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second quarter 2017 issue 106

FIRE & RESCUE

INTERNATIONAL INDEPENDENT INTELLIGENCE

Healthy at heart?

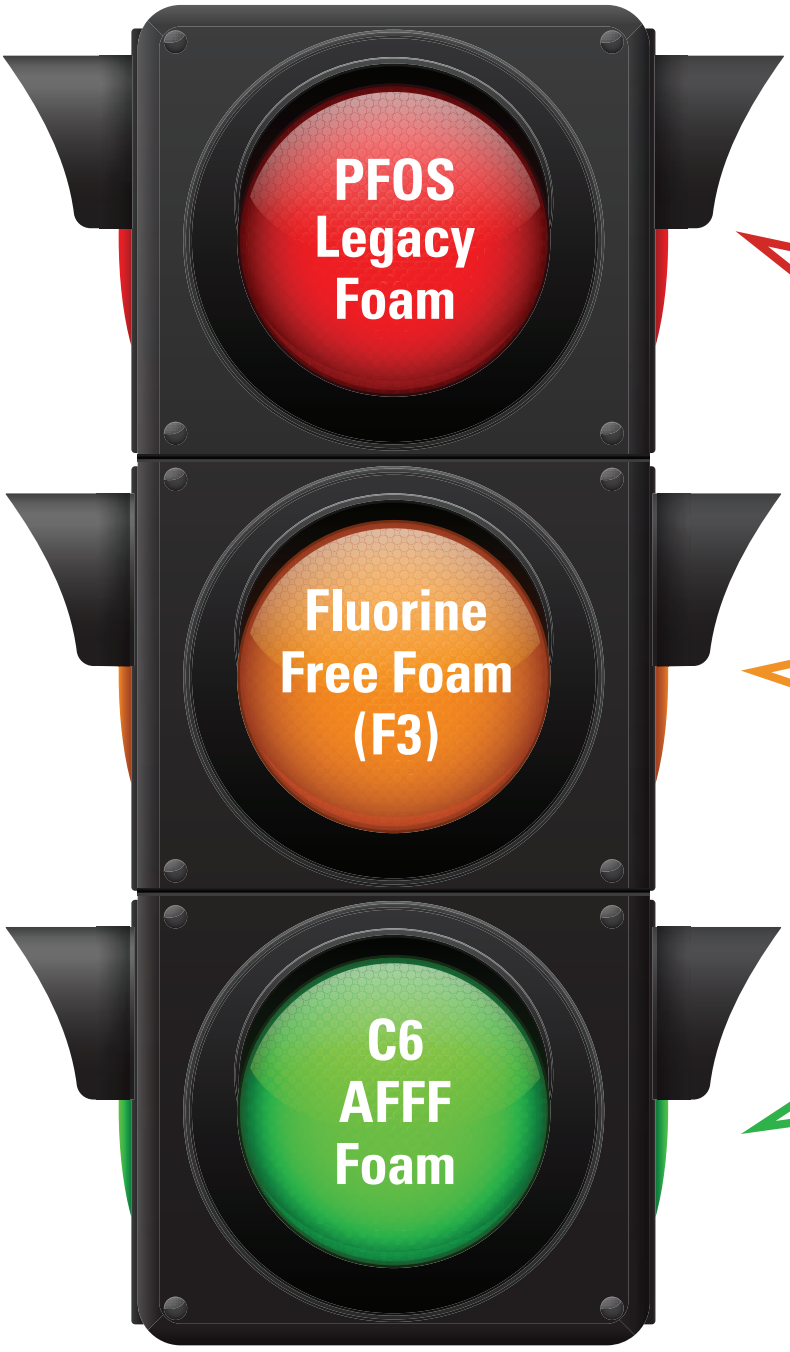
New research sheds light on link between heart disease and fire suppression

NFPA® CONFERENCE & EXPO

IAFC's Annual Conference & Expo
FRI 2017
FIRE-RESCUE INTERNATIONAL

Disaster & Emergency Management Summit 2017
22 – 23 August, Singapore

Proceed on Green



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

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

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

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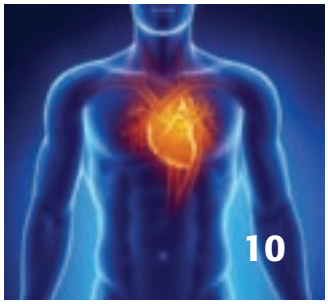

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EDITOR'S COMMENT

A favourite phrase of US President Harry Truman was: 'If you can't stand the heat, get out of the kitchen'. It means that if the pressure or stress is too great, don't persist, leave the situation. However, this is often not an option for firefighters, whose job requires them to persist in extreme conditions to complete the operation.

But this creates a dangerous dilemma. Statistics from the NFPA in the US have routinely shown that nearly half of all firefighters who die on duty each year do so as a result of heart attacks. Now, new research from the University of Edinburgh in the UK has revealed a direct link between the heat and physical activity levels encountered during the course of duty and the risk of suffering a heart attack.

The study revealed that firefighters' blood becomes stickier and is about 66% more likely to form potentially harmful clots during fire suppression. Their blood vessels also failed to relax in response to medication. It was also found that the exposure to extreme temperatures caused minor injury to the heart muscle. On page 10 you can read the details of the research in our exclusive report. However, all is not lost. Now we know why so many firefighters suffer from heart attacks, we can start addressing the problem by implementing measures to combat the effects of heat stress, ranging from rehydration and cool down procedures to PPE selection and even physiological monitoring.

Ann-Marie Knegt, Editor

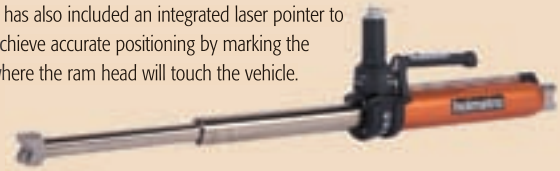
New lightweight telescopic rams from Holmatro

Holmatro has launched three lightweight telescopic rams that provide both more length and higher second plunger spreading force.

The new models from the hydraulic equipment supplier are ergonomically designed and feature new carting and control handles for improved grip, as well as LED lights at the front and back to provide a well-lit working environment. Six LED lights illuminate the plunger and the base of the ram.

The reduced weight of the new rams means they are easier to carry and handle, reducing the physical strain on rescuers. The control handle also features an improved ergonomic design that provides better grip, and a speed valve that sees the plunger quickly extend to the desired distance, speeding up the positioning process.

Holmatro has also included an integrated laser pointer to help users achieve accurate positioning by marking the exact spot where the ram head will touch the vehicle.



ZIEGLER LAUNCHES Z-CAB XL

Firefighting vehicle and technology supplier Ziegler has added a new, roomier option for crew cabins with the launch of the Z-Cab XL. This is designed as a premium option in the Z-Cab range and comes in a number of different versions.

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

The Z-Cab XL is offered in different widths and lengths. It can be configured with a generous width of 2.5m, or a narrower width of 2.3m for urban areas. There are also options for seat design, with ergonomic upholstered seats available.

The new cabin improves on crew safety with the option of Z-Protec airbag and belt tensioning system that protects the crew in an event of an incident. The outer seats are equipped with head airbags for all body sizes to protect from serious head injuries.

The cabin is mountable on all conventional fire engine chassis.

AIRBUS INTRODUCES LATEST RELEASE OF TACTILON AGNET

The latest version of the Tactilon Agnet misson-critical group communication application from Airbus incorporates geolocalisation and sophisticated functions for commanding officers of public safety and various industries.

Tactilon Agnet enables emergency responders to communicate securely by LTE. It is fully interoperable with Tetra and Tetrapol and allows secure and flexible communication between LTE device users and Tetra or Tetrapol terminal users.

The latest iteration includes enhanced services such as permanent geolocalisation, navigation, group positioning, and user presence as well as status displays on a map for commanding officers. This special variant runs on a tablet and is designed for field commanders who want the full picture of a situation. It enables them to follow each ongoing group communication and improve mission efficiency.

The app can be incorporated into Tetra or Tetrapol networks to enhance secure group communications. Users can send photos, data and videos securely to a control room or colleague at the touch of a button.

Tactilon Agnet offers full critical connectivity for smartphones. It has been developed in line with the introduction of the LTE quality of service management. Its mission-critical voice capabilities are aligned with the release of the international telecommunications standards of the Third Generation Partnership Project (3GPP), dealing with MCPTT functions of future PMR networks. The application's multimedia functions are based on the principles of 3GPP's release 14.

WATERAX MINI-STRIKER LIGHTWEIGHT PUMPS

A range of lightweight, portable pumps designed to act as initial attack units has been launched by Waterax.

The Waterax Mini-Striker pumps pair a reliable single-stage pump end with the Honda GXH50 4-stroke 2.5hp engine to achieve pressures of up to 85psi (5.9 bar), a maximum head of 60m, or a volume supply of up to 303lpm.

At just 9kg, the Mini-Striker is light enough to be carried and performs well when used independently or in tandem with other pumps, even over long distances. It is ideal for sprinkler operations, entry-level slip-on or vehicle-mount applications and is also well-suited to some of the latest fire control techniques that require lightweight equipment.

The Mini-Striker is available in four different configurations. In addition to the 9kg portable version, there is a portable cart system that can be equipped with professional grade equipment, an entry-level skid deck version that allows you to build your own fire apparatus and convert an ATV or pickup into a fire truck, and a lightweight vehicle-mount pump system.

High-tech rescue camera from Agility Technologies

A live-streaming, 360° technical search and rescue camera that aims to decrease search times has been launched by Agility Technologies Corporation, based in British Columbia in Canada.

The Firstlook360 has been designed for use in a range of technical rescue situations, including structural collapse, trench, high-angle, and vehicle extrication and can also provide improved on-scene situational awareness. It captures seamless high-definition streaming spherical panorama video with wired and wireless connectivity and is housed in a ruggedised IP67 housing that will fit through a standard 5cm (2inch) coring hole.

ATC has engineered the new live-streaming camera to offer increased battery life, and the design is free from the rubber bellows that usually cover the joints and moving parts in other rescue cameras currently on the market.

FL360 also offers mobile integration in the form of an Android app that enables users to record video, take snapshots, and transmit and receive two-way audio via its robust, multi-camera head. In addition, by using the tablet provided, a rescuer can view an entire space by swiping across the screen or by using the app's virtual joystick to control the focus area.

The Firstlook360 will be available as part of ATC's USAR range.

PFOS, PFOA blood tests for Queensland firefighters

Firefighters in Queensland worried about exposure to toxic chemicals in firefighting foams can now access free blood tests after the Queensland Government signed a policy in May offering the tests as part of a study into the long-term effects of the PFOS and PFOA.

The chemicals, found in aqueous film-forming foams, have been implicated in a number of contamination cases across Australia, and the Queensland study will make blood tests available to all past and present firefighters in the state. The Queensland Fire and Emergency Service has been offering free blood tests since the end of 2016 but it is not known how many firefighters have been tested.

The blood tests will identify the presence of the chemicals in firefighters' blood and the results will become part of a baseline study looking into the effects on human health. While they have been linked with various forms of cancer as well as other illnesses, both the Queensland and federal governments maintain there is no consistent evidence of adverse impact on health. The study could shed more light on the longer-term ramifications for those exposed.

CARE HOME FIRE SAFETY FINE

A care home in Burnham-on-Sea in the west of England has been fined £100,000 (US$125,000) for breaching fire safety regulations at its staff accommodation.

Almondsbury Care was charged with five offences under the Regulatory Reform (Fire Safety) Order 2005 by Devon and Somerset Fire and Rescue Service after an inspection of the premises revealed a number of failings. These included failure to provide a sufficient fire detection and warning system; a fire exit door that could not be opened; inadequate protection to the means of escape; and cupboards on the means of escape being used for storage.

In summing up, the judge said the premises had a whole range of failures that should have been 'abundantly obvious to anyone who chose to think about it.'

The company failed to make a proper assessment and their own risk assessment clearly identified deficiencies which they ignored. The judge added that the company had allowed people to stay in a premises they knew placed people at risk of death or serious injury. The fire safety provisions fell far below the standard required, resulting in a high risk of harm.

Business safety manager Paul Bray of Devon and Somerset FRS said: 'The severity of the fines imposed by the court gives out a clear message to those who have control of a premises and show a disregard for the law and those they have a duty to protect.'

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Intelligent thermal imaging system from Scott Safety

An in-mask thermal imaging intelligence system has just been launched by Scott Safety. Scott Sight integrates a lightweight thermal imaging camera into the mask's display, providing a hands-free thermal view at all times.

