medium-sized rescue pumping appliance – this is without taking into account cost variations between the different types of chassis and bodywork available. London Fire Brigade, for instance, bought 53 units at a price of US\$301,579 (£229,857) per appliance while the FRS in Merseyside bought two units for just US\$126,563 (£96,470) each. Staffordshire FRS pays the most, with the brigade purchasing four units at US\$364,533 (£277,845).

Brandon Lewis, Minister for Policing and Fire Services, said that authorities should collaborate more to drive down prices of their essential equipment. "It makes no sense for fire and rescue authorities to buy separately when there are both financial and operational benefits to buying together. While some fire and rescue authorities are already collaborating on procurement and reaping the benefits, there is still a lot more to be done," he commented.

The push for authorities to work together is already being felt around the country. Devon & Somerset FRA, Kent FRA, and Essex FRA were awarded US\$485,000 (£370,000) in May 2015 to jointly establish a national procurement collaboration hub for the sector.

*The data can be downloaded via the following link: [www.gov.uk/government/publications/fire-and-rescue-authority-procurement-data](http://www.gov.uk/government/publications/fire-and-rescue-authority-procurement-data).*

## SCOTT SIGHT IN EUROPE

A new innovative in-mask thermal imaging system has been introduced by Scott Safety.

Scott Safety presented Scott Sight to the European market during an innovation day at Biggin Hill Airport near London in June.

The new TIC comprises a tiny thermal imaging display screen integrated within the helmet visor and a side-mounted camera on the outside.

The in-mask screen has been made possible thanks to advances in micro-display technology enabling the size and power requirement of components to be reduced. Bluetooth technology connects the lightweight, in-mask display with the miniature, head-mounted and hands-free thermal imaging camera that keeps the

thermal image in view at all times.

Scott Sight was developed after research by Scott revealed a requirement for thermal imaging technology that was more accessible and easier to use.

Scott Sight enables firefighters to have visibility in dark environments while keeping their hands free at the same time. In addition, as the camera enables the eyes to focus on the fire the whole time, Scott says that it significantly enhances performance by reducing the chances that hazards are missed, as well as speeding up victim location and improving orientation. This new system also enables immediate identification of the secondary egress should a situation deteriorate suddenly.





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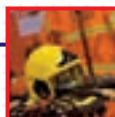
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# Stronger together

Elevated lighting is essential for nighttime operations but what is better, separate lights or one light tower? Roger Weinmeister investigates.

**D**uring an emergency what responders can see is just as important as what they can't. Nevertheless they are routinely tasked with work that is as technical as surgery but in lighting conditions that are closer to those of the hospital parking lot than those in the operating room. And yet the ability to light up the area directly beside the apparatus, whether it be for a hazmat incident, car crashed over the side of an embankment or a large fire scene, is completely dependent on the equipment specified during the purchase of the apparatus.

With new, more powerful LED lights available, a common misconception is that providing four pole lights or even four alley lights on a truck will adequately light an emergency scene.

Command Light has recently carried out studies to determine effectiveness of scene lighting both to assist in product development but also help people determine the best solutions for their application. To do this, advanced software that measures light intensity and light fall-off is used along with different inputs according to the types of light sources.

The light intensity of two scenarios have been compared, one which uses LED heads grouped in a light tower and another where the light is provided by four LED lights mounted on separate poles on a truck (see above).

The comparison demonstrates that positioning LED heads together on a tower results in a brighter, wider zone of light with minimal shadow than with the four separate poles – which is why stadiums cluster lights into banks.

There are a number of additional advantages over separate lighting. Set-up is quicker with a single LED tower, which can be carried out in just 15 seconds. To set up a pole light, in comparison, a responder has to walk to the location, electrically or manually raise and point the pole light – then they have to do the same thing with the other three poles (on the fire scenes I have been on, you don't even bother with the two off-side lights because it takes too long).

The cost of individual lights is higher too, as they require separate power runs and overload protection. In contrast, the use of towers avoids temporary night blindness in responders, the public as well as potential helicopter pilots on the scene, as the elevation and angle means they don't get lights in their eyes.

Lastly, the use of a tower prevents the off-side lighting from being wasted – if there is a pole on each corner of the apparatus, one side is always further away from the scene (the off side, on the top of the vehicle). In contrast, the tower creates more light where the rescuers can use it to their advantage in both speed and safety.

For many departments the initial cost of a lighting tower may seem hard to justify in these times of tight budgets. However, the world is increasingly more complex and the cost of a mistake in the field has grown exponentially. Misreading that a vehicle has a supplemental restraint system; that a victim has suffered a back injury from stepping into a ditch; or just leaving a critical tool – can all lead to more serious consequences, which is why lighting and the ability to adjust it into different positions can play a major role in the success of an emergency response.

*Roger Weinmeister is president of Command Light.*

Research has indicated that grouping LEDs on a tower results in a brighter, wider zone of light compared to using four separate truck-mounted pole lights.

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# 2016: the year of the drone

The US Federal Aviation Administration's rules on commercial unmanned aerial vehicles were relaxed last month, which is expected to provide a massive boost to the uptake of this technology. But where are we as regards incident response and use by high-hazard industry? Jose Sanchez de Muniain reports.

**T**he sound of the flight of the drone is getting louder in all corners of the world and the indications are that quite soon this aerial technology will be commonplace for both emergency responders and operators of high-hazard industrial sites.

The trend is being driven by a number of factors, namely the dramatic decrease in the price of the hardware coupled with new drone technology that is opening up a whole raft of new applications in the emergency response and security field. A high-tech drone that might have cost US\$140,000 three years ago is probably now available with a higher tech spec for as little as US\$11,000.

It is not surprising then that the technology is beginning to be taken seriously as another tool for emergency response, with many emergency services currently conducting trials for use of drones in chemical spills, road traffic incidents, wildland fires and rescue operations.

In June the US FAA announced that the rules regarding flying drones in the country were to be greatly relaxed. As of August, commercial operators no longer need a licence to fly drones weighing less than 25kg nor do they need a Section 333 exemption, which had previously been required on a case-by-case basis and which could take six to nine months to secure. In fact, the new regulations state that commercial drones can be flown as long as the pilot is over the age of 16

and has passed an aeronautics safety test; has the drone in his line of sight; and does not elevate over 122m above ground level.

One of the countries leading the way in drone usage is the UK, where the Civil Aviation Authority has just granted Amazon permission to carry out extensive drone trials in Cambridge without the requirement to adhere to its strict flying restrictions. The CAA is allowing Amazon's employees to operate multiple drones simultaneously and without a direct line of sight, trialling 'sense and avoid' technology that lets drones automatically avoid obstacles while in the air.

The UK's emergency services are also actively engaging with the technology and it was recently reported by Sky News that two thirds of UK fire services and half of police forces were planning to use drones or were already doing so. Last year Greater Manchester Fire and Rescue Service became the first to enjoy 24/7 access to drone support from a number of trained operators. Another pioneer is Mid and West Wales FRS, which bought a number of drones in 2015 after securing a US\$30,000 grant from the Welsh Government.

A company that is riding the drone wave is Rectrix AS, a tech start-up based in Stockton-on-Tees in North East England that is carving a niche in the industrial high-hazard sector and the emergency response field for its UAV services. Rectrix AS founder and owner Alex Westwood explains that the petrochemical and oil and gas industries are waking up to the potential applications and benefits of drones. "In the UK we recently carried some thermal inspection work on an array of steam pipes because the client wanted to know where the thermal insulation had broken down. We were able to execute the task to the client's needs providing the radiometric thermography information without the need for aerial platform or expensive scaffold hire. A three- of four-day operation was conducted in one day."