The lightweight in-mask camera weighs just 240g. It is designed to improve a firefighter's situational awareness, and provides 160x120 resolution at nine frames per second through an infinity lens. This ensures a clear picture and eliminates eye strain.

Scott Safety worked closely with firefighters in the development of the new Scott Sight system in order to create thermal imaging technology that is both more accessible and easier to use. The hands-free visibility enables firefighters to stay focused on the fire rather than their camera, and makes it easier for them to spot hazards, locate casualties, and identify a secondary means of escape in the event of a sudden change in circumstances.

Scott Sight can be configured to suit the needs of each wearer. The display can be set to the wearer's line of sight and various user interfaces are available to suit different tastes. Hotspot and ambient temperature settings can also be selected. The system is compatible with the new AV-3000 EN firefighting mask from Scott Safety.

IAFC RECOMMENDS STRATEGY FOR DISASTER MITIGATION AND RECOVERY

International Association of Fire Chiefs President John Sinclair has advised the US Congress to adopt a comprehensive national strategy to deal with and mitigate the effects of disasters and major incidents in the country.

Fire Chief John Sinclair is the IAFC president and chairman of the board and he has said that the organisation is concerned about the increasing number of disasters and the increasing costs of these.

Chief Sinclair testified during a Congressional hearing on mitigating damage and recovering from disasters. He said that there is a need to develop a comprehensive national strategy for addressing the problem.

Sinclair testified before the House Transportation and Infrastructure Committee's subcommittee on Economic Development, Public Buildings, and Emergency Management, chaired by Rep Louis J Barletta (R-Pa).

'Every disaster starts at the local level,' Sinclair said 'The local fire department is usually the first to respond on-scene during an incident and the last to leave. It is an all-hazards response force that must be prepared to respond to a variety of missions.

'The IAFC is concerned by the increasing number of disasters in the United States. Between 1960 and 1969, the average number of disaster declarations was approximately 19 per year. Between 2010 and 2014, this number skyrocketed to 67 incidents per year, with a record 99 major disaster declarations in 2011. In addition, the costs of these disasters are increasing. Between 2009 and 2012, the average annual cost of federal wildland fire suppression was $1.25 billion. For the following four years, the average annual cost increased by 32% to $1.84 billion.

'The nation must develop a comprehensive strategy for addressing this problem. The strategy must highlight the importance of investing in pre-disaster mitigation, ensuring an effective emergency response, and authorising critical post-disaster mitigation,' commented Chief Sinclair.

THE COUNTDOWN TO INTERSCHUTZ 2020 HAS COMMENCED

Interschutz 2020 will open its doors from 15-20 June 2020 at Hanover Fair in Germany.

The German Fire Service Association (DFV), the German Fire Protection Association (vfdb) and the event producers at Deutsche Messe AG have agreed to develop interschutz.de, a website that will provide the latest news and product updates related to firefighting, rescue, fire protection, disaster relief, and safety and security.

Dr Andreas Gruchow, a member of the managing board at Deutsche Messe said: 'Our objectives include expanding the international reach of Interschutz. At the same time, we naturally want to offer an event that highlights the attractive power of the leading international event for the fire industry.'

'Planning for Interschutz 2020 has got off to a very constructive start,' said Dirk Aschenbrenner, president of the vfdb association. 'I have no doubt that the show will be more than just a carbon copy of the highly successful Interschutz 2015 – it will also represent a further advance to fulfil the requirements of exhibitors and visitors from this dynamic sector.'

'There will be an appealing event programme that will showcase innovation as well as proven technology. This will all be made even more attractive by focusing on a spate of new developments and refinements,' commented DFV vice-president Frank Hachemer, who is in charge of Interschutz at his organisation.

The last edition of Interschutz was held in June 2015. It featured 1,500 exhibitors and was attended by 157,000 visitors from across the globe.

World's first gondola rescue simulator developed

XSplatforms has developed the first building maintenance unit (BMU) that can recreate a real-life emergency situation with a worker trapped inside a gondola that can be used for training purposes.

As the number of high-rise buildings increases, more BMUs are being installed, and while these are built to strict standards, there is still a possibility of an accident occurring. There is also the potential for more emergency situations with suspended gondolas.

Saving workers trapped inside a tilted gondola is difficult, because the gondola is unstable. This means rescue workers have to be very cautious, and operation-specific training is required.

Specialised training can now be provided at height with the BMU Rescue Simulator. This has been designed so that it can recreate emergency situations for training purposes. It can be tilted to an angle of up to 60 degrees while it hangs suspended in the air. The process of tilting is slow to ensure safety, and the gondola is manually controlled by an operator.

FIRESCAPE™

Firescape recently hosted a Launch Event on the 24th of April, at The HAC, Armoury House, City Road, London. The event was attended by over 250 people from a range of industries, including Fire and Rescue Services, Insurance Providers, and Construction, with representatives from countries as far as Australia and Japan. The event included live product demonstrations and the donation of two de commissioned fire appliances to the Bahamas Fire Service and the Romanian Fire Service to promote the recruitment and training of women in the fire service.

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4-7 JUNE, NFPA CONFERENCE AND EXPO, BOSTON CONFERENCE AND EXHIBITION CENTER, BOSTON, USA

Over 5,000 fire and life safety professionals, including electricians, firefighters, facility managers, architects, fire marshals, and government officials will gather in Boston for the 2017 NFPA Conference and Expo. Several changes have been made to the event in 2017 that organisers say will add value to the experience of attendees both during and after the conference.

A significant effort has been made in 2017 to ensure attendees have more tangible, concrete benefits from their conference experience. The concept permeates this year's event, from organising more hands-on learning experiences to smaller custom sessions and a simplified, easier-to-follow schedule.

'People consistently told us last year that the education presentations were good, but a lot of people said they walked out of the sessions saying, "Ok, what do I do next?"' says Guy Colonna, a division director at NFPA and part of the NFPA Conference executive committee.'If stakeholders are saying we've got great information but they don't know what to do with it, there is obviously a disconnect. What we've been trying to do is select education sessions where that connection can be made more strongly.'

A much greater emphasis has been placed in 2017 on creating education sessions and events tailored for specific audiences – think of them as 'mini-conferences within a conference' for an array of stakeholder groups.

'The presentations are more stakeholder-based rather than topic based, so whatever your role is in the safety world – if you run a facility, if you're a contractor, an inspector, an electrician, a first responder – it will be clear which sessions will be most relevant based on your job,' says Matt Klaus, NFPA's technical lead for fire protection engineering.

Helping further, the number of education session tracks has been slashed from 12 to seven in an effort to make the vast number of offerings more navigable and to help attendees find their way based on their job titles and what information is important to them.

Responders will have a dedicated track focused on many key areas impacting the fire service, most notably occupational exposure and cancer, the impact of emerging technologies, and general health and wellness issues. Topics covered include:

- The marijuana industry – a chronic problem
- Firefighter health – reducing cancer in firefighters
- Drones – unmanned aerial systems
- Emerging technology – energy storage systems.

For more information www.nfpa.org/training-and-events/by-type/conferences/conference

22-25 AUGUST, DISASTER AND EMERGENCY MANAGEMENT SUMMIT, SINGAPORE

A conference focusing on preparedness and strategies for dealing with terrorist attacks and natural disasters is set to take place in August in Singapore.

The Disaster and Emergency Management Summit, organised by Equip Global, will feature numerous case studies on recent emergencies from participants such as governmental agencies, disaster management authorities, and the frontline responders involved in planning and executing rescue operations.

The conference aims to assist delegates in meeting the evolving challenges of global security and disaster relief and facilitate knowledge sharing to enable effective planning in disaster management and emergency response.

Key themes for the event will include strengthening community resilience, building capacity at a local level and in response operations, and improving the communication and coordination between internal and external agencies.

The conference programme covers a wide range of topics from search and rescue operations in remote areas and collapsed buildings, to maximising preparedness and response for terrorist attacks. It will also address current trends in community resilience, and best practice in increasing emergency preparedness.

There will also be four additional workshops aimed specifically at encouraging and improving information and experience sharing between delegates and industry experts.

The Disaster and Emergency Management Summit is targeted at people who are responsible for disaster and emergency management at national, regional, and local levels, as well as national disaster response forces or national search and rescue, civil defence forces that handle hazardous materials, and police departments that include a focus on counter terrorism or special tactics. Last but not least, it is also aimed at emergency response teams and fire safety managers from corporate organisations. Readers of *Fire & Rescue* should state this when registering to receive a 10% discount.

Email: enquiry@equip-global.com or visit www.equip-global.com/disaster-and-emergency-management-summit-2017.

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

This year's Emergency Services Show will feature a host of new learning opportunities including CPD-accredited seminars, live demonstrations, and new extrication and trauma challenges. Free to attend, it returns to Hall 5 at the NEC in Birmingham from 20 to 21 September 2017.

West Midlands Fire Service (WMFS) will host an Extrication Challenge judged by United Kingdom Rescue Organisation officials. Teams of firefighters from WMFS as well as other brigades from across the UK will be briefed on road traffic collision scenarios and then compete in extractions from two car wreckages using the latest kit and rescue techniques.

A Medical and Trauma Challenge will also take place in an 'immersive environment' tent that will provide a realistic backdrop to the trauma scenarios. To add to the authenticity, the WMFS Casualty Simulation Group will be providing casualties with realistic make-up and prosthetics. Meanwhile, the WMFS Road Casualty Reduction Team (RCRT) will be demonstrating virtual reality goggles, which simulate a car journey and shows drivers the consequences of their choices and actions. Together with the Central Motorway Police Group, WMFS RCRT will be offering road and motorway safety advice and there will be a presentation from the emergency service's blue light response driving instructor.

Entry to the exhibition and seminars, as well as parking, is free. The NEC is physically linked to Birmingham International Station and Birmingham Airport and is directly accessible from the UK motorway network.

For more information visit www.emergencyuk.com/

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Hot on health

Firefighters' blood gets stickier and is 66% more likely to clot after exposure to fires and high temperatures, new research has found. Lotte Debell reports.

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

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

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

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

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

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

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

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

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

Read our e-magazine at www.hemmingfire.com

saw their core temperatures rise by 1°C – a huge physiological change.

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

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

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

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

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

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

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

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

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

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

Combating heat stress

A number of factors combine to cause heat stress in firefighters, and strategies to manage the risk of this potentially deadly condition need to consider everything from PPE selection to cool-down procedures, reports Lotte Debell.

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

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

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

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

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

Weight too has an impact. Bristol's technical manager Ivan Rich believes that restrictions on the weight of PPE may appear in upcoming revisions to European standard EN469 that governs protective clothing for firefighters. This process is also likely to include recommendations to help combat heat stress, such as guidelines on the maximum time firefighters wearing PPE can be exposed to certain temperatures.

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

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

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

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

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

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

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

Above: Layered PPE solutions, as supplied by Bristol Uniforms, combine full structural protection with the flexibility of lighter garments for operations such as wildland firefighting or technical rescue.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Mutual aid in The Netherlands

Public-private collaboration in emergency response can save money and improve services, argue Philip Stohr and Kees Kappetijn from Kappetijn Safety Specialists.

Involvement in a mutual aid organisation as municipality, safety authority, or public stakeholder can significantly improve the quality and efficiency of public emergency response. How? Because these organisations combine resources, streamline processes, build expertise, and address area-specific risks. They also save money.

Historically, firefighting and rescue services have been classified as a public responsibility. As with public order, the availability of sewers and street lighting, a public government organises these types of services because they are essential for a well-functioning society.

However, the fact that firefighting is a public responsibility makes it more difficult to effect change to improve how these services run. A certain quality level must be guaranteed, but taxes must also be spent in a cost effective way. While it might seem controversial at first, the solution to bringing about improved quality and efficiency in public services could lie in collaboration with private industrial partners.

Industrial emergency response services and mutual aid

Besides the public emergency response services, larger industrial companies – often in high-hazard industries – maintain their own emergency response services. Typically, these companies have a risk profile that requires specific measures to protect the health of a company's employees and the environment, both on site and in the immediate surroundings. They also need to protect assets and stocks.

Private companies often invest heavily in dedicated emergency services that can provide a 24/7 response. However, while they might not need their services often, as the risk of an incident is low, the costs of equipping and training a permanent professional, risk-focused emergency team are relatively high. This is particularly the case when specialised equipment and training is required to deal with specific scenarios.

In industrial areas where sites are located relatively close to each other, companies can join forces. If two or more companies share the organisation of emergency response services, or share emergency response procedures or equipment, it is called mutual aid.