The company receives enquiries from all over the world to either carry out periodic inspections or to supply a ready-made package of drone capability. It was recently approached to carry out pipeline inspections in northern Alberta, Canada to ascertain whether produced water, a by-product of oil extraction, was leaking into the environment and damaging nearby swamps. The company is also working

The industrial high-risk sector is waking up to the cost-saving benefits provided by unmanned aerial vehicles.







on a project to develop a drone that can autonomously conduct daily patrols along an 80km pipeline in the West Nile Desert in Egypt.

Passive fire protection manufacturer Advanced Industrial Solutions recently formed a strategic partnership with Rectrix AS to bring a range of services in the energy and construction industries. The two are offering specialist services such as visual surveys, thermal inspections and risk assessments using drones for inaccessible places.

Westwood believes that drones will eventually find their way into every large-scale industrial facility, albeit with a number of roles. "In the next five or ten years the drones will be fully autonomous and will provide the security aspect, lifting off the ground every hour and patrolling the fence lines looking for anomalies and unauthorised activity. They will also be used for asset integrity management and routine operations such as flare stack inspections."

It is in the field of situational awareness during an incident that Westwood sees the real safety benefits, however, with drones providing better information quickly and in a safer manner. "The technology is getting smaller every year, which opens up the possibility for drones to carry technology such as chemical identification sensors and radiation analysis equipment. You could send the drones over a hazmat event and pick up particulate matter such as asbestos as well as test the concentration of a gas cloud – the data is all geo-tagged so it could provide the concentration in any part of that cloud."

In the not-so-distant future most response teams in the world are expected to adopt UAVs into their core service work and Rectrix AS is currently working with a fire truck manufacturer to provide UAV capability as part of the vehicle equipment package.

The drone, attached to the back of a fire truck, would be launched at the touch of a button and be directed by the incident commander on the ground. "The concept is a bit like a telescopic tower, but one with a range of 100m, limited only by its optional tether. A tethered system means the drone is being powered from the ground and can stay in the air for 24 hours if necessary, transmitting data wirelessly for protracted incidents," says Westwood.

Manufacturers have also spotted this gap in the market and are actively courting it with ready-to-fly bundles. In April, Flir Systems began bundling packages of its thermal imaging technology within DJI's Inspire 1 drone in aerial first-responder kits that are available in basic or advanced versions.

So far, however, the emergency and industrial worlds are only just scratching the surface as regards potential applications for UAVs – as some research efforts around the world are demonstrating.

Earlier this year a team from the University of Nebraska-Lincoln in the US demonstrated a drone that it had designed to carry out prescribed burns. These burns are used to reduce instances of uncontrolled wildland fires and are normally instigated by low-flying helicopters – a dangerous and expensive operation.

The Unmanned Aerial System for Firefighting drops ethylene-filled ignition spheres which burst into flames on hitting the ground. The technology could easily also be applied to fighting wildland fires for the creation of fire paths.

The devil is in the detail, however, and drones still face some challenges that will need to be overcome if they are to be fully embraced in life safety. Weather is still a factor for most air frames, whether they be fixed wing, rotary or hybrid; and the fuel source impacts the flight time significantly. Off-the-shelf 'prosumer' devices generally have flight times of 15-18 minutes dependent on payload. In addition, most regulations also

## ROBOTICISTS WITHOUT BORDERS

Did you know that the RWB programme enables any organisation to request land, sea, or aerial rescue robots at no cost for up to ten days during an incident? The humanitarian effort was launched by the Centre for Robot-Assisted Search and Rescue (CRASAR) at Texas A&M University, which aims to speed adoption of robot technology by first responders. The end goal is for responders all over the world to own and regularly deploy truly usable robots by 2021.

The RWB model comprises a pool of professionals in ground, aerial or marine robots or emergency response who are trained in disaster response and incident management. RWB is funded by donations and research grants and, during a deployment, it will either draw from those reserves or be reimbursed by the requesting agency. While RWB prefers the reimbursement option, its costs can generally be covered by CRASAR in order not to disincentivise requests to assist during an incident.

The first deployment of RWB was to the 9/11 World Trade Centre collapse and other high-profile deployments include Hurricane Katrina, the Midas Gold Mine collapse, the Crandall Canyon Mine Disaster, Hurricane Wilma and Ike, the two Tohoku Tsunami recovery deployments and, this year, a project to help prevent refugees drowning in Greece.

require operators have line of sight of the drone, which according to the UK Civil Aviation Authority equates to 500m horizontally and 120m vertically from the pilot.

Furthermore, the market has yet to respond comprehensively to calls for the ability to connect accessories such as gas or radiation monitors as well as universal delivery systems for carrying small items of equipment.

Nevertheless one thing is clear: drones have arrived and they are here to stay (until the battery is recharged anyway).

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# Robot patrol



The world's first commercially-available fully autonomous security robot with fire detection technology has been launched and its makers are already working on adding fire extinguishing capabilities, reports Jose Sanchez de Muniain.

**U**nveiled in June this year the Ramsee robot has been designed to do the dull, dirty and dangerous patrol jobs that nobody wants to do. The result of a partnership between Gamma 2 Robotics and Hexagon Safety & Infrastructure, it can autonomously patrol an area without any supervision whilst providing real-time data on intruders, motion, heat, fire, smoke and gas.

The software backbone of the Ramsee is provided by Hexagon Safety & Infrastructure, a company that owns the Intergraph-branded command, control and communications suite of security and safety products. Its chief technology officer Kalyn Sims explains that the company partnered with Gamma 2 Robotics because it could see the value of adding a robot with sensors to its existing range of UAVs, normal alarms and video surveillance capabilities. "When you are able to set patrols and rules for mobile platforms, the whole suite of robots provides the ability to really augment the human capability whilst reducing risk," says Sims.

All the sensors on the Ramsee are fully customisable to fit into a variety of different environments. In a warehouse where forklifts could be operating on propane gas, for example, the detection threshold would be adjusted upwards, while for an office the opposite would be more appropriate.

In the event of a fire the Ramsee can act as a visual and audio alerting device, as it carries as standard a powerful emergency voice alarm with a 240-watt sound system as well as onboard fire flashers.

"We wanted it to have a very robust sensor package and obviously include alarms for abnormal heat and smoke – all the things that are normal for human patrol officers," explains Lew Pincus, chief executive officer of Gamma 2 Robotics. "Ramsee may pick up smoke or heat before it reaches other sensors but we never intended it to replace existing smoke detection or any stand-alone system already in place in a warehouse or data centre. It is a force multiplier designed to augment systems already in place."

An existing Hexagon customer is considering the Ramsee as a possible solution to the millions of dollars it spends a year on false alarms. "They regard the robot as a kind of first responder that could be deployed to an alarm zone to take readings and provide footage to determine if it really is necessary to call the fire service," says Pincus.

Although originally intended for applications such as data centres and warehouses, the robot is attracting potential uses

in other environments. "We've had an enquiry about whether Ramsee could be equipped with radiation sensors to carry out inspections in areas not suitable for humans within a radiation facility. We've also been approached about using the robot to carry out autonomous mapping for a mining group."

The end game could, for a high-security facility, result in an interconnected fleet of UAVs and robots working together and providing constant feedback and video surveillance via a cloud-based system.

Gamma 2 Robotics and Hexagon are already looking at the future and under development is a 'fire watch' robot that will be able to monitor a construction or demolition site (or other structure) on a 24/7 basis, as well as be able to sound the alarm in the event of a fire.

In California, for example, a fire watch must be established when any required fire protection system, such as a fire alarm, sprinkler or fire pump, has been out of service for more than four hours in an occupied area. As well as keeping a watch, these personnel are required to have fire extinguishing equipment readily available and they must be trained in its use. "We get calls for this application from people who are paying anything from 40 to 60 dollars per hour for a security officer to stand there and just watch a construction zone. One of the code requirements for a fire watch is the ability to extinguish a small flame so we are looking to add this to the robot, alongside the capability to alarm through the Hexagon command portal if there is an incident," says Pincus.