One of the main areas of advantages is in efficiency. Without mutual aid, every company must have its own emergency response service. When they start to share services, the number of services, teams, equipment and, in larger geographical areas, the number of service stations can decrease. Costs will also be reduced.

The reduction in costs is far from the only argument for companies to work together in this way. Mutual aid collaboration can also help to improve the quality of emergency response services. It simplifies day-to-day management and can unify preparation and attack procedures. And, because the incident frequency of a single industrial site is usually very low, company emergency response teams are generally less experienced in real incident situations. Working on a larger scale will ensure that the crew are more experienced, and make developments in the training programme possible.

Public-private partnerships

In areas with large public and private interests, such as harbours and centralised industrial areas, public stakeholders can be part of a mutual aid organisation. In this case, public emergency response tasks and industrial emergency response tasks will be performed by one organisation.

There are several models for public-private partnerships in mutual aid. A robust example is an independent mutual aid organisation, set up as a separate legal entity, which is managed and financed jointly by public and private partners.

There are also several other variations of PPPs. For example, public emergency response tasks can be outsourced to one or more of the private stakeholders, or industrial stakeholders can outsource the required capabilities to a public fire and rescue service. The stakeholders involved have a contract with KPIs for the required performance, cost sharing, governance, and quality standards.

In the Port of Rotterdam all major container terminals are members of a mutual aid organisation. Pictures by Bettina Smak-Gregoor and Rob Jastrzebski.

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PPP-MUTUAL AID MODELS IN THE NETHERLANDS

PPP-mutual aid has been commonplace in The Netherlands for 25 years and has been adopted nationwide.

High-hazard industry is spread all over the country, but it is concentrated in industrial and harbour areas, which often consist of dozens of companies. In these areas, industrial companies, municipalities, safety authorities, and harbour authorities work together to provide industrial firefighting, hazmat teams, and emergency response.

All the main ports in the country have some form of PPP, but they all differ. In the Rotterdam area, the municipality, the regional safety authority, and 65 companies have set up a mutual aid organisation for all types of incidents from fires in buildings, industrial facilities, tanks and on ships to road traffic accidents and search and rescue operations.

In the Amsterdam port area, the tank storage industry and two safety authorities have joined forces specifically to deal with incidents concerning tank storage.

At Schiphol Airport, the municipality, the safety authority (fire, police, and ambulance), the airport, and the companies that run the airport's gasoline station and the maintenance department of KLM have joined in a large mutual aid/PPP that combines tasks for public fire and rescue, industrial fire and airport firefighting.

The nuclear research facility in Petten is run by NRG. NRG provides fire and rescue services for all industrial facilities on site and provides public suppression services for the municipality and safety region.

In Sittard-Geleen, Chemelot, the former industrial area of DSM, works with a large mutual aid organisation for all chemical companies on site. The mutual aid is broadened to a PPP with the regional safety authority by sharing a hazmat team and a foam tender for chemical incidents outside the industrial estate in public areas.

Finally, both in the industrial area of the municipality of Delfzijl and the train yard of the municipality of Zwijndrecht, private owners and public bodies have chosen a mutual aid model in which the responsibility of organising fire and rescue services is shared, but the performance is put in the hands of Falck as a specialised service provider for these kind of services. This is the outsourced version of mutual aid/PPP.

The PPP model that is best for a specific area will depend on the local circumstances and the characteristics of that area.

A good example of public-private collaboration in emergency response is the Rotterdam harbour area, where the Unified Industrial Fire and Rescue Service (UIFRS) has performed both public and private firefighting, rescue, and emergency response management tasks since the 1990s.

The UIFRS serves an area with over 100 SEVESO companies. It is 40km wide and only has eight fire stations. Only the five refineries within the area maintain a small personal emergency response service.

Without this collaboration, the industrial companies in the harbour area would all have to organise their own firefighting capabilities. This means that there would be around 65 separate industrial fire brigades. The municipality of Rotterdam would also need four fire stations to take care of fire and rescue services in the public domain and the two suburbs that are close to the industrial area.

With the industrial and public stakeholders working together, the number of fire stations is reduced from 69 to eight. And the educational level of the firefighters is highly specialised and focused on the credible scenarios in the area, as are the vehicles and equipment.

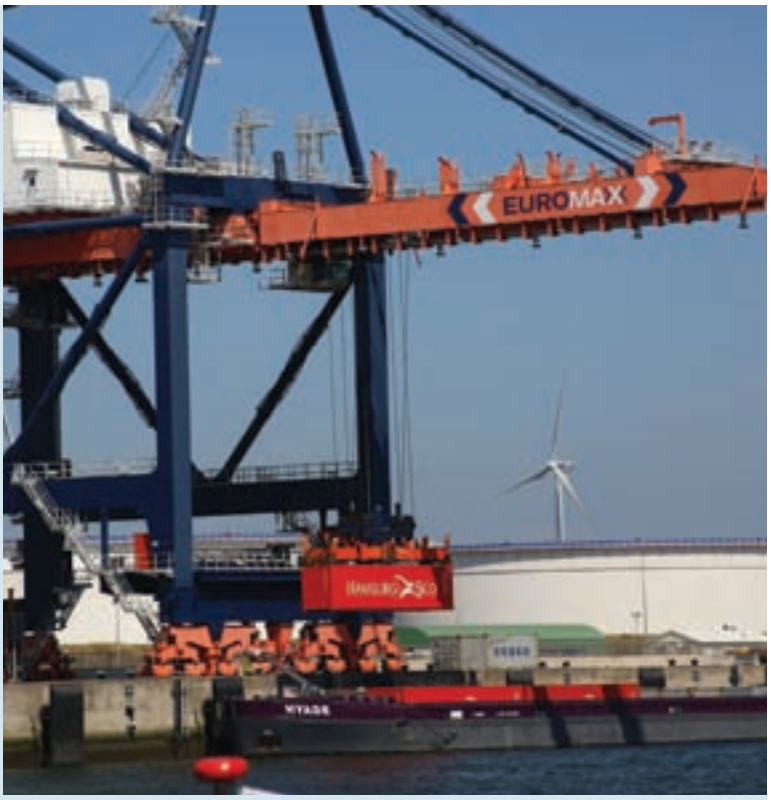
Efficiency is not the only advantage of public-private collaboration, however. Quality is another. The larger scale of the resulting organisation enables the development of a high-end training programme tailored to the specific risks and needs of the area. More call outs also mean experienced personnel who have attended more real-life incidents.

The UIFRS is highly trained to deal with the risks specific to its service area, and also performs a number of specialised additional services such as tank and bund firefighting, maritime firefighting, high-angle rescue, and oil boom services for chemical spills on surface waters in the harbour.

Another important advantage of public-private collaboration is the alignment of working methods between the public and industrial services. When public and private services only work together during an actual incident, issues can often arise with communication, the compatibility of equipment, alarm and scaling, and sufficient availability of foam stocks. When there is one mutual aid organisation, the emergency response capability is centralised in one organisation, so these problems don't occur.

The biggest advantage of public-private collaboration, however, is that stakeholders can demonstrate that they are taking responsibility for the risks that arise from their activities and that they are choosing to trust and work with each other to place safety over self-interest.

Mutual aid through PPPs is a proven concept in The Netherlands, where it operates in various guises and in locations as diverse as large industrial areas with chemical plants and tank storage, nuclear facilities, train yards, container terminals, and airports. If you think it could work in your area, start talking to local industrial companies and find out.



Incidents are never on- or off-site. Picture by Bettina Smak-Gregoor and Rob Jastrzebski.

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Philip Stohr and Kees Kappetijn are consultants at Kappetijn Safety Specialists, based in The Netherlands. KSS prepares safety authorities and industrial companies working in the high-hazard industry in their tasks and responsibilities in regards to emergency response, industrial fire services, and crisis and continuity management. Together with JOIFF, the company researches mutual aid organisations and PPP-based emergency response organisations worldwide. For further information, contact Philip Stohr at p.stohr@kappetijn.eu or Kees Kappetijn at k.kappetijn@kappetijn.eu.

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A win-win concept

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

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

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

Heading the exercise are Chas McGill MBE, Hampshire Fire and Rescue Service, and PC Mike Batten, Hampshire Police.

The fire command vehicle, parked around 70m from the incident, where incident commanders congregated mid-exercise.

Both are highly experienced in organising complex training exercises that involve multiple emergency response agencies working together with organisations that range from airports, refineries, and stately homes to shipping line operators. For today's project, it is the aerospace industry.

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

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

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

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

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

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

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

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

HARTs were established in 2004 to provide medical teams to patients in hazardous environments, essentially bringing treatment closer to the patient in such situations and giving them a greater chance of survival. Due to the nature and

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requirements of their roles, team members are highly trained in a variety of response specialisms.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

'If it's going to be a protracted incident then it makes sense to adopt an interoperability channel. But at the moment we are responding to this situation as if it were a more complicated and large-scale road traffic collision, adopting much the same

Paul Haly, HART vehicle team leader at the South Central Ambulance Service NHS Foundation Trust, pictured during Excercise Winner.

Extrication of the patient from the crashed Lynx helicopter.

principles that we would apply to that situation. And now we have a focal point which keeps all the commanders together.'

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

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

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

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

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

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

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

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

High-intensity training

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

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

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

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

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

'Crawl-walk-run' is a recognised method of learning, commonly used by the military, particularly the US and UK. The methodology perfectly suited our circumstances and

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Smaller-scale, shorter, intensive exercises supported by – and in company with – industrial partners and stakeholders may provide a better solution to ensuring training is more relevant and frequent.

provided us with a good means of imparting the JESIP joint doctrine in a practical, easily understood manner.

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

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

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

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

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

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

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

During the build-up we invited and briefed representatives from each agency as well as private industry to act as umpires, using the JESIP Umpire Evaluation Log. This was a major part of the training, as we wanted to ensure that we captured all the learning from several different perspectives. Umpires were assigned to each of the three sectors within the exercise, as well as to wherever the command point would be established on the day. We also arranged for the exercise to be professionally filmed.

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

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

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

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

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

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

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

A large fire burning in a mountain forest near a village in Spain poses an imminent threat. Picture by Silvia Pascual. ©Shutterstock

Fighting for cover

When a study revealed that more than one million people in Spain were without access to fire services, the country turned to the EU's Exchange of Experts programme in 2015 to find solutions. Two years on, Commander Franchesco Echeverria from the fire service in the province of Navarra, Spain, reports on the current situation.

Data collected by the Professional Association of Fire Technicians (APTB) in Spain in 2013 showed that the proportion of the country not covered by firefighters was much higher than previously thought.

The study relied on data supplied by all fire services in the country and concluded that there were 1,061,828 people out of a total of 47 million in Spain, mostly in rural areas, whose administration did not recognise the right to be attended by a fire service. This represented a total area of 31,160 km^2.

The APTB published the *'National Fire Service Statistics'* in 2013 because of a lack of official information nationally. The organisation contacted every fire service in Spain, before compiling the data and analysing the emergency fire services situation at a national level.

This data showed, among other things, the total number of firefighters, the type and number of services, the number of stations per service, as well as interesting indicators about the emergency services situation in Spain. It also highlighted the high numbers of people without recourse to firefighting services – three to four times higher than previous estimates.

As a result of the study's findings, a meeting was held in Barcelona in March 2015 under the EU's Exchange of Experts (EoE) programme. Representatives from Sweden, Denmark, Finland, Norway, Belgium, Czech Republic, England, Ireland, Slovenia and Spain attended. The host of the meeting, the Catalonia Generalidad Fire Service, also invited representatives from France and Germany.

The meeting discussed in depth how emergency fire services are organised in each of the participating countries, with a special focus on rural areas. The main objective was to determine possible areas of improvement that could be implemented in territories where emergency services coverage had been identified as deficient and could not guarantee attendance for all citizens.

The meeting recognised the right of every citizen to receive appropriate emergency services, everywhere and at all times, and reached a number of conclusions regarding emergency services in rural areas.

These included that the authorities responsible for providing emergency response must establish the resources

A meeting was held in Barcelona in March 2015 under the EU's Exchange of Experts programme. Representatives from Sweden, Denmark, Finland, Norway, Belgium, Czech Republic, England, Ireland, Slovenia and Spain, France, and Germany.

Types of firefighter per country in Europe.