The suppression agent for the fire watch robot will be a dry chemical stored in a tank inside the robot, and Gamma 2 Robotics chief robotics officer Francis Bovis expects this feature to be integrated later next year, once the research and development phase is complete.

The current version of the Ramsee is built to last a minimum of five years on a three-year amortisation schedule, which Pincus describes as a similar process to buying or renting a car. "On the service side you buy the robot and pay an annual maintenance fee which would cover everything. The robot's brain is completely transferable so if you have to put a new robot in a location, we can transfer the information from the old to the new and it can start patrols with no downtime."

The first Ramsee robots are expected to be out in the market as soon as 2017, with the first contracts in place in the fourth quarter of this year.

The next-generation of Ramsee robots may have the capability to provide a fire-watch function.





# On the face of it

Fire safety and tall building facades – is there a problem? Andrew Kay looks at the evidence.

**T**he prospect of a fire in a tall building is always an emotive subject, as the perceived potential for loss of life is that much higher. From back in the 70s we have the images portrayed in the iconic Hollywood movie *Towering Inferno* to the more modern phenomena with social media spreading global news of fires in tall buildings from all corners of the world. Thankfully these occurrences are rare, but when they happen they invariably make global news, and can add to the perception that the risk is greater than a more conventional 'low rise' building.

This article focuses on the facades – or 'skins' – of these buildings, outlining some questions on the challenges that face us in respect of fire, using some real fire situations in tall buildings to tease out some possible issues and lessons that might be learnt from fires of the past.

## Are we using correct materials test standards?

The Address fire in Dubai was beamed live into the living rooms of the World on New Year's Eve 2015 – a 63-storey building on fire is bound to attract attention.

The cladding panels on this building had been successfully tested to US standard ASTM E119, which outlines test methods to evaluate how long certain types of building element contain a fire and retain their structural integrity during a predetermined test exposure.

Whilst there is nothing wrong with this test for determining levels of fire resistance, commentators have pointed out that a more appropriate test would have been NFPA 285. This standard provides a standardised fire test procedure for evaluating the suitability of exterior, non-load bearing wall assemblies and panels used as components of curtain wall assemblies that are constructed using combustible materials or that incorporate combustible components for installation on buildings where the exterior walls are required to be non-combustible.

This test should be more appropriate in determining the propensity for flame spread – which was probably a factor in this particular case. The UAE will doubtless take into account the lessons learnt and the appropriate building codes will be adjusted accordingly.

## What can happen when we substitute materials?

The Lacrosse building in Melbourne is a classic case of the potential for our eyes to deceive us. This was a residential apartment block in the popular Dockland district, which caught fire on the 6th Floor, allegedly down to a smouldering cigarette. The fire took hold and leapt 13 floors in just 11 minutes.

For whatever reason, probably economic, a cladding panel that had been specified for that project with a specific, non-combustible core was substituted for an alternative panel that, to all intent and purposes, looked exactly the same as that specified.

However, instead of a product with a specific non-combustible core, the substitute material had a combustible core. It is not unreasonable to suggest, as did many local commentators, that this was a contributory factor to the spread of the fire. The panels looked exactly the same and were acceptable from an aesthetic point of view; but from the point of view of their behaviour in a fire, the installed panel was crucially inferior to the originally specified product. Whilst it is desirable from an economic viewpoint to seek alternatives and to promote competition, the perils of ill-considered substitution are highlighted vividly by the example of this particular building. Moreover, the ongoing battle between authorities and the builder on the appropriate



Above: aftermath of the fire at The Address Hotel, which started on New Year's Eve 2015 in Dubai, UAE (photo: Mehdi Photos, Shutterstock).  
Left: top of the Windsor Tower in Madrid, Spain (photo: Inigo González, Wikimedia).



remedial works will add considerable cost that could have potentially been avoided if a suitable risk assessment had been considered at the time of substitution.

### Can product installation be a factor?

In February 2005 the landmark Windsor Tower in Madrid found itself in the grip of a fire caused by an electrical fault. The fire started on the 21st floor at around 11pm and by midnight the fire had spread to all floors above the 21st. By 8.30 am the following morning the fire had spread to all the floors below the 21st floor.

Amongst many observations, Arup highlighted the possible contribution to the fire spread to the upper floors of the structure by the failure of compartmentation measures. These are necessary to provide fire stops at the junctions of internal floor slabs and facades, by closing off the potential for fire to move from one part of the building to another by the route of these hidden voids.

On the assumption that the products selected for the curtain wall fire stops were of suitable performance, then notwithstanding any overall design faults, one has to consider the impact of products being inappropriately installed. In this example, not only did the compartmentation possibly not function well in preventing vertical fire spread, there was also evidence that burning embers and debris fell down the voids and created secondary problems in the lower parts of the building. This shows that compartmentation and fire stopping needs to work in all plains of fire/smoke movement.

I have personally witnessed many examples of good installation of such measures, but equally examples that leave a lot to be desired. Well developed products that are inappropriately installed can allow fire and smoke to move unhindered from one part of the building to another via these hidden facades or gaps. The best of designs and products will only function if they are correctly installed.

### Are we using outdated test regimen?

In February 1997 the 36-storey President Tower in Bangkok suffered a vapour explosion on the seventh floor. The fire affected over four floors and the damage took over a year to repair. Notably, the sprinkler system failed to operate and the local fire service took 45 minutes to arrive and attack the blaze.

An investigation commissioned by the curtain wall contractor highlighted some points of significance, amongst them was the fact that the compartmentation (or 'fire stopping') measures appeared – similarly to the situation in the Windsor Tower in Madrid – not to have functioned correctly. This allowed the fire and smoke to spread rapidly through the openings in the floor, including that vital gap between the facade and the floor slab, again in a similar fashion to the Windsor Tower. The subtle differences here, as shown in the report, were that the lightweight curtain wall structure, when impacted upon by the fire, moved significantly and that the compartmentation system had not been designed or – more importantly – tested, to accommodate such movement. How can this be the case?

In the UK the default test regimen of many specifiers and other stakeholders is the BS 476 suite of tests, and in the case of the type of products discussed here, Part 20 in particular. This particular test measures the fire performance of compartmentation products when sandwiched in-between two concrete structures, which typically behave the same in respect of expansion and behaviour under a fire load. In reality, however, for building such as the President Tower one of the structures in the facades consists of lightweight

aluminium. This, of course, is likely to behave very differently than the two similar structures used in the BS 476 tests.

One could be forgiven for following the BS 476 test regimen where no suitable alternative exists and, given the rate of development of different building types and configurations, that sometimes can be the case. However, in the case of testing for curtain wall configurations, a suite of suitable tests does exist, in the form of BSEN 1364 and notably Part 4, *Fire resistance tests for non-loadbearing elements. Curtain walling. Part configuration*.

This test set-up allows for the testing of scenario-specific configurations in curtain walling and, therefore allows for products to be tested with one of the structures being typical of what is encountered in real construction situations. It also replicates the movement of the curtain wall element of the assembly in a way that the traditional BS 476 tests cannot. From my perspective, for this particular application, the BSEN 1364 Part 4 would appear to be a more representative test, and greater comfort should be taken from a test to this standard for curtain walling as opposed to the more traditional or static BS 476 type. It is a mystery why one would continue to quote a generic standard when a more specific test is available. One argument proposed is that it may be difficult to find appropriate products that have passed these new tests. And yet, whilst we continue to allow the use of products tested under the general BS 476 Part 20 standard, there is no real incentive for manufacturers to innovate and pass more onerous examinations of their products in more representative, 'real life' situations. Thankfully, some more enlightened manufacturers have grasped that nettle and products are available.

In summary, tall building facades pose a different fire risk and challenge to more traditional types of construction, and incidents involving these will always attract media attention. Attention to specification, materials, appropriate testing, installation and design will ensure that the facades of tall buildings continue to develop and that The Towering Inferno-type of films are not replicated in real life.



### ABOUT THE AUTHOR

Andrew Kay, former global facades manager for Siderise, has over 30 years' experience in the construction industry. The bulk of this was gained in his 25 years spent at Hilti where he managed a variety of different markets. His last 10 years were spent managing Hilti's fire protection team where he was responsible for bringing the first curtain wall spray firestops into the UK market. Prior to joining Siderise Kay gained invaluable experience at Exova Warrington fire working on third-party certification schemes, CE marking and fire testing.

Kay is an ex-chairman of both the Association for Specialist Fire Protection and the Firestopping Forum as well as vice chair of the Fire Safety Development Group. His passion is ensuring the correct supply and installation of fire protection materials to ensure a safer environment for all.



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Current UK Government policy favours a 'stay put' strategy for purpose-built blocks of flats (photo: Fotograff, Shutterstock).

**S**moke is the real killer in a fire incident, which is why in October 2009 the UK Department for Communities and Local Government launched its 'breathe' advertising campaign with a series of 'Don't drown in toxic smoke' adverts. London Fire Brigade and other fire services vigorously promoted the campaign, emphasising how dangerous and toxic smoke can be. The thick black smoke produced by the synthetic material and electronic gadgetry found in most homes inhibits visibility and disorients anyone trapped in the building. Modern day fires are in essence chemical fires and people are quickly rendered unconscious when inhaling this smoke.

This changing fire environment is a real problem generally, but even more so for high-rise residential dwellings where the means of escape is also the means of rescue by firefighters.

These dangers were shown by the 2009 Lakanal House tower block fire of 3 July 2009 in Camberwell, London, where three adults and three children, unable to escape through the smoke-logged corridor, sadly perished.

Two years after the tragedy, the DCLG issued a guide to ensuring adequate fire safety in purpose-built blocks of flats, regardless of age, titled *Fire safety in purpose-built blocks of flats*.

The report favoured a 'stay put' policy, stating: 'when a fire occurs in one dwelling (or, less likely, in the common parts), it is normally safe for the other residents to remain within their own flat'. However, while the report assumed effective compartmentation (or 'fire-stopping'), where each flat is a fire-resisting enclosure, it didn't take into account either the volume of smoke produced by modern day chemical fires or human behaviour.

Purpose-built blocks of flats have been used to house people for over a hundred years and their fire safety standards are reflective of the building regulations applicable at the time of their construction. Applying current building regulations retrospectively has proved to be a challenge, especially with regard to compartmentation.

Fire doors, when first installed, are fit for purpose, but they may be opened and closed a hundred times a day. Even if kept

# Vent and disperse

A robust smoke ventilation system helps to preserve lives and protect property in high-rise apartment blocks, writes Paul Evans.

closed at all times, which cannot always be guaranteed, over time their effectiveness in containing the volume of smoke diminishes.

Human behaviour also plays an important role in compromising compartmentation. Residents drilling cables through their walls for satellite television, removing the self-closing door hinges, lifestyle choices and careless vandalism all contribute towards potential breaches of the compartmentation. Just a tiny breach is sufficient for acrid smoke to spread into and through flats and common parts, jeopardising the means of escape.

Recently, in June this year, when a fire broke out in an apartment block in Deeley Road, Nine Elms, London, three residents evacuated their flat leaving their door wide open. This allowed the smoke to quickly spread through the building and into the common parts, leaving 40 people on the upper floors unable to escape. In this case, fortunately, all were rescued by firefighters and no one was seriously injured. While the argument for venting this lethal smoke is increasingly compelling, there is also a strong business case too.

The ongoing costs of automatic opening vents (AOVs) have often been regarded as a prohibiting factor by landlords considering smoke ventilation. Older AOV systems can be overridden by residents for climate-control purposes, which are then left open, vulnerable to high winds or rainwater ingress that can result in slip hazards. Modern AOV systems such as the Naturvent SSV, however, are secure and tamper-proof.

When installed in the common parts of high-rise dwellings, these modern AOVs will manage the smoke in harmony with the fire-stopping measures that form part of the fabric of the building. They are easily retrofitted without the need for external scaffolding, are secure and offer unrivalled smoke ventilation from any given aperture. In addition, the size and location of these vents are specific to the building so as to exhaust the maximum amount of toxic smoke without contributing to the fire spread. By maintaining a free escape from the building they also assist the fire service in their duties, an important factor when, in the face of unprecedented funding cuts, there are legitimate concerns about response times. In addition, modern AOVs work on all types of purpose-built high-rise dwellings, regardless of age.

The lethal effects of smoke were fully revealed by the Lakanal House tragedy and smoke continues to be the biggest threat to human life in a fire situation. Although fire incidents can never be fully avoided, the ventilation of its most potent danger, smoke, should be a priority measure for the persons responsible for social and private high-rise apartment dwellings.



#### About the author

Paul Evans is the CEO of Ash Fire Management and a member of the Fire Sector Federation and Fire Safe Europe.





# Critical integration



With the number of worldwide internet users increasing to well over 2 billion and a growth rate of more than 400%, it is perhaps not surprising that the high-tech world of data centres is spearheading the integration of fire, power management and security in one

package. *IFJ* speaks with Philippe Heim of Siemens Building Technologies about Datacenter Clarity LC.

## Where does fire protection fit within the integration of building and data processing management?

A key aspect is visualisation of all critical alarms – including fire alarms. Customers are specifically asking to have a single interface that collects all the alarms from the data centre, no matter if they relate to access control, a generator running out of fuel or a fire detector alerting. And not just visualise it, but report the alarm to an operator or team via a specific medium such as SMS or email.

Beyond fire alarms it is also about fire asset management. The entire data centre is monitored in 3D mode, which includes fire extinguishers mounted on the wall, so we can introduce a rule for all these assets to alert for planned maintenance.

## Can this type of integration enhance safety?

Yes, because once a fire has been detected, the same system can quickly communicate with the access control system and release locked doors for evacuation, for example. CCTV can also be used to observe particular areas of interest. That's the beauty of integration, once you have one application, you can add automated workflows based on case scenarios, which makes life easier. This type of integration will become common in the future, but the addition of automatic workflows is quite sophisticated and will follow later.

## Why are data centres in particular so prone to this type of integration?

Typically after two or three years data centres reach a level of maturity and expansion where they cannot cope with the huge volumes of data that are generated by all the different types of IT tools and excel spreadsheets. At this point they go to the market for a service provider and we then offer a suite of modules, be it a dashboard that aggregates all the data or a computational fluid dynamics module to create 'what if' scenarios. And based on those customer requirements they start the integration journey.

## What next for Datacenter Clarity LC and data centres?

At the moment building management systems that control comfort levels in a building are separate from the system that is used to cool servers and racks. We are now putting the two together and taking it to the next level. Yes we can already exchange information about alarms and events, but we would like to be able to send hot-spot information directly to a building management system to automatically adjust temperatures to avoid something escalating. So we are moving from pure monitoring to automation. We are looking to take this to the market towards the end of this year.



## ABOUT DATACENTER CLARITY LC

The software addresses the key challenges of data centres, namely security, business continuity, management of energy usage and environmental impact minimisation.

Clarity delivers real-time energy management in server rooms by combining computation fluid dynamics analysis with environmental monitoring for cooling management. It continuously monitors the air temperature in server rooms and instantly identifies any potential problem areas, such as hot spots.

In addition, dashboards and key performance indicators provide second-by-second information on data centre performance. This real-time monitoring, as well as alarm and critical event notification with escalation, enable immediate response and corrective action to ensure the protection of sensitive material and irreplaceable data.

## INDUSTRY FIRST IN ADDRESSABLE NOTIFICATION



Tyco is introducing the fire alarm industry's first addressable notification appliances with individual on/off audio control – a new innovation in notification technology that Tyco claims will enhance protection, reduce costs and simplify building operations.