COUNTRY	FIREFIGHTER TYPE			
	Full time	Local	Paid 'volunteer'	Non-paid volunteer
Slovenia	700			113800
Norway	3500	8500		
Belgium	5000		12000	
Spain	28000		2500	2500
Sweden	5000	10600		2400*
Ireland	1200	2200		
Czech Republic	9000	2900		68000
Finland	4000	5000	8500	
France* **	40000		192000	
Germany	33700		1015000	
United Kingdom	26000	13000		**
Denmark	1700	4000		3000*

** In remote locations*
*** Only one station in the whole country*
**** France also has 12,000 military firefighters*

necessary for that response to be provided in a timely manner, while ensuring the quality of service through the provision of appropriate training and resources. The meeting also discovered that there was no single common system for organising fire and recue services at a European level.

New technologies, infrastructure, and vehicle performance mean that currently it is the time required to arrive at an incident, rather than the distance, that most significantly affects the result of an intervention. Thus the need for a study of options to reduce response times was identified.

To guarantee the response and technical quality of operational personnel in areas where the risk index is low and there are fewer incidents – generally in rural areas – it was decided that professional part-time firefighters must be integrated into fire service operations. These can organise shifts locally to attend emergencies and guarantee a previously established minimum response time by part-time firefighters, except for those places with a long and firmly established tradition of voluntary firefighting.

In relation to Spain, it was found that the country has lots of different types of fire service. This differs from nearby countries, which tend to have a more standardised model.

It was also noted that although a lot of progress has been made in emergency services at the national level in recent years, Spain still has a long way to go to reach the level provided in other countries, especially for rural areas.

The meeting also identified operational personnel models not implemented in Spain that could help solve these issues.

The situation in 2017

Two years on from the Exchange of Experts meeting in Barcelona, it is appropriate to reflect on the current situation and analyse future options for bringing the emergency services in Spain's rural areas more in line with those in neighbouring countries in Europe.

In Spain, firefighters are typically full-time, and there were around 28,000 full-time firefighters in 2010. In addition, there are around 5,000 volunteer firefighters operating in some regions. The professional part-time firefighter does not exist.

These figures can be compared with those obtained at the EoE meeting in the table above. It should be noted that, in countries such as France, the paid volunteer firefighter is very similar to a part-time firefighter. As an example, 80% of England is served by fire stations with part-time personnel. In Finland, this figure is 95%, while in Ireland, with the exception of its four largest cities, this figure is 100%.

Another significant finding was published in the UK Department for Communities and Local Government study in May 2013, entitled '*Facing The Future: findings from the review of efficiencies and operations in fire and rescue authorities in England*', commissioned by Brandon Lewis, the UK Minister for Policing and the Fire Service of England. This not only pointed out opportunities to increase the number of part-time firefighters in the country, but also highlighted the fact that the cost of part-time personnel is equivalent to 10% of the cost of full-time personnel – to which should be added additional costs for training and mobilisation for intervention.

It should be remembered that firefighter premises and facilities with localised part-time staff are significantly cheaper than those of permanent stations, both in operating and construction costs, as they require less infrastructure.

Each fire station is assigned a territorial coverage which is limited isochronously by its response time, where this is understood to be the time taken from the moment the mobilised resources receive the alarm until they arrive at the place of the intervention.

There is no European firefighter standard to establish this duration. However, the Federation of European Fire Officers Associations in the study *'Survey of the career of professional firefighters in Europe'* analysed the response times established in certain countries. This found that most of the countries involved (Czech Republic, France, Ireland, and the UK) were stipulated at 20 minutes, including rural areas. Germany was eight minutes, Finland ten minutes, and Denmark 15 minutes. Meanwhile Sweden and Norway were slightly longer, at 20-30 minutes and 30 minutes respectively.

It must be understood that the areas outside the isochron of 20 minutes are outside the territorial coverage of the fire station, and consequently poorly attended.

Fire stations that have full-time personnel have a response time equal to the travel time, as they can respond almost immediately. Thus, the isochron that determines the territorial coverage for these fire stations would be 20 minutes. Meanwhile, fire stations staffed by part-time firefighters must include the time required for on-call staff to reach the station.

According to the participants at the EoE meeting, this is five minutes for Sweden, Ireland, the Czech Republic and England; five to ten minutes for Finland; and in Denmark it depends on the area. Therefore the isochron that determines territorial coverage of part-time stations would be 15 minutes.

The part-time firefighter must live within reach of the station where they provides their services, as they must reach the station within five minutes of receiving the warning.

By applying these criteria and GIS tools, the population and the area actually served by each existing fire station in Spain can be calculated. Once the existing deficiencies are determined, the most suitable sites for the location of new fire stations can be established. A good way to reduce response times is to locate new fire stations in rural areas.

In view of the emergency service situation in rural Spain and the need to reduce response times, it must be concluded that the part-time firefighter model could solve the existing shortcomings and be an effective, efficient solution.

ABOUT THE AUTHOR:

Francesco Echeverría is the Fire Service Commander of Navarra. He has also worked in Catalunya and Galicia and has a detailed understanding of fire and rescue services knows the F&R Services in Europe as he was the delegate of the Spanish APTB for 24 years.

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AFOA report: part two

Eric Gillett, policy specialist dangerous goods, CAA

The carriage of lithium metal and lithium-ion cells and batteries represents a growing potential risk of fire, Eric Gillett of the CAA told delegates. Faulty and abused cells can experience 'thermal runaway', whereby an increase in temperature leads to further increases. Hydrogen and hydrocarbons are released, causing a gaseous flammable environment in which cells can ignite and explode.

There is a risk when these items, which include batteries used in laptops and other personal electronic devices and 'power bank' backup batteries, are carried on aircrafts. And the increasing use of such items by passengers means that carriage is growing.

The risk is greater when lithium-ion cells are fully charged, Gillett explained, and this diminishes as the amount of charge lessens. For this reason, since April 2016 lithium-ion cells and batteries shipped as cargo must be offered for transport at a state of charge not exceeding 30% of their rated capacity.

Two of the main areas of concern in cargo carriage are the shipper misclassifying the items for carriage, and the shipment of untested counterfeit goods.

When carried by passengers, personal electronic devices (PEDs) should be carried in the cabin so crew can more easily respond to a fire. However, care must be taken if cabin baggage is transferred to the hold to ensure that all spare batteries remain in the cabin.

Gillett set out a checklist of actions for cabin crew to take if there is a fire in a PED. This includes moving passengers away from the immediate area and informing the flight crew; using a fire extinguisher to knock down any flames; cooling the PED with lots of water or other non-flammable liquids; keeping a check on the PED in case of re-ignition; avoiding the use of ice to cool the PED as this could activate other neighbouring cells; and immersing the PED in water.

If the PED goes missing in a seat, he said, the passenger should be moved and the area monitored. On arrival, engineering staff should be asked to locate the device. If there is an in-flight emergency of any kind, the flight crew must inform air traffic control of any potentially hazardous goods onboard the aircraft.

Gillett pointed out that it is the duty of the airline, ground handling agent, and the airport to ensure that passengers are aware of forbidden dangerous goods. They must be informed not just at the point of purchase of the ticket, but also when the boarding pass is issued. Information that includes visual examples of dangerous goods forbidden from transport aboard an aircraft must be presented at ticket desks, check-in and boarding areas, using posters or screens.

Gillett ended his presentation by informing delegates that a range of simple-to-use fire containment and cooling bags are available, which can safely contain a thermal runaway event in the cabin. Airlines are encouraged to consider making such equipment available to cabin crew for use in such situations.

Ann-Marie Knegt concludes *Fire & Rescue*'s coverage of the topics addressed at the18th annual conference of the Airport Fire Officers Association, held in January 2017, including the growing risk of lithium-ion batteries, changes in aerodrome regulations covering emergency planning, and strategies to improve the wellbeing of firefighters.

Neil Gray, principal aerodrome inspector, CAA

Like many other aspects of aerodrome operations, emergency planning and the provision of rescue and firefighting services is going through a period of change, said Neil Gray, principal aerodrome inspector for the CAA.

'Our role as a regulator is to work alongside aerodrome operators as they plan these changes, determine which are right, and implement them when they are agreed and approved. From the perspective of the aerodrome RFFS, we need to work out how best to assess new and emerging risks and improve the way in which incidents are handled.'

A significant change that has had an impact on approximately 600 aerodromes within the European Union was the introduction in March 2014 of Commission Regulation (EU) 139/2014. The European Aviation Safety Agency (EASA) established a four-year transition period, which ends in December 2017, during which all aerodromes within the scope of the EASA must become compliant with the new regulation.

The UK is currently ahead of the game in the transition, but there is a lot of work still to be done. As of 31 December 2016, 35 UK aerodromes have transitioned, leaving a further 15 to complete the task. All in-scope UK aerodromes are expected to be compliant with the new regulation by the end of this year. Those aerodromes that transitioned back in 2014 are now being audited against the EU regulation, which includes emergency planning and RFFS.

The UK's EU referendum result in June has raised many questions about the UK's future relationship with EASA and the European aviation system. 'We are not sure yet what Brexit means, but the UK continues to be part of the European Single Market, which underpins the safety, security, and consumer protection on aerodromes across Europe,' said Gray. He stressed the CAA's belief that a joined-up approach was a necessity, and that the organisation wants to remain part of the aviation industry's single market in Europe.

EASA has also introduced new acceptable means of compliance and supporting guidance material that relates to the level of rescue and firefighting protection at aerodromes. This includes the reintroduction of 'remission', and details of acceptable levels of RFFS for all-cargo and other non-passenger transport operations. EASA is also looking closely at new physical and medical fitness standards, to be discussed in 2017.

In addition to the changes brought about by EASA, discussions continue to be held on Speed Limit Exemptions for aerodrome RFFS when responding to incidents on the public highway, and the overriding need to ensure safety and compliance with existing rules. The third edition of CAP 699 for RFFS personnel was published during the conference.

'It has taken a lot of hard work to cover the ground,' Gray acknowledged. 'The initial document was produced last year and submitted for consultation, and comments received so far indicate that the revisions have been widely welcomed.'

Rebecca Milner, business psychology consultant, ARUP, and Haydn Beynon, head of Dubai Airports Fire Service

A fit and healthy workforce is naturally going to be able to function more efficiently and effectively than an unhealthy one, but can this be quantified? That was the topic addressed by ARUP business psychology consultant Rebecca Milner and Haydn Beynon, head of Dubai Airports Fire Service. Together they presented ARUP's detailed wellbeing survey and its practical implementation in Dubai as a proven example of how firefighter health and effectiveness can be influenced by changes to the working environment.

When considering the broad question of a healthy working environment, people often automatically focus on health and safety, but the issue is a lot more complex, according to Milner. It needs to be treated in a holistic way, and must include employee wellbeing. The ARUP survey quantifies the relationship between two workplace wellbeing measures – engagement and burnout, and performance. Key factors include the effects of individual sleep cycle preferences, and the improvements made possible by identifying problems and taking action.

Beynon highlighted the potential problems faced by fire services, identifying ageing workforces, shift working, and the historic culture of working practices as among the stresses and strains suffered by employees.

ARUP's detailed survey of 327 firefighters in Dubai showed that nearly half suffered from pre-hypertension, weight conditions and/or smoked, leading to other associated problems. The solution was the implementation of new working practices, which involved instigating fixed routines, PPE, exercise, diet, rest and relaxation, monitoring, the adoption of new technology, and the enforcement of some of the new directives.

Dubai Airports also commissioned an investigation into the ergonomics and design of the offices and associated rooms at the fire service. The organisation then invested in re-designed offices, rest rooms, a gymnasium, and a conference or meeting room, as well as redecorating the complex to make it more welcoming.

The results, Beynon said, included a dramatic fall in short-term sickness reporting; a significant increase in the number of job applications to join the fire service; improved staff retention; better understanding of the challenges of the job; improved morale; and a fitter and healthier team.

Milner wrapped up the presentation with a detailed checklist of how fire departments can benefit from a holistic approach to wellbeing, including training and monitoring, and a range of tips.

Oliver North, managing director, Rosenbauer UK

Rosenbauer UK's MD Oliver North explained how the company, which is involved in the research, design, development, and manufacture of dedicated airport fire vehicles, has taken a major step forward in building a strong base to serve UK airports.

A separate UK company was formed in 2014 as a result of the purchase by the Rosenbauer Group of North Fire Limited. Rosenbauer UK is based in Holmfirth, West Yorkshire, and the executive team has extensive experience in sectors directly linked to the fire service and specialist vehicle engineering.

The Panther, Rosenbauer's crash tender, now has a dedicated service and parts supply operation in the UK backed up by a continuous investment programme. One of the first tasks of the new company was to stop sales through third parties and establish a direct, dedicated sales team. This ensures that airport fire services can deal one-to-one with the manufacturer.

The Panther is available in both 4x4 or 6x6 drive modes, and North showed a film of the vehicle undergoing rigorous trials to demonstrate its high-speed capability, manoeuvrability at speed, rough terrain and all-terrain abilities, and ergonomic cab design, which can carry the firefighting team comfortably and safely. The film reached a crescendo with the activation of two powerful and dramatic water jets.

North went on to explain the details of the range of attachments for various Rosenbauer vehicles, all of which have been developed specifically to meet the needs of airfield fire incidents of all types, sizes, and difficulty.

A special mention was made of the Panther's Stinger HRET, which can penetrate an aircraft's fuselage in just 0.1 seconds and enable the fastest possible fire treatment and passenger rescue.

Simon Petts, chairman of the Airport Fire Officers Association, reports from the ARFF Chief and Leadership Conference held in Las Vegas in February 2017.

Following AFOA's invitation to the ARFF Working Group to attend our conference in 2017, a reciprocal arrangement was extended to me as the current AFOA chair to attend the ARFF conference.

This was similar to the AFOA event in many ways, targeted at strategic level leadership in the US aviation fire and rescue services and their co-responding partners. And, like AFOA, the aim is to act as a conduit for greater information sharing between fire services.

The programme featured a variety of speakers covering everything from regulatory and industry updates to organisational management and case studies. It was immediately clear that the issues faced by aviation fire and rescue services in the US mirror those in the UK, and that there is considerable duplication in our work streams.

A clear example of this came in a presentation on a vehicle roll-over at Oakland Airport in California in 2014 during a timed response exercise. The incident resulted in a long-standing member of the ARFF community leaving under medical early retirement. The speaker described the difficulty of finding information on previous roll-over events or case studies, which was frustrating when you consider the work done in the UK by the CAA, Graeme Day and others. I forwarded the document developed by this team on behalf of the UK FRS.

The conference programme also included two military aircraft incidents. One of these was the Blue Angel crash during a public air show in which Marine Captain Jeff Kuss lost his life. The incident highlighted once again the particular set of risks and emergency response challenges these events pose.

Other incidents of note covered at the conference were the American Airlines B767 catastrophic engine failure fire at Chicago O'Hare Airport in October 2016, and the FedEx MD-10 at Ft Lauderdale. At both incidents, ARFF/RFFS played a crucial part in the successful outcome.

In closing, I was invited to say a few words regarding the AFOA/UK current position and emphasise the relationship both groups are aiming to strengthen. I believe both organisations have a strong desire for greater information sharing. However, as neither has a huge pool of resources, it is vital that we take every opportunity to reduce the duplication of work, and this is something I am keen to work towards.

Thought leaders

From terrorism to migration, fire dynamics to flashovers, the ninth annual International Fire Instructors Workshop in Hong Kong featured a wide-ranging and fascinating programme. Dr Katherine Lamb reports.

The latest in fire ventilation and behaviour, occupational health and safety, and firefighting training and techniques were the focus of the ninth annual International Fire Instructors Workshop at the Hong Kong Fire Service Department's state-of-the-art Fire and Ambulance Service Academy in January.

The conference saw presentations from across the world, including Hong Kong, Canada, Australia, UK, Croatia, Germany, US, Greece, and The Netherlands, among many others. Topics covered everything from fire dynamics to training, migration, ventilation, terrorist attacks, and flashovers, and saw the sharing of a huge amount of expertise, knowledge, and learning among speakers and attendees. Below are some of the many highlights of the event.

Fire services and migration corridors – are we prepared? Dario Gauš, Croatia

After Hungary closed its border to prevent migrants from entering the country, Croatia become part of the main migration route for refugees on their way from the Middle East towards central Europe.

Between September and November 2015 more than 300,000 migrants passed through Croatia, which has a population of only 4.5 million, and this proved to be a major challenge for all the services involved.

One of the questions raised by this influx was where the fire service fits into the migration crisis. During this three-month period in 2015, fire departments from eight countries – including 2,065 firefighters, both voluntary and professional, and 508 fire vehicles – were involved in the crisis.

Their duties included establishing logistical support for refugee camps, such as the provision of water and electricity, and fire service personnel were also deployed at train stations and on national borders. They supplied refugees with food and water, and assisted the elderly, disabled and less mobile on their way across the border.

The fire services also faced other challenges, such as rioting, cultural awareness, language barriers, separated families, and deaths among refugees, among many others. In short, the fire services were one piece of a puzzle in what was widely recognised as an international humanitarian crisis.

Firefighter rehabilitation: triggers and traps. Peter McBride, Canada

Firefighting is hot, strenuous work. Firefighters work in extremely hot environments with little opportunity to cool their bodies through normal sweating. Even moderate to heavy work demands at routine emergencies generate metabolic heat.

Bunker gear makes it difficult to dissipate this heat build-up, which can result in heat stress. The presentation from Peter McBride examined best practices for triggering operational rehabilitation and looked at ways that firefighters can avoid the traps that can lead to injury or death.

CFBT in Greece – establishing a training programme in a period of crisis. George Bogkias, Greece

George Bogkias provided an overview of the current situation of the Hellenic Fire Service, and the problems it is facing as an organisation in a period of financial crisis.

He also presented a different approach to the problems facing the fire service that are not the result of the country's financial problems, but a result of human behavior and the modern way of living. He looked at modern ethics that influence fire services and firehouses all around the world.

The International Fire Instructors Workshop was started in 2008 by Dr Stefan Svensson of the Swedish Civil Contingency Agency who wanted to see what would happen if he put several operational fire officers, instructors, scientists, and engineers in a room together for the discussion of ideas of mutual interest. Since then, the workshop has continued to provide a forum for a loosely organised network of operational firefighters and fire officers, engineers, and scientists with a passionate interest in fire dynamics and firefighting.

The conference provides the opportunity for those interested in both scientific and practical aspects of fire operations and protection to acquaint themselves with the latest advancements and trends in these areas, and to observe practical demonstrations. Participation by a host of international specialists at the 2017 event provided a perfect opportunity to establish closer and lasting global networks.

The unique character of the event results from the participation of experts from the US, Canada, Australia, Hong Kong, and many European countries. The 2018 IFIW conference will be hosted by MSB, the Swedish Civil Contingencies Agency, as the consortium returns to the location of the inaugural conference to celebrate its 10th anniversary.

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Thinking commanders and operational discretion. Dr Katherine Lamb, UK

Thinking firefighters become thinking commanders, said Dr katherine Lamb, who focused on developing decision-making behaviours to empower commanders to take operational discretion with confidence.

Operational Discretion: This is an unknown, and everyone has a slightly different explanation or interpretation of what it means. Dr Lamb argued that it is a state of professionalism whereby individuals are asked to make a decision that is outside the procedures by which they have abided for many years, or a decision that they know may also be outside the organisational risk philosophy.

Operational Accountability: All fire departments are accountable for the actions of their personnel. In an era of litigation, fire departments need to be comfortable and assured that their personnel are qualified and confident in making decisions. Dr Lamb looked at the question of how to train them to attain this confidence.

Fire suppression using water. Dr Stefan Sardqvist, Sweden

Dr Sardqvist's presentation covered current knowledge on the use of water for fire suppression, both from a theoretical and from a practical point of view.

Starting with Braidwood and Lloyd Layman, Dr Sardqvist described different principles of the use of water in relation to recent research on fire dynamics, in particular regarding under-ventilated fires.

Different situations require different techniques, depending on whether the attack is carried out in an offensive or defensive mode, and if it is done from the exterior or from the interior. Critical and optimal flow rates were discussed, from an empirical and theoretic point of view.

Dr Sardqvist also presented a new statistical study describing how fire and rescue services apply a standard tool approach, a perimeter approach, or a maximum flow approach depending primarily on the fire size.

Fire in the combustible insulation of the façade of a high-rise building. Karel Lambert, Belgium

Karel Lambert presented a high-rise fire case study to the workshop delegates.

On 3 November 2015, Lambert's crew attended a small fire in the façade of a high-rise building. The fire was accidentally started by construction workers on the roof of an adjacent building. Insulation in the façade caught fire on the second floor and started spreading.

Lambert detailed the importance of understanding building construction techniques and how this understanding, in conjunction with the use of state-of-the-art equipment, limited the damage caused by the fire.

Control the flow path and snuff the fire – proven European tactics and SOPs. Dr Michael Reick, Germany.

The principles of controlling smoke flows and fire development have been studied extensively in central Europe in the last 15 years. One of the main approaches is that of fire crews partially blocking openings and applying either positive-pressure ventilation or anti-ventilation.

Dr Reick explained the principles and limitations of these strategies and provided multiple examples of real fireground experiences where these approaches have been applied. He also presented experience from volunteer and professional fire departments in Europe as to how to implement this knowledge into standard operational procedures.

The Hong Kong Fire Department hosted the 2017 conference at its state-of-the-art training centre.

Making the switch

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

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

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

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

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

However, by substituting long-chain with short-chain fluoro-surfactants, 40% more volume was required to meet Underwriters Laboratory UL 162 standards for firefighting. Therefore, this trade-off was not positive. The solution was to create a halogen-free foam concentrate. The creation of 'green' foams for firefighting and hazardous material vapour suppression satisfied both issues. The resulting product ensured both firefighting performance and environmental compatibility.

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

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

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

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

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

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

Fluorine-free foam in storage containers at a facility in Europe.

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

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

All of these things should be considered before final storage tank placement is decided upon as once your storage tank is completed you will have to work around any problems in the event of an emergency. The goal is to implement a system that cannot fail even in a disaster situation.

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

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

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

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

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

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

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

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

Getting foam storage right is critical for successful emergency incident response. Proper consider and monitoring of foam storage is therefore essential.

ABOUT THE AUTHOR:

Michael F Schunck, or '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 on topics such as philosophy, environmental technology, hazmat, bio-weapons and terrorist response.

You can follow Schunck's blog at: www.hazmatmike.com/about-mike/

Hytrans bulk water transfer

Fire and Rescue New South Wales put its Hytrans bulk water transfer system into action at a recent fire at the Chullora Waste Recycling Centre.

The fire at the Chullora Waste Recycling Centre near Sydney, broke out on February 23, 2017. Over 100 firefighters attended the incident, and the blaze caused a black smokeplume that could be seen for miles.

FRNSW needed water to fight the fire, but the onsite firewater tanks were emptied quickly, the nearby hydrant was already in use, and the nearest large capacity hydrant was almost 1.5km away.

After evaluating the situation, FRNSW quickly deployed the bulk water transfer system, manufactured by Dutch producer Hytrans, which the brigade bought in 2015.

The HydroSub 150 mobile pump unit consists of a diesel-hydraulic power pack pump unit with a portable hydraulic-driven submersible pump, complete with floating device, designed to quickly transport large volumes of water across long distances, even when roads are not an option.

At the Chullora Waste Recycling fire, two remote hydrants were connected to a 152mm yellow hose, and the Hytrans hydraulic pump boosted pressure. The yellow hose was deployed at nearly 40kmph.

When it neared the fire, a manifold was connected that split the flow into five 70mm lines, which fed monitors and appliances. It took two FRNSW firefighters approximately 20 minutes to set up this 1,300m-long distance mobile water supply system, which provided their colleagues with a continuous flow of at least 2,500 litres per minute.

This procedure enabled firefighters to extinguish the fire and prevent further spread.

The Hytrans bulk water transport system is a modular system, and parts such as the hydraulic pump unit and hose box can be transported separately. It is ideal for use after major emergencies and provides an efficient solution in cases of flood, landslides or earthquakes that destroy roads. The hose can even be deployed by helicopter if necessary.

Queensland toxic foam spills

Two spills of firefighting foam containing PFOA occurred in the Brisbane area of Queensland, Australia, within the space of three weeks, prompting environmental and health concerns.

On April 10, 22,000 litres of foam leaked from a faulty sprinkler at a Qantas hangar at Brisbane Airport, about a quarter of which is believed to have made it into the Brisbane River and local waterways.

Residents were advised to avoid recreational activities and eating seafood from the affected area – advice that was still in place several weeks after the spill.

Levels of PFOA 50 times higher than the safe recreational limit were found in samples from Boggy Creek near the airport. Subsequent tests of crabs, prawns, squid and water from the affected areas indicated this level is declining, but environmental medicine expert Dr Andrew Jeremijenko warned that the environmentally persistent nature of the chemical means the impacts of the spill could be felt in the area for decades.

The Queensland government has been criticised for taking three days to warn the public about the spill. Both the state and federal governments maintain that there is no conclusive evidence of harm to human health from PFOA.