The Simplex Truealert ES audio speakers are designed to deliver audio messages to specifically targeted areas within a building. Each audio unit has its own address on the fire alarm system and is supervised by the Simplex fire alarm panel. This means

the fire alarm panel can be programmed to select which speakers are to be used and what message will be played on them during emergencies. This targeted audio paging capability enables the delivery of critical, event-specific information where it's needed. For example, in the case of a small isolated event, an individual speaker can be activated to deliver a message in that specific area. In broader emergency situations, groups of speakers can be used to deliver critical evacuation instructions for specific parts of the building based on the nature of the emergency. The new speakers also provide a self-testing capability that takes just seconds to complete, and can be initiated manually or programmed via the fire alarm control panel to run automatically at a convenient time. The addressable speaker technology is also highly scalable and can expand the notification system as buildings change and life-safety needs evolve.

## FIRE DETECTORS

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# Sharp focus

Video-based fire detection technologies in warehouses can offer faster and more accurate detection of potentially devastating fires, writes Stefan Haug.



**M**ost warehouses are characterised by high ceilings and very large areas with huge volumes of air, all of which represent a major challenge for the traditional fire detection technologies that are designed to detect the presence of smoke, heat or flames.

Smoke detection is considered to be a reliable option for early fire detection. Smoke is usually produced way before any flames become visible, however, traditional point smoke detectors need the smoke to migrate to their location, a challenge in large warehouses. Mounted at ceiling level, the detectors are usually far away from the source of the smoke. Furthermore, given the large volume of a warehouse, the smoke is heavily diluted. A starting fire may thus not produce enough smoke to be detected or not enough buoyancy to drive the smoke upwards to the ceiling where the detectors are located.

The only smoke detection technology that does not need the smoke to migrate to the sensor is video.

Video-based fire detection is basically a set of algorithms in an intelligent camera. These algorithms process the camera image to determine whether smoke is present, and they can detect a fire as soon as the smoke enters their field of view. This way they can cover larger areas and volumes than point-type, beam or aspiration detectors, making them a much more affordable solution for warehouse environments. Furthermore, in such environments video is much faster than common smoke detection. It can detect a starting fire within seconds while other technologies will need minutes due to the slow smoke migration – minutes that can make the difference between a nuisance and a disaster.

In addition, video can do more than just smoke detection. If you use one set of algorithms to identify smoke, you can just as well implement another set to deal with flames. Flame characteristics of different fires are well understood, and thus flame detection through intelligent algorithms is just as reliable as smoke detection. Using video to detect flames adds additional value by way of full video visualisation of the scene. The operator can therefore precisely pinpoint the location of the fire as well as involved commodities, potentially providing valuable time for fire fighting. The video image can also be used to verify alarms in the first place, avoiding costly false alarms.

Video-based fire detection (VFD) is highly immune against such false



Stefan Haug is product marketing manager at Bosch Security Systems.



alarms. Intelligent algorithms within the camera result in highly precise differentiation between a real fire and disturbing values such as movement, reflections or changing lighting conditions. In internal tests, Bosch Security Systems has therefore achieved highest detection reliability in all test fires (TF1 through TF8) as specified in EN 54.

Video-based fire detection systems scales well from a single camera to a networked system of distributed cameras with a central console and management system. They can transmit alarms via ethernet to the monitoring centre or even a mobile device, but can just as well relay it to an existing fire alarm panel. Cameras cover broad areas: need little maintenance: and do not even require individual power supplies. With power-over-ethernet, power and video signals use the same cable and enable the camera to benefit from uninterruptable power supply in the ethernet switches. Video-based solutions thus come with a very affordable cost of ownership.

While video-based fire detection can be more reliable and more affordable than other technologies in most warehouse scenarios, it offers an additional benefit that no other option can. It can combine safety and security.

Having installed a video-based fire detection system, the operator of a warehouse can use the very same cameras for video surveillance. There are lots of reasons to monitor the warehouse, avoiding theft being the most obvious one. But just as intelligent algorithms can identify smoke or flames, others can detect unusual movements as well as blocked aisles or emergency exits, thus increasing safety and operational efficiency. Finally, many fires in warehouses are a result of arson, and here video surveillance can be a very efficient means of prevention.

In the US the National Fire Incident Reporting System and the National Fire Protection Association have published surveys indicating that arson was the cause of 13% of all warehouse fires (second only to electrical problems with 14%). And being designed for destruction, arson causes much more damage than incidental fires. Representing 13% of the fires, arson resulted in 21% of the damage done. In the UK the Fire Protection Association has even published data indicating that arson was responsible for 46% of all large fires in warehouses in the late 90s. Video surveillance combined with video-based fire detection can therefore not only offer fast and reliable detection of warehouse fires, but potentially also prevent many of them or help with root-cause analysis.

There are two different approaches to video-based fire detection. VFD can complement existing technologies such as sprinklers or smoke detectors, greatly increasing speed and accuracy of fire detection. There are many other scenarios for which solutions exist, but are unsatisfactory. These include environments with high ceilings, dusty and humid areas or very large open spaces where VFD could be a solution. Think of saw mills with their extreme fire load – according to NFIRS and NFPA sawn wood is the most common material to ignite in warehouses. Hangars or large monitoring areas such as generator halls in power plants are other examples.

Although video-based fire detection offers a lot of benefits including additional safety, it must be mentioned that today it cannot replace EN 54 installations. It is an Active Work Item in ISO, however, and we can expect certification in the not-so-distant future. FM 3232 and UL 286B are available today. However, VFD can be the best available option where no EN 54 compliant solution exists. In some situations it even has the potential to enable insurance coverage for an environment that so far had to go uninsured. In other scenarios it may very well complement existing fire alarm systems to increase the safety level and integrate video surveillance.

A precondition that is inherent to video is that it needs light. Flames and/or smoke must be visible for the video camera to detect it. Today Bosch offers VFD with its IP camera, the Aviotec Starlight 8000, which only requires 7 lux as a minimum. The company produces its Starlight series for very low light conditions, which will, once integrated, offer video-based fire detection in highly unfavorable surroundings.



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# DETECTION NEWS

## A new infrared flame detector with an explosion-proof cover is to be launched by Control Logic in 2017.



The new electronic optical fire detector RIV-601P/FX will have the same performance characteristics as the IP66-rated RIV-601P/F, which has been designed to provide fast alarm in outdoor/indoor areas containing highly flammable materials.

In contrast with some triple-sensor infrared detectors, where a main sensor monitors a wide range of the radiation spectrum while two other sensors monitor adjacent colours on the spectrum, Control Logic's sensor uses a single sensor with an optical filter to narrow down the radiation spectrum to a flame's flickering infrared frequency. This, says Control Logic, results in a high level of immunity to false alarms and it means that the detector can respond immediately to a fire, even registering small flames at long distances.

The minimum flame size that can be detected by the RIV-601P/F varies with the distance and is roughly around 2-3% of the distance. At 10m, for example, the smallest detectable flame size is 20-30cm.

For the last 30 years explosion-proof covers have been available separately by Control Logic for existing IR detectors for use in areas with a high risk of explosion (Zone 1 and 2 for gases, Zones 21 and 22 for dust). The explosion-proof cover for the new RIV-601P/FX will be smaller and lighter than the current offering.

The new infrared detector will also be equipped with a device to test the sensor's response to a fire. The teletest device comprises an incandescent bulb and a modulator circuit that generates pulses of thermal infrared radiation in front of the sensor. When the sensor detects the teletest, a series of short pulses are emitted that are recognised as test pulses by the alarm panel.

Two years ago the Italian company introduced a 10-year warranty where any faulty detectors are repaired or replaced free of charge.

## Detection manufacturer Spectrex has recently won a number of high-profile contracts.

A number of Spectrex detectors with built-in test capabilities are now in place protecting key areas within the Indian Space Research Organisation's facilities.