Qantas has been issued with an investigation notice by the Queensland Environment Department and could be fined more than AUD$180,000 (US$134,000). The notice requires Qantas to undertake monitoring of marine life and sediment and report on the extent of the environmental damage caused.

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

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

In response to the spill, the federal government has said that it is considering options for 'transitional removal' of foams containing PFOA and PFOS. Queensland Environment Minister Steven Miles has called for the Commonwealth to ban PFAS foams.

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

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

Improving

A next-generation Raman-based handheld detector from Cobalt Light Systems enables through-barrier identification of hazardous materials and improves the safety and efficiency of hazmat response, writes Ann-Marie Knegt.

In the rapidly-evolving world of hazardous response and incident management, fire departments are constantly on the lookout for tools that can assist the modern hazmat officer in fast, safe, and accurate identification of unknown materials. Tools that enable hazmat teams to analyse materials safely and efficiently, minimising the risk of exposure to potentially harmful materials, enable first responders to make more informed decisions early in an operation, prior to escalation.

Handheld Raman-based chemical detectors have been used for more than a decade by hazmat, military, and security personnel to identify unknown chemicals. One of the main advantages of Raman-based chemical detectors over other technologies is that they can be used to identify unknown chemicals contained in thin, transparent bottles and bags, without opening the container.

However, explains Dr Oliver Presly from Cobalt Light Systems, a company that specialises in non-invasive chemical detection systems, the scope of previous-generation detectors was limited because they could not identify samples contained within operationally-relevant thick, opaque or coloured packaging.

The technology works with coloured and opaque plastics, dark glass, paper and plastic sacks and envelopes, as well as clear plastic bags and clear glass vials. Below: Resolve identifies the contents of unopened coloured plastic containers like this yellow palm oil container (YPOC).

'When this real-world scenario is encountered, the container must be disturbed so a sample can be collected, which decreases operational efficiency and increases the risk to the operator and the public,' he explains.

To combat this problem, Cobalt has recently developed and launched a new product, called Resolve. This uses the company's Spatially Offset Raman Spectroscopy (SORS) technology, a technique that can identify unknown 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 data libraries, including explosives and precursors, toxic industrial chemicals, chemical agents, narcotics and new psychoactive substances, as well as household chemicals,' says Presly. 'The new capability expands the number of scenarios that can be properly assessed while keeping the sample contained and undisturbed.'

The technique is fast – it takes less than two minutes – and simple, enabling more efficient use of a firefighter's time in the hot zone and reducing the time spent in level A PPE. Furthermore, in some cases, SORS allows Raman to be deployed at an earlier stage in the operation, before more intrusive techniques are used – a quick 'what are we dealing with' check.

'Resolve enables operators to quickly identify a container's contents without opening or moving the container, and without compromising the integrity of the packaging in any way,' says Presly. This offers a number of clear benefits, including eliminating the risk of releasing an unknown material through taking a sample, which helps keep the operator and the public safer and reduces any potential environmental impact due to spillage.

Taking samples to identify materials can also be dangerous if the substance in question is particularly volatile or, as can be the case, becomes less stable or more hazardous when exposed to air. For example, says Presly, some sensitive, home-made explosive materials, such as triacetone triperoxide or silver fulminate, can appear to be white powders and have been known to be present in environments where explosives are not expected, and where hazmat teams are first on the scene. 'Materials like these can be extremely sensitive to disturbance.'

The Resolve detector is fast, ruggedised and simple to use, even in heavy gloves, as its interface is controlled using seven large buttons. The user simply chooses the container type and the system then determines which measurement mode to use: through-barrier, surface scan or vial holder.

'Through-barrier measurements take about one minute, with no sample preparation or consumables needed,' explains

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hazmat response

Presly. 'Surface scan mode is for ''point-and-shoot'' measurements where there is direct line-of-sight to the sample, similar to conventional handheld Raman devices, while vial holder mode can be used when a small sample has been taken.'

Resolve works with a wide variety of common container types, and the technology can also identify substances through multiple layers of different packaging materials – for example, a coloured plastic pot inside a padded courier envelope.

'This means that the system has potential for use in applications such as mail and parcel screening at sorting offices and customs checkpoints, particularly with the increasing incidence of powerful synthetic opiates such as fentanyl,' explains Presly. 'Use of Resolve allows identification in many cases whilst reducing the risk of exposure to the operator.'

While the ability to identify potentially hazardous substances through containers is a key new CBRNe detection capability, like traditional 'point-and-shoot' handheld Raman systems, Resolve also enables the more routine analysis of substances either not in a container – such as a typical 'white powder' incident – or materials in clear glass vials and clear plastic bags.

Launched in 2016, the device has already been picked up by a number of emergency services around the world, and Resolve is now deployed by fire and police departments in the US, Canada, the UK, The Netherlands and Australia.

REUSABLE GAS MONITOR FROM SCOTT

A new reusable single gas monitor that is configurable to detect 13 different gases has been launched by Scott Safety.

The Protégé SG is a universal portable gas detector with features including smart plug-and-play sensors and a replaceable lithium battery. The swappable sensors are equipped with a smart sensor board that automatically recognises sensor type and updates the gas label on the LCD display while automatically downloading the necessary calibration parameters.

With an IP66/67 rating, global regulatory approvals, multiple languages accessible on the LCD, and internal data logging for up to 5,000 events, the Protégé SG provides industrial workers and first responders maximum flexibility to focus on the task at hand and not on their equipment.

The Protégé SG is the first in a new line of cost-effective, high-performance portable gas monitors from the company. All Protégé devices will have a similar look, feel, and user interface as well as standard features, such as smart plug-and-play sensors and lithium/alkaline battery options that are interchangeable between monitors.

Completing the new range of monitors is the Masterdock II, an expandable docking station with up to ten bays. The Masterdock II has Ethernet and USB connectivity and supports six gas bottles simultaneously with the ability to bump, calibrate, and charge each device. Advanced software on the dashboard interface also allows users to print certificates, configure monitors, and centralise data storage for improved fleet management capabilities.

Post-structural fire hazard: how to prevent exposure

Are fire services doing enough to detect and protect from post-fire hazards? Do current procedures go far enough in keeping firefighters safe from potential chemical exposure? Chief Tim Dorsey reports.

Firefighters today are exposed to far greater chemical hazards than ever before, and we don't yet know the full extent of these or their consequences. As a result, monitoring for potential hazards after structural fires is more important than ever, and is an area that has attracted considerable interest in recent years. There are a number of different schools of thought around the world, all of them thought-provoking, but the real question is: are fire services meeting the mark when it comes to accounting for all the hazards our firefighters are exposed to?

For years the fire service relied on carbon monoxide and oxygen readings from basic 4-5 gas detection systems to determine when the use of breathing apparatus could be discontinued and a scene declared safe.

Hydrogen cyanide (HCN) was later added to this list as a result of further research from around the world. And now, with the growing prevalence of cancer among firefighters, more and more studies have identified not only respiratory risks, but also dermal-absorption risks for firefighters from structural PPE.

In addition, the byproducts released though the combustion of household contents means there is now a long list of chemicals that we know of – and some that we don't – that may have an impact on the increased rate of cancer among firefighters.

So, the question is, what can we in the fire service do to protect ourselves against the increased risk of cancer due to these unidentified exposures? And how can we measure such exposures?

NEW 'FIT-AND-FORGET' PORTABLE GAS MONITOR

A portable four-gas monitor that can operate continuously for two years without the need to change sensors or charge batteries has just been launched by Honeywell.

The BW Clip4 monitor uses non-dispersive infrared sensing technology, which consumes 1,000-times less battery power than a catalytic bead (pellistor) sensor, the traditional technology used to detect flammable gases in a portable device.

The wearable device offers simultaneous monitoring of H2S, CO, O_2 and combustibles (LEL) and is ideal for applications such as oil and gas, wastewater, confined space, and heavy manufacturing.

The two-year runtime offers savings in maintenance costs through long battery life and by eliminating repairs and the need to stock spare sensors and units. Once turned on, it runs continuously, helping to drive safety compliance and ensuring that workers wearing the device are protected.

Other features include a real-time display for instant gas readings, even in non-alarm conditions. Current gas concentration levels and changes in atmospheric conditions are also displayed. In addition, the unit generates record and compliance reports automatically via the Honeywell Intellidox instrument management system, and its internal test function tracks battery life and alerts users when the battery requires replacement.

Unfortunately, at this time there is no simple answer. As a profession we are struggling with this issue around the world. Every day, a number of our brothers and sisters receive an exposure that will eventually result in cancer of some kind. This is a fact that is now well known.

So how do we reduce our exposure? As far as respiratory exposure goes, we know that the use of an SCBA in an unknown atmosphere is the gold standard. But how can potential exposures be definitively measured without the use of specialised hazmat-level monitoring equipment at each structural fire, such as a gas chromatograph/mass spectrometer?

With current staff levels and the high cost of equipment, this is something that will likely never happen. Is a 4-5 gas meter with HCN enough? Probably not. Therefore, if fire services are still assessing structures for the discontinuation of SCBA in this way, they are being lulled into a false sense of security – the scene has not been definitively cleared of all harmful agents.

How do we reduce dermal exposure from the many byproducts of combustion? A number of new studies have shown that particulate absorption is prevalent through the neck and groin area of firefighters. Our current PPE has not been manufactured as a hazmat ensemble with limited or no particulate inward leakage or exposure. Firefighting PPE is designed to protect against external heat while allowing for some breathability for comfort. It is also made up of a number of distinct garments, allowing for an influx of contaminants at the numerous interfaces between the layers of our PPE.

What do we do in the short term until PPE controls and standards can be revised to reduce our exposures? One school of thought advocates immediate gross decontamination: the removal of contaminated PPE, quick clean wipes of the face, neck, and groin areas, followed as soon as possible by a full body shower and the proper decontamination and cleaning of structural firefighting PPE, either in house or outsourced.

However, is this practical and cost effective? That all depends of the degree of risk that fire services are comfortable with. However, the US Interagency Board for Equipment Standardisation and Interoperability has compiled a position paper and a white paper on this topic with recommendations that continue to be of paramount importance for fire services nationally and internationally [(1)(2)].

These recommendations include:

- Comprehensive identification and quantification of the hazards, threats and risks to human health presented in the post-fire environment.
- Efficacy of current respiratory protective equipment in the post fire environment, and identification of alternatives if necessary.
- Determination as to whether currently available air-purifying respiratory protective equipment may have applicability in the post-fire environment when used in conjunction with commonly available basic gas detection technologies.
- Efficacy of structural firefighter protective ensemble against identified dermal hazards and potential workable enhancements that would reduce skin absorptive risks.
- Development of a set of mitigation strategies and PPE selection guidelines based upon the above findings.
- Efficacy of methods and determination of best practices for decontamination (including field expedient decontamination) from post-fire hazards.
- Identification of man-portable or vehicle-transportable detection and analysis capabilities capable of identifying and quantifying the full spectrum of risks to responders and the public.

Firefighter health issues are serious and need to be addressed, and we are fortunate in the current time to have government agencies, universities, and funding all working to identify and resolve these risks moving forward. It may not happen quickly, but as time goes on our profession will become much more informed about the risks our firefighters are facing on a daily basis, and therefore much safer.

(1) www.interagencyboard.org/sites/default/files/publications/Evaluation%20of%20Hazards%20in%20the%20Post-Fire%20Environment.pdf
(2) www.interagencyboard.org/sites/default/files/publications/Recommended%20Actions%20Related%20to%20Reducing%20the%20Known%20Risk%20of%2Cancer%20in%20FFs_0.pdf

ABOUT THE AUTHOR:

Chief Tim Dorsey has been in the fire and rescue service for 30 years. He serves as chair of the Missouri State Fire Safety Education/Advisory Commission in the Office of the State Fire Marshal and is the Equipment Sub Group State/Local co-chair on the Federal Inter Agency Board. Dorsey has instructed internationally in various disciplines including water/swiftwater rescue, rescue boat operations, firefighting, EMS, hazardous materials, and technical rescue. He has been an adjunct instructor with the US National Fire Academy, and master instructor with the USA Rescue Network, amongst others. Dorsey also serves as a rescue team manager on FEMA/Missouri US&R Task Force 1. He was awarded the Missouri Public Safety Officer Medal of Valor in December 2015.

Chock-a-blocks

A new take on a traditional vehicle stabilisation device offers improved options for dealing with modern vehicle constructions and technology at road traffic collisions, reports David Dalrymple from Roadside Rescue.