Although headquartered in Bangalore, ISRO's primary spaceport is the Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh, where on June 22 the space agency set a world record with launch of 20 satellites in a single payload.

The 40/40LB UV/IR flame detector combines UV and IR sensors where the IR sensor operates at a wavelength of 2.5-3  $\mu\text{m}$ , and can detect hydrocarbon-based fuel and gas fires, hydroxyl and hydrogen fires, as well as metal and inorganic fires.



The other contract win helped to safeguard the Rio Olympics, where the SAFE automatic fire detection and suppression system was installed in the Plasan Guarder armoured personnel carrier.

To protect the special weapons and tactics team of the police department of Sao Paulo, the Guarder vehicle was equipped with advanced optical detectors to provide fast response time and high false alarm immunity alongside homogeneous and efficient suppression agent dispersion.

The company's patented optical UV/IR and IR3 Flame Detectors and SAFE systems are integrated in over 30,000 vehicles and are approved by US Army, NATO forces and other leading armies.

## Halma company FFE will be showcasing the latest in smoke and flame detection at Security Essen 27-30 September with its Fireray optical beam smoke detectors and Talentum specialist flame detectors.



Fireray beam detectors are specifically designed to provide protection in large buildings with high ceilings, where conventional point smoke detectors are ineffective. With their

modern design and minimal footprint, Fireray detectors are used in applications ranging from airports, railways stations and warehouses to shopping centres, sports arenas and places of worship.

Talentum flame detectors are used in sensitive or dangerous environments to detect fires even before smoke is produced, or where smokeless fires may occur. By watching for and recognising the non-visible ultraviolet and infrared signatures of flames, the Talentum range does not need smoke to detect a fire. The detectors can even detect flames through steam, smoke and, with an air purge kit, dust, and are immune to the effects of wind.

Nine Talentum flame detectors and one Fireray beam detector were recently installed at Cambridge International Airport (pictured) to protect workers during aircraft spray-painting.

## Apollo Fire Detectors has introduced a new auto-aligning beam detector that is designed for detecting smoke in large open areas such as warehouses, churches and sports centres.



The new Intelligent Beam Detector is compatible with Apollo's new digital communication protocol Coreprotocol. The device is also backwards compatible with existing Apollo XP95 and Discovery protocols and can be installed with up to two detector heads per controller, thus saving on installation time and costs.

The device comprises a ground level loop-powered controller and detector head with an operating range of 8m-50m with a receiver and an alignment motor in the same housing for quick and simple installation. An optional additional detector head can be connected to the controller. The detector automatically compensates for environmental effects on the beam signal by a combination of drift compensation and motorised realignment of the beam.

The operating range of each detector head can be increased up to 100m with an extension kit comprising three additional reflective prisms.





Courtesy of Pino Engineering

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# In the cold

Maximising fire safety in cold storage and unheated spaces presents a unique set of challenges, writes Gijsbert van Rooyen.

**F**ires in warehouses, multi-storey car parks and loading docks have far reaching impacts beyond the threat to life safety, where insurance losses through building damage and business interruption or closure have a significant effect on a business. From 2009-14, for instance, the economic impact of preventable warehouse fires in the UK alone totalled US\$1.5 billion and losses of 5,000 full-time jobs[1]; during the same five-year period in the US, fire departments responded to an average of 1,210 fires in warehouse properties per year. [2] [3]

The protection of cold and unheated spaces poses challenges in the design of an effective fire suppression solution because it covers such a wide range of applications, ranging from cold storage and unheated warehouses to multi-storey car parks and loading docks, each with distinct design complexities as regards fixed and manual fire protection.

Not only can refrigerated warehouses contain a wide variety of hazards, including flammable products and combustible packaging materials, the construction materials of these cold storage areas may also typically feature flammable insulation such as polyurethane and expanded polystyrene foam to ensure the cold air remains within the required area. While newer buildings comprise much safer

materials with a fire-safe insulation core, including mineral fibres, treated polyurethane or polyisocyanurate, the problem remains that older buildings may still use more combustible materials. From an insurance perspective, although these building products tend not to be the cause of fires, they can contribute to a fire event becoming a total loss.

Fires in partially enclosed spaces such as multi-storey car parks present a different set of fire safety challenges. These fires tend to be started by vehicle defects or faults in the building's infrastructure and, once they start, they have the potential to spread rapidly. The open sides of a multi-storey structure can help to fan flames and smoke throughout multiple levels of the building, potentially hampering evacuation and firefighting efforts. Controlling the spread of fire in these spaces is critical to prevent an isolated fire in one vehicle or part of the building from escalating into a more serious event.

All these different areas are particularly subject to intense and rapidly developing fires with the added complexity of requiring a fire protection solution robust enough for cold environments. Nevertheless, automatic sprinkler systems provide a proven method of controlling fires in these spaces and are designed specifically for the hazard. These systems require a range of ancillary products, such as valves and piping components, to ensure robust performance characteristics which meet the needs of the application.

Dry pipe sprinkler systems are commonly used in unheated warehouses, parking garages, loading docks and other areas exposed to freezing temperatures. One such system is the DPV-1 Dry Pipe Valve sprinkler system which, when commissioned for service, is filled with air or nitrogen instead of water to avoid damage from the freeze/thaw cycle.

When a sprinkler is exposed to heat from a fire, the DPV-1 registers the loss of pressure and opens to allow a flow of water into the sprinkler system.

The UL and FM-approved DPV-1 Dry Pipe Valve is a differential type valve that uses a substantially lower system pressure than the supply pressure to maintain the set position. It automatically controls the flow of water into the dry pipe fire protection sprinkler system while also providing the actuation of the fire alarm upon system operation.

While technology such as the above provides an effective answer to fires in cold or unheated spaces, the driving force behind risk reduction initiatives across Europe typically comes from the insurance industry. Regulations have also had an impact, such as the Regulatory Reform (Fire Safety) Order 2005 in the UK, which requires building owners and occupiers to operate a building safely and plan an effective response in

Gijsbert van Rooyen is product manager, valves and devices, at Tyco Fire Protection Products.

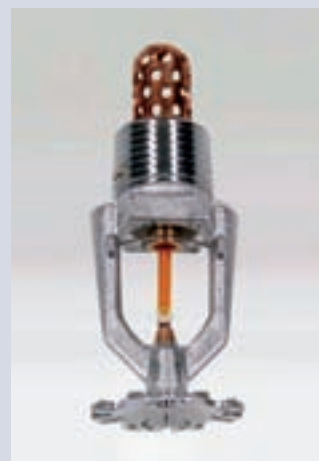
## LOW-PRESSURE WATER MIST FOR OFFICES

A new low-pressure water-mist system for the protection of offices has been developed by Tyco Fire Protection Products. The Aquamist Ultra Low Flow system has been designed to provide fast fire suppression for working environments with limited and concealed spaces, including above-ceiling and below-floor void areas containing electrical and data cables. The system's low-pressure discharge and low water consumption help to minimise damage to property and reduce clean-up costs and operational downtime. In addition, smaller water storage tanks, pumps, pipes and fittings help to reduce space demand and installation costs.

The integrated system includes a range of fire protection products and components such as fire valves, G-press pipes and the Aquamist Control Centre pump set, which comes pre-assembled and factory-tested.

The system is supported by FM and VdS-approved components comprising low-pressure nozzles producing a range of water droplet sizes suited for the control of Class A fires.

More information about the system can be found in Tyco's newly developed dedicated Aquamist website, which also includes helpful resources for the protection of data centres, industrial fryers, machinery spaces, cable tunnels, archives and commercial environments.





# All-In Design. All-Out Performance.

**Tyco knows what it takes to deliver pure performance—for designers, contractors and owners alike.** The RED-E Cabinet is enhanced with thirteen new features to make installation and service even easier and more cost-effective, including:

- Unique splash-proof drain cup, designed to be fail-safe should drain blockage occur
- Elongated door for easier access to couplings
- Aligned supply and drain headers across all cabinet sizes

Our industry-leading DV-5 deluge valve comes standard, along with system shut-off control, downstream shut-off and automatic water control valves. Pre-wired electric actuation, galvanized trim and supervisory switches are also built in.