As rescuers we know we need to secure the vehicles involved in a motor vehicle crash. And, as rescuers, we know that most motor vehicles involved in a crash end up upright with the vehicle sitting on its wheels.

Normally we grab a wedge to chock a tyre and four step chocks to stabilise the vehicle. A decade or so ago, this was no problem. Step chocks slid right under the vehicle and we could knock a wedge to make them tight or deflate the tyres, or both, to make the vehicle rock solid to put tools to.

But how about today? Everything from low profile tyres, wider rims (more than 50cm in some applications), run-flat tyres, and tyre pressure monitoring systems with steel valve stems have changed the tyres and wheels in vehicles.

And what about the ride height of vehicles? Early in the 2000s, we saw the influx of SUVs and pickup trucks, but now we are seeing new trends. To assist with mileage and performance, vehicles have become lower to the ground. On some models the bodywork has been designed to make the vehicle edges even lower.

Added to this is the way vehicles are now constructed and their ability to absorb crash energy, especially from the front and rear, to allow the structure to crush and redistribute that energy throughout the vehicle. This even includes the drive train dropping down on the ground and the tyres deflating.

All this makes a difference to us in many ways. Let's start with the most basic principle – vehicle stabilisation. How far can you get those step chocks in today? One, maybe two steps? And then they might stick out far enough to become a trip hazard, or even get in the way of simple door or side evolutions.

However, let's take a different approach to this issue and consider a different kind of chock – a quick chock.

The quick chock consists of two pieces. The first piece is a platform of three or four 4×4 cribs, 18 inches (46cm) long, screwed and glued together with a top plate of 0.5 inches (1.25cm) plywood screwed on top of the platform. The second piece is a 6x6 or 4x6 wedge approximately 18 inches (46cm) long. You can build these easily in the station.

The quick chock is placed under the vehicle like step chocks, with the platform being the base and the wedge driven in between the platform and the vehicle underbody. This allows for rapid set up and a flexible approach.

Depending on ride height and vehicle damage, you can add or subtract parts to fill in space to stabilise the vehicle. The nice thing about the entire system is that it is flexible, fast, and easy to apply.

We should always ensure the vehicle is stabilised, even if the drive train is on the ground. We can use the wide wedges behind the front tyres and slide the platform and wedge in front of the rear wheels. This not only gives flexibility but we can also place our stabilisation flush against the vehicle and achieve greater contact with the vehicle and the ground.

Once you've made them, there are other ways you can use quick chocks in operations. First, we can use the platform for when we need to cross-ram the vehicle interior. This way we can spread the force from the ram head out. We can also use

Above and left: jack rabbit pads from Turtle Plastics are a version of the quick chock made from recycled plastic.

Turtle Plastic's jack rabbit pads are made so that many of the various strut system bases can nest in the pad to spread the base of contact.

more than one platform at a time to gain height when faced with an SUV or pickup truck. We can even use the platform for smaller lifting bag platforms.

In addition, the wedges can be used when we're faced with a damaged vehicle that's very close to the ground, either alone or on top of single cribbing. And, since the wedges are larger, we can use them to chock larger vehicle tyres.

Technology has stepped up to the plate in this area. Turtle Plastics has developed recycled plastic versions of quick chocks that are even better. Called jack rabbit pads, from the company's Dura Crib range, these platforms not only allow for a variety of width and length of wedge, but also for a variety of cribbing for nesting in height.

Tom Norton and Kristin Saez from Turtle Plastics have been instrumental in helping to develop a specific version for motorsports use, with a large-toothed wedge the width of the pad in a grooved arrangement so the wedge slides forwards and backwards while staying married to the jack rabbit pad. It is a low profile platform with a large-toothed wedge on top that can be pushed forwards to make it tight.

Another nice thing about making the jack rabbit pads out of recycled plastics is the ease of clean up after an incident. Plus they are made so that many of the various strut system bases can nest in the pad to spread the base of contact.

While step chocks are still useful, quick chocks are a better option with today's vehicles, offering enhanced flexibility for our cribbing tasks at a motor vehicle crash.

Wooden chocks and wedges are still very popular with fire services all over the world.

SAFE EXTRICATION WITH THE WAUK BOARD

The Wauk board patient dolly from Med Alliance should be the standard of care for the extrication of patients with or without evidence of spinal cord injury, according to Dr Gregory R Brammer, EMS training specialist from the Greater Seattle area.

Dr Brammer has reviewed every major extrication device on the market, including stretchers, scoop stretchers, and backboards, and believes that the Wauk board is the superior option, in part because it is a patient dolly..

'This allows first responders to roll patients downstairs and out of tight spaces rather than carrying them. This prevents back injuries to first responders. Any time a first responder has to carry a patient that must remain supine, they can now roll them using the dolly function of the Wauk board.'

The Wauk board's footrest prevents patients from sliding off the board when they are moved from a horizontal position. 'The patient straps can therefore be tightened snugly rather than tightly, which prevents aggravation of a patient's injury and avoids any breathing restriction.'

The Wauk board also requires very little room to evacuate patients. Using the dolly, first responders can lift patients into a vertical position, creating a small footprint for extraction from tight and restricted spaces.

The Wauk board also floats, making it ideal for use in flood and water rescue conditions. The device's total capacity is 500lb.

VIRTUAL REALITY YOUNG DRIVER INITIATIVE

Devon and Somerset FRS in the UK are piloting a road safety initiative using virtual reality headsets to educate young drivers before they get behind the wheel. The initiative aims to improve the safety of all road users by driving home the dangers of mobile phone use when driving.

The VR headsets allow wearers to experience the distraction of using a mobile phone at the wheel inside convincing virtual surroundings.

Watch Manage Dan Searle, who works in Community Road Safety for Devon and Somerset Fire and Rescue Service, said: 'The VR headsets encourage dynamic conversations with both new and young drivers with the intention of forewarning them, resulting in safer young drivers on our roads. The early valuation of these headsets shows that this does change behaviours.'

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NAME: IAN DUNBAR
AGE: 42
JOB DESCRIPTION: INDEPENDENT RESCUE CONSULTANT, ACADEMY OF PROFESSIONAL DEVELOPMENT

What is the best thing about being a rescue instructor?
The ability to positively influence an individual's performance, understanding, and behaviour. This doesn't necessarily mean they have to come around to your way of thinking, or do things your way. But rather that they feel empowered because you have been able to make them better at what they do simply by promoting open discussion and providing a wide range of mental and physical tools.

What is the main mistake you see students make?
Students often formulate opinions based on misinformation or lack of evidence. This means there are sometimes barriers to learning, which have to be overcome before development can really begin.

What should they be taught instead?
Students need to understand that misinformation is all too common in the rescue industry. People and companies often make claims that are false or misleading to gain a commercial advantage. In rescue this can have negative consequences. Personal opinion is fine but must not be taken as gospel. Listen to what people say, consider it, check the facts and see if it is useful within your professional context.

What do you see as the main strategic development in rescue training at the moment?
The use of social media has helped enormously. It allows the sharing of ideas and concepts. In the future, new technologies such as augmented reality will assist in the delivery of rescue training.

What is your favourite rescue tool and why?
The human brain – it is capable of so much and can be easily adapted to all situations. It is the ultimate multi tool.

What sets your rescue discipline apart from others?
Unlike many rescue disciplines, vehicle extrication has so many uncontrollable variables. This means that extrication training can only be partially specific and there is a lot of space for personal interpretation. Whilst this can be a good thing, it means that everybody has a view on the best way of doing things. To the inexperienced, this can be overwhelming and confusing.

What is your rescue mantra?
'The most important thing about knowledge is passing it on.'

What is your favourite rescue quote?
'Every patient deserves the best of your skills, knowledge, and application.'

What makes your training academy the best in the industry?
The focus on users – understanding the challenges they face and developing innovative tools that help them perform safely, quickly and easily. Teaching people in a non-didactic manner, based on theory and proven practice and allowing them to share their knowledge and experience.

NAME: DAVID DALRYMPLE
AGE: 52
JOB DESCRIPTION: LEAD INSTRUCTOR AT ROADWAY RESCUE

What is the best thing about being a rescue instructor?
Knowing that my students take away what they have learned from me, no matter on what level, and use that knowledge to save lives. Whether that's on an interstate highway, a special stage rally, or on a high peak in Afghanistan, knowing that they are using what I have taught them is a very humbling experience indeed.

What is the main mistake you see students make?
I would have to say today's new recruits believe in the 'one school' rule – that they only need attend one programme and they become experts in the field. Trying to bring these students into the fold can be frustrating at times.

What should they be taught instead?
Reaching these students takes a combination of technology and approach. If I could make a PS4 or Xbox One game on vehicle extrication, it would help tremendously. Technology wows this type of student, so instructors need to embrace technology and develop new ways of delivering the message.

What do you see as the main strategic development in rescue training at the moment?
There is a major switch in the type of presentation and the industry is embracing technology to assist with the mode of delivery. When I taught for ICET (Netherlands) in the early 2000s, they were big on 'telling the story' – not simply reciting the facts but bringing the material to life. That left its mark on me because students can grasp stories much better than facts alone. Even today corporate trainers use that same mindset but call it TED.

What is your favorite rescue tool and why?
I have many go-to tools for educational programmes. For power hydraulics, I'd have to say Holmatro. They are constantly developing tools and challenging norms. I like Diablo blades and Dewalt saws for reciprocating saws. Dewalt is a personal favourite, and Diablo Demon blades are the only blades I know of that can defeat UHSS, boron, and similar alloys nearly every time. And CRS on my iPad and on my Note5 – I never leave home without them. Where else can you have the entire vehicle database back to 1989 in the palm of your hand, and the ability to look up vehicle hazards?

What sets your rescue discipline apart from others?
We show our students that technology is the rescuer's friend not foe, and how it can assist at the scene. We've also used patients, be it live or simulated, in every practical programme since the very beginning. How can you focus on the patient without representing them in some way? In addition, the use of multimedia, especially with new vehicles, demonstrating tool evolutions on new vehicles, and sharing this information across the various programmes we deliver, ensures they are always timely, fresh, and up to date.

We also teach tool evolutions that work on today's vehicles as we have had the opportunity to extricate new vehicles on a fairly regular

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basis. We show what works well today and what doesn't. Plus, we preach common sense.

So, in a nutshell, our students receive commonsense, patient management-driven, technology-focused vehicle rescue education. We don't just teach extrication, but also a rescue discipline and mindset. This isn't just training, it is education. And we always strive to ensure a better patient outcome.

What is your rescue mantra?

'Speed is life, baby!'

What is your favorite rescue quote?

'Preparing you for your day on the highway.'

What makes your rescue company the best in the industry?

We strive every day to further our collective knowledge of vehicle rescue and improve what we do, be that on the street, on the race track, or a rally stage. We also enjoy what we do. Every year we go to the New York International Auto Show. We look at the vehicles, look for changes, and talk to the various manufacturer representatives. I also belong to the Society of Automotive Engineers and this gives me insight into new technologies. Motorsport-wise, we belong to various bodies and participate in racing events, either as responders or spectators.

We are truly immersed in all areas of vehicle rescue, but there are also other factors. For example, we've been using a drone for class photography for two years now. We have also started to use miniature video cameras and 360° cameras on tools and inside vehicles to gain better multimedia clips for our classes.

Wildland extrication heroes

As the threat of wildfire increases worldwide, there is a growing need for wildland fire paramedics with high-angle rope rescue capability. These highly trained professionals are deployed to wildland fires in case someone in inaccessible terrain sustains a serious injury, writes Michael Davis.

Change comes slowly in the fire service, and often at a high cost. Each of the ten standard firefighting orders and 18 watch-out situations in the US wildfire '*Incident Response Pocket Guide*'[1] is there because someone paid a price, in some cases the ultimate price, to learn that lesson.

So it should come as no surprise that wildland firefighters have suffered and died because no one thought about how to get them out of the hellish places they go into to fight fires. A physically fit 20-something hotshot can traverse the steepest ravine and bushwhack his way through just about any tangle nature can throw at him, but what if once he's there, something goes wrong? What if he breaks a leg? What if he is bleeding, or can't breathe? Now what?

On July 25 2008, Andy Palmer hiked down a steep dozer line (a fire line constructed by a bulldozer) on the Eagle Fire, part of the Iron Complex in California. He had graduated high school the month before, and although he'd only had a month of training, he was there as an Olympic National Park firefighter on his first wildland assignment.

Palmer was young and strong and made his way into the area without difficulty, but shortly after arriving things went terribly wrong. Another faller, also lacking proper training, tipped a huge Ponderosa Pine. As the big tree fell, it struck a second tree. The impact caused the upper portion of the second tree to snap off and fall up-slope, toward the saw crew.