**The RED-E Cabinet is part of Tyco's extensive range of fire protection solutions. Find the best solution for your fire protection needs at [www.Tyco-Fire.com/Cabinets](http://www.Tyco-Fire.com/Cabinets).**



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Fire Protection Products



## FLEXIBLE FREEZE PROTECTION PIPING

Innovative flexible piping for use with dry sprinklers in unheated locations has been developed by Victaulic.

In contrast to traditional rigid dry sprinklers, the new hose can bend for accurate and easy installation. The Vicflex VS1 braided hose connects the main branch of the sprinkler system located in the heated environment with the sprinkler nozzle located in the unheated location, such as a car park.

The new braided hose is available in three lengths in order to meet NFPA 13 requirements, which require a minimum length for the hose in the heated space between the main branch of the sprinkler system and the outside interface. This minimum barrel length is intended to prevent the water in the main branch from freezing. Consequently, the colder the unheated space's ambient temperature the longer the barrel's specified length.

The Vicflex Dry Sprinkler is available as a K5.6 commercial dry sprinkler in both sidewall and pendent orientations, including a flat-plate concealed version. All styles are available in 965mm, 1,270mm or 1,475mm lengths.

As well as car parks, common applications for the new system include multi-family residential apartments, balconies, roofed outdoor passages and assisted living facilities.

the event of a fire. However, these initiatives could be perceived as not going far enough and can be confused by different local or regional legislation. For example, in England and Wales, warehouses must be 20,000m<sup>2</sup> – a space roughly two and a half times the size of Wembley Stadium – before the installation of sprinklers is mandated. In comparison, the limit in Germany is 1,800m<sup>2</sup>. [4]

Insurance requirements alone are not enough to fully protect businesses from the impact of fire. Investing in proven products and total fire protection systems from a leading/ accredited manufacturer ensures an effective fire protection solution designed around the needs of the building and its specific hazards. By placing greater emphasis on critical fire protection, building owners can take responsibility for the safety of cold-storage and unheated warehouses, multi-storey car parks and loading docks to safeguard their operations and reputation.

*References: [1] Centre for Economics and Business Research - <http://www.cebr.com/reports/economic-impact-of-warehouse-fires/>. [2] NFPA - <http://www.nfpa.org/research/reports-and-statistics/fires-by-property-type/storage/structure-fires-in-us-warehouses>. [3] This excludes refrigerated and cold storage facilities. [4] <http://www.foodmanufacture.co.uk/Supply-Chain/Focus-on-cold-storage-Blow-hot-and-cold>.*

# To vent, suppress or isolate



Jim Marquedant  
is electrical  
systems manager  
at FM Approvals.

Above left: basic fire triangle: oxygen, heat or ignition source, and fuel.  
Above right: the conditions necessary for a dust explosion or deflagration require that the fire triangle be expanded to include both dispersion and confinement. Dust must be dispersed at a sufficient density (minimum explosible concentration) and confined to a room, vessel or ductwork.

**W**hat does it take to turn common commodities such as milk, sugar, corn, wheat, coffee, or cotton into an explosive powerful enough to destroy even the strongest building? What about coal, sulphur, aluminum, ascorbic acid or PVC?

Almost any organic material, metal or plastic can become combustible if reduced to small enough particles – typically less than 420 microns. At this size, the dust becomes the fuel in the classic fire triangle, which requires only oxygen and heat in order to burn. However, to create an explosion, two additional components are needed to fulfill the dust explosion pentagon: dispersion and confinement.

While businesses can substantially reduce the threat of dust explosions through proper risk analysis and mitigation, the risk to industry persists and the results have been devastating. Following three catastrophic dust explosions in 2003, a study by the US Chemical Safety and Hazard Investigation Board found that 281 dust explosion incidents occurred between 1980 and 2005.

During a 33-year period ending in 2006, commercial and industrial property insurer FM Global recorded 166 dust explosion property losses amounting to a gross loss of US\$339 million. The woodworking industry was the top incident producer, followed by food processing and metal processing. Other industries, including chemical/pharmaceutical, pulp and paper, and minerals were also major contributors.

FM Approvals has embarked on an effort to strengthen and extend its standards for explosion protection systems, writes Jim Marquedant.

FM Approvals has long worked to help industry reduce the property loss potential from flammable or combustible materials, including gases, vapours, dusts or fibers. Its standards and associated test programs help manufacturers verify the effectiveness and applicability of products and systems designed to help mitigate property losses from combustible hazards in the workplace.

In recent years, the FM Global Group, which includes FM Global, FM Approvals, and other entities, has invested in new facilities and staff to enable ongoing research and provide the basis for new and updated Approval Standards covering explosion protection products.

A key example of this new investment is the expansion of the explosion testing capabilities available at the 6.5km<sup>2</sup> FM Global Research Campus in West Gloucester, Rhode Island, USA. The expansion included the addition of 2.5m<sup>3</sup>, 8m<sup>3</sup> and 25m<sup>3</sup> explosion test vessels, as well as associated diagnostic instruments and data acquisition systems.

Within the framework of FM Global's research programme on explosions and material reactivity, researchers set out in 2010 on a multiphase research effort covering three key explosion protection areas. First is explosion venting, which mitigates explosion overpressure by providing a pathway for expanding explosion byproducts to escape: secondly is explosion suppression, which involves detecting and chemically suppressing an explosion in its earliest stages to mitigate





explosion overpressure; and lastly, explosion isolation, which prevents an explosion from propagating from one part of an industrial process to another through the use of fast-deploying isolation valves and/or chemical suppressants.

Companies often use a combination of venting, suppression, containment and/or isolation to provide explosion protection. Wherever possible, at-risk systems such as dust collectors or facilities where dust or fine particles are produced intentionally or as a manufacturing byproduct will provide explosion venting panels on buildings, vessels and other systems.

The best case is to vent to the outdoors so that deflagration or explosion pressure and combustion byproducts are directed outside and away from property. In some cases, an explosion vent on a vessel or system located a significant distance away from an outer wall can be ducted to reach the outdoors. However, there are many situations when a system that needs protection is located indoors and too far from an outer wall to make external explosion venting possible, or, an outdoor system may be located near a walkway or other vulnerable equipment where uncontrolled explosion venting would be undesirable or dangerous.

One solution in these cases is to use a flameless explosion-venting device (FEVD) mounted over an explosion vent. FEVDs can take many forms, but typically are drum- or box-shaped structures made from layers of stainless steel or ceramic mesh. The FEVD cools the explosive gases and traps the dust, protecting people and equipment from flames and secondary explosions.

FM Global research into FEVD systems was incorporated into Approval Standard 7330, Explosion venting devices, as the key means to evaluate system performance. The standard, released in 2014, employs test methodologies developed during the research to determine the venting system efficiency and other performance factors. Approval Standard 7730 encompasses both standard and flameless explosion venting devices.

Over the past two years, approval standard development efforts have been focused on explosion suppression systems, which are used to detect and suppress a developing dust or gas explosion. Most suppression systems use one or more suppressant bottles, which are mounted on a vessel or enclosure to be protected such as an industrial dryer, ductwork, conveyor, dust collectors, silos or cyclones.

Pressure sensors or infrared detectors are typically mounted on the protected equipment, along with the suppressant bottles, and linked to a monitoring panel. An explosion takes only milliseconds to develop, so suppression systems must be able to react almost instantly when a spark or other ignition source ignites the combustible dust or gas mixture. The suppressant bottle is pressurised and uses a fast-acting valve to disperse suppressant – typically sodium bicarbonate or monoammonium phosphate – and quench the explosion, reducing the overall pressure rise to a level below the enclosure strength.

Based upon a multi-year investigation to understand the effect of different factors (eg injection-to-ignition location, system activation pressure, etc.) on the final reduced pressure due to suppression, a basic model was developed and, in conjunction with full-scale tests, will be incorporated into a new version of Approval Standard 5700, *Explosion suppression systems*. The standard will include a series of new tests to determine the performance limits for a desired reduced pressure and a given suppressant bottle.

Approval Standard 5700 will be released later this year and will provide for the evaluation and certification of complete explosion suppression systems. The new standard will include performance tests to determine full-scale suppression performance, suppressant storage container tests, actuation

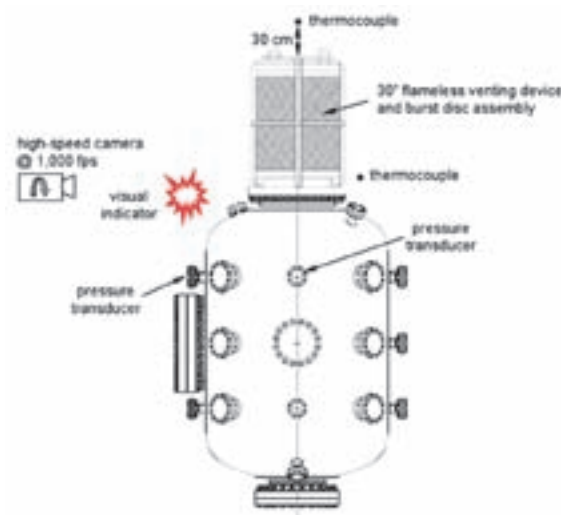


Diagram of the new 8m³ explosion test vessel. Shown are various components and devices used in conducting a dust explosion test of a flameless explosion venting device, mounted on top of the vessel.

device operation, hydrostatic pressure, corrosion resistance and others factors.

Explosion suppression systems certified under the new version of Approval Standard 5700 can be installed with confidence at larger scales, provided that the maximum performance limits are satisfied.

The final phase in the current round of explosion protection research is currently underway and is focused on explosion isolation systems. These systems are designed to detect and react to incipient explosions and cut off the deflagration from traveling to interconnected equipment.

Explosion isolation systems can be chemical systems that discharge a suppressant into pipes or ductwork to quench a deflagration as it tries to move out from the point of origin. These systems can also be mechanically active, using a powered high-speed valve or plate to contain the deflagration, or passive in which an isolation valve or flap deploys in response to the deflagration pressure. A new approval standard, based on this new explosion isolation research, is planned.

In summary, explosion protection systems are commonly used by industry to reduce the risk of explosion due to combustible dusts and vapors. New research into explosion protection systems – including venting, suppression and isolation – has led to new approval standards that will eventually result in increased availability of FM Approved explosion protection systems worldwide.



High-speed photo of cornstarch dust explosion exiting the top of the 8m³ test vessel. A flameless explosion venting device quenches the heat, preventing a secondary explosion outside the device.



# Testing in flux

High-heat flux testing (in the region of  $350\text{kW/m}^2$ ) of passive fire protection materials is now being offered by many test houses but, without a formal standard, how can the results be validated? More shared research is needed, writes Deborah Willoughby.

adapted into the ISO standard ISO 22899-1 in 2007. Part 2 of the standard (ISO/TR 22899-2) was then published as a Technical Report in 2013.

The test, as defined by the standard, determines the resistance to jet fires of passive fire protection materials and systems. Specimens are subjected to a  $0.3\text{kg/s}$  release of propane vapour that is directed into a recirculation chamber, giving rise to heat flux in the order of  $250$  to  $300\text{kW/m}^2$  as well as high erosive forces due to the velocity of the jet. Heat flux is defined as the amount of heat transferred per unit area per unit time to a surface. Following the test, the specimen's temperature and integrity is assessed in order to quantify its performance.

Items such as cable transits and pipe penetration seals, specimens of 'non-standard geometry' – ie which fall outside the scope of the original test standard – are now routinely tested. These include items such as emergency shutdown valves, water pipes, electrical cables and accommodation walls.

This increased requirement for jet-fire resistance testing has seen greater numbers of test houses offering jet-fire resistance testing. Whilst at face value this may appear beneficial for industry, it is vital that those offering jet-fire testing – and any third-party accreditor – are fully conversant with the requirements of the standard and its testing arrangements; particularly where non-standard items are to be tested.

As a result of changes to requirements, largely driven by the offshore Norwegian sector, for some applications it has become necessary to adapt the current jet-fire resistance test so that high-heat flux testing can be carried out.

In the case of high-heat flux jet-fire testing, there is currently no formal standard and little uniformity in the way tests are carried out, ad-hoc, by different test houses. This means that testing cannot be validated against an agreed benchmark.

Whilst high-heat flux testing for some applications is already required in sectors where there is no specific fire analysis, at present it is not required for the UK sector since a fire-risk analysis is conducted as part of HSE's Prevention of Fire and Explosion, and Emergency Response (PFEER) regulations.

A further variation on the test that has been requested by

**I**n the two decades since the first jet fire tests were conducted, the Health and Safety Laboratory has carried out extensive jet-fire testing of passive fire protection (PFP) materials and systems both commercially and for research purposes. However, the variety of materials and items requiring jet-fire resistance testing has expanded significantly since the OTI standard was published in 1995.

In the wake of Piper Alpha it was recognised that the heat flux from high-momentum jet fires posed an extremely serious threat to PFP materials. This led to the Jet Fire Working Group being set up in 1992 by the UK Health and Safety Executive and the Norwegian Petroleum Directorate, along with members from UKOOA, Shell, British Gas and SINTEF. The resulting standard for testing the resistance of PFP materials to jet fires, Offshore Technology Report OTI 95 635, was published by the HSE in 1995 and subsequently

Deborah Willoughby is technical delivery manager (major hazards) at the UK's Health and Safety Laboratory.

Testing of passive protection material in accordance to Jet Fire Test ISO 22899.





# INTUMESCENT FIRESTOP SYSTEMS

- Mixed-, cable- and pipe penetration sealings
- Joint seals with movement capability

## References:



Medicine



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The jet-fire rig produces a 2m fireball as it impinges on the material being tested.

manufacturers is vertical jet-fire testing, which requires the orientation of the jet to be changed from horizontal to facing vertically downwards. This alters the characteristics of the fire within the recirculation chamber, elongating it and increasing its tendency to rise, and also changing the balance between convective and radiative heat transfer.

HSL has conducted its own testing to measure heat flux with

a vertically-oriented jet, and found it to be lower, resulting in a less onerous jet-fire test. Whilst vertical jet-fire testing may be useful in certain applications, there is currently no validation for this type of testing, although a number of industry bodies will provide an independent assessment for both high-heat flux and vertical jet-fire tests on a project-specific basis.

HSL's view is that more shared research and evidence is needed to compare the performance of materials in high-heat flux and vertical jet-fire testing in order to secure a consistent and measurable approach.

The ISO test was developed as an affordable means for assessing the jet-fire resistance of PFP materials, and to provide a level playing field for the qualification of material performance. The test was validated against the large-scale, natural gas jet-fire test and produces the key conditions typical of large-scale fires resulting from high pressure releases of natural gas.

HSL's expertise and long experience of conducting jet-fire tests suggest that it would be a backward step for industry if businesses investing in the more expensive high-heat flux test, which operates within similar parameters to the ISO test, gained no significant benefit in quantifying the performance of PFP materials. Without further research and validation, the cost benefit of the high-heat flux test cannot yet be determined.

HSL has developed its own small-scale erosive burn rig which replicates both the heat flux and high erosive forces delivered during the jet-fire resistance test. Small-scale testing with this facility offers a competitive testing regime to determine a specimen's test performance or configuration prior to its submission to a full-scale ISO test.

# Reach the decision-makers



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