When the section of timber hit the ground, it shattered into five pieces. One of these pieces struck Palmer, fracturing his right shoulder and crumpling his left leg. Palmer's femur was shattered and he was bleeding profusely.

Suddenly, this tough young firefighter was in desperate need of medical care and extraction, but no one on the fireline knew what to do. Members of his crew took off their shirts and held pressure on his shattered leg in a futile attempt to staunch the bleeding. They made frantic radio calls for help.

In structural firefighting, there is a rapid intervention team standing by. If you get into trouble and call in a mayday, the RIT team will come to your aid, but in wildland firefighting there are no rapid intervention teams. Palmer's fate was in the hands of the firefighters on the line with him, and they were ill-prepared for the task. They argued over the best way to get him out. Should they hike him out? Call for a chopper? Amid this indecision and chaos, Andy Palmer's life ebbed away.

The accident became known as the Dutch Creek Incident, and today it is used as a case study in wildland classes across the US. While the young firefighter's injuries were severe, they need not have been fatal. Dutch Creek and other avoidable fireline tragedies were the impetus for the development of the Rapid Extrication Module (REM) concept, wildland fire's answer to the rapid intervention team.

In January of 2015, a Firescope Task Force representing California Fire Service developed the '*Rapid extrication module support manual*'. The handbook lays out minimum qualifications and staffing for an REM.

The first documented use of an REM was in September 2015, on the Rough Fire, near Fresno, California. A member of a hotshot crew working in a remote area suffered severe burns. Rough terrain made access by vehicle impossible. The

The wildfire Rapid Extrication Module combines advanced medical care with high-angle rescue technicians.

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patient couldn't walk and was in terrible pain. He needed to get to a hospital as quickly as possible, but if his crew had tried to carry him out it would have put both them and their patient in considerable danger.

An REM was dispatched and was able to extract the firefighter safely while providing pre-hospital care. The team transported the patient to a field ambulance on a dirt track. The ambulance drove him to a temporary helispot, where he was loaded and flown to a nearby hospital.

Currently, there are only a handful of REMs across the US, but the concept is gaining acceptance. And some in the wildland medical community are working to take the REM to the next level.

One of these is wildland firefighter and fireline paramedic Amy Lynn Evans. When Evans was deployed to fires, she and paramedic Jeran Brands would run 'what if' scenarios in their down time. 'We would ask ourselves: ''What will we do if someone gets hurt on the other side of that ridge? How will we get there? How will we treat them and how will we get them out?'''

Brands' experience working with Army special operations medics and his military hoist operations training allowed him to contribute unconventional rescue and patient care ideas.

Evans said that when the REM concept was unveiled, the marriage of technical rescue and advanced medical care seemed to her like a natural progression. After all, it was what she and Brands had been planning in the 'what if' scenarios they had been running.

Phil Wurr, a captain with the Phoenix Fire Department, had already talked with Evans about creating an advanced medical team for wildland fire. She shared her thoughts on the REM concept, and the idea gained momentum. Rick Hiltner and Christopher Krechmar, two top flight Level 3 SPRAT-certified [2] high-angle rescue technicians, joined the conversation. After a great deal of work and planning, Wurr, Evans, Brands, Hiltner and Krechmar formed the Paramedics Unlimited Wildland Fire Rapid Extraction Module.

The Paramedics Unlimited (PU) REM is based on the Firescope REM model, but it goes further. Where the guideline calls for a two-person team, trained to the level of emergency medical technician and capable of providing basic life support, Paramedics Unlimited field a four-person team with two qualified fireline paramedics who can deliver advanced life support.

The PU team also carries an EKG (electrocardiogram), enabling 12-lead cardiology diagnostics in the field. They also pack equipment needed to manage advanced airways, IV therapy,

Currently there are only a handful of REMs across the US, but the concept is gaining momentum.

Paramedics Unlimited's Wildland Fire Rapid Extraction Module has to be requested by incident command.

intraosseous access [3], and drug therapy including narcotic pain management. Equipment includes a SKED (a specialised high angle and technical rescue stretcher), backboard, and splinting equipment.

On the rescue side, the team brings two expert high-angle rescue technicians. They arrive in a four-wheel-drive, off-road vehicle carrying a specially outfitted ATV. Their rescue packs include rope and hardware to build rescue lines capable of hoisting or lowering a patient, and accessory equipment, webbing, harnesses, and hand tools.

Each team member comes with advanced training and in the best possible physical condition. They must all complete the NWCG Pack Test (three miles with a 45lb pack in under 45-minutes), then undergo an endurance test adapted from the smokejumper and hotshot training regimens.

'I never want to have to try to explain to someone that I couldn't save their loved one because I wasn't in good enough shape,' says Amy Evans. 'I want the firefighters to know that when no one else can get to them, we can, and when we get there, we can do things others can't.'

It took months of planning and work for the team to form and overcome the obstacles they faced, including paying for equipment and securing assignments, but the Paramedics Unlimited Wildland Fire Rapid Extraction Module is available this fire season. They are private contractors and have to be requested by incident command. The team is meeting with incident commanders and foresters across the region, getting the word out about who they are and what they can do.

Evans is confident that Paramedics Unlimited will be a success, and hopes that rapid extrication modules will be used at all large wildland incidents in the future. She sees the potential to save lives, reduce suffering, and give injured wildland firefighters a chance for a better medical outcome as a result of advanced pre-hospital care and rapid transport to medical facilities.

'I don't think of it as my idea,' says Evans. 'This is a model that can benefit the wildland fire community as a whole. I hope others will follow our example. It's not about money, it's about saving lives. If we can save just one person, then it will all be worth it.'

It is hoped that rapid extrication modules (REM) will be used internationally at all large wildland incidents in the future.

[1] The Incident Response Pocket Guide is published by the National Wildfire Coordinating Group (NWCG) and is required equipment for every wildland firefighter. It contains sections and on operations, hazards, aviation, and numerous reference guides. The 10s and 18s are prominently listed on the back outside cover for quick reference.

[2] SPRAT: The Society of Professional Rope Access Technicians is a member-driven organisation that advances the safe use of rope access through education, standards development, and administering certifications.

[3] Intraosseous access is the process of injecting directly into the marrow of a bone to provide a non-collapsible entry point into the systemic venous system.

ABOUT THE AUTHOR:

Michael Davis is a firefighter and public information officer with the Elk Creek Fire Protection District in Conifer, Colorado. He also serves as lead public information officer for the Colorado Wildland Fire and Incident Management Academy, as well as being part of the Jefferson County Type III Incident Management Team (Jeffco Type III IMT).

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Intelligence gathering

Global warming is changing the nature of wildfires but the advancing technology of drones and fire-prediction software is helping fire services keep pace with the threat. Jemma Dempsey reports.

Drones are proving to be an invaluable tool for fire and rescue services around the world in the fight against wildfires. These are burning hotter and longer than ever before, and while many principles of wildland firefighting are still valid, the changing nature of fires is forcing the industry to consider new techniques.

Research carried out by Colorado University suggests that the western United States has entered a 'new era of wildfires'. Average temperatures are now 2°C higher than in the 1970s, and the burning season is nearly three months longer. The growing number and intensity of these fires is just one of the consequences of global warming. Warm air carries more moisture, which dries out vegetation, helping to create tinder-dry fuel in areas like the western US.

'Wildfire is catching up with us,' says Dr Tania Schoennagel, lead author on the research. 'For a long time we've thought that if we try harder and do better, we can get ahead of wildfire and reduce the risks. We can no longer do that. This is bigger than us and we're going to have to adapt to wildfire rather than the other way around.'

There are now various programmes underway to evaluate the effectiveness of drones in the US. The Big Cypress National Preserve in Florida is in the early stages of a pilot programme that aims to reduce firefighter injuries and death.

A study from Centers for Disease Control and Prevention found there were 298 wildland firefighter fatalities between 2000 and 2013. Consequently there are strict safety guidelines have to be followed during all phases of firefighting, and this is where drones come in.

'Drones are a way of gaining intelligence while lowering risk for firefighters,' says Jordan McKnight, chief of fire operations at Big Cypress. 'Smoke issues and wildland-urban interface tend to raise the complexity of fires and increase risks. Managing those and keeping firefighters safe while balancing fire benefits with liabilities is of ongoing interest to me.'

The gathering of intelligence is where drones are revolutionising the industry. Tim Murrell, group manager at Lancashire Fire and Rescue in the UK, says moorland fires often start at around 16.00 when the heat of the day is at its height. Geography is the main problem his teams face.

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Various programmes are underway in the US to evaluate the effectiveness of drones.

'The fire could be three or four miles away from the nearest road. By the time we've got there and are ready to start firefighting operations, it is starting to get dark. We tend not to fight fires on the moor in the dark because they are dangerous places. If the wind changes, the fire can change direction, and firefighters can get hurt. If we put the drone up as the first strike, we can work out our tactics and whether or not we wait until the morning.'

Jordan McKnight says small, crew-packed drones have real potential to improve intelligence in places like Florida where there is no elevated ground for lookouts. 'Drones could make a significant impact in helping our crews observe how the fire is behaving near them, and scouting unburned areas for spot fires. Larger reconnaissance drones could have an impact at fire management level, replacing air attack platforms and live streaming real-time imagery to incident command.'

Image clarity and immediacy are at the heart of the issue, and how quickly the live stream or images can be relayed for interpretation. That depends on the payload of the drone. Murrell explains that Lancashire has thermal imaging with normal electrical optic payloads as well as zoom payloads, and these are critical for instant situational awareness.

'Our drone can zoom in and can give you a number plate up to a kilometre away. You don't need to fly the drone to where you need to get to if you've got a good zoom.'

Good thermal imaging is also critical. Lancashire's heather moorland can disguise stubborn hot spots, but these are easily picked up with infrared. This was proven with a recent fire. 'We were coming off the moors thinking we had extinguished the fire, when the incident commander sent the drone over one last time and it picked up hot spots,' says Murrell. 'So we went back. If we hadn't, the fire would have shown itself again through the heather in another 30 to 40 minutes and we would have had to start again.'

Drones can't anticipate the movement of fires, but new technology coming out of Australia is seeking to change that.

Australis is the brainchild of Professor George Milne from the University of Western Australia. It is an interactive wildfire simulator that forecasts the progression of wildfire across a landscape, and projects it as a series of fire perimeters, called isochrons, onto a map. It is already being used as a predictive aid for wildfire incident management by the Department of Fire and Emergency Services for Western Australia, which has fires burning every day of the year.

Created to run without an internet connection, Australis can be used even in remote WA where there is no coverage. And the technology has been proven, says Professor Milne. 'We have validated it against historical fires where there is good data. These are generally where fatalities occurred and a detailed fire history is prepared by fire behaviour experts for the coronial inquest.'

The feedback from fire chiefs has been positive, as Australis offers an improvement over manually looking up tables to estimate the direction of a fast moving fire. With Australis, this calculation only takes a minute.

It not just Australia backing this technology. Professor Milne attended the 14th International Wildland Fire Safety Summit in Barcelona this February and says there was interest in using the Australis system to manage moor burning in the UK.

Grouse moors in Scotland and northern England are managed carefully to support healthy populations of grouse and so generate significant shooting revenue. Burning takes place when the heather has no moisture and grouse are not nesting. But, as Professor Milne notes: 'If you set lots of patches of dry heather on fire you run the risk of escapes. So our Australis system could estimate how a fire would progress if set on a given day with a given weather forecast.'

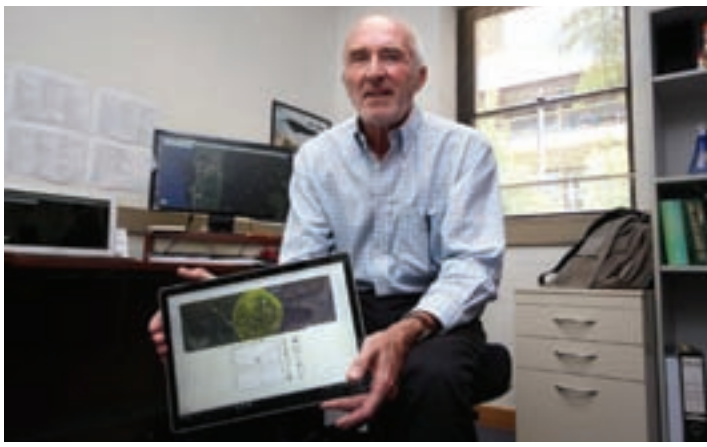
However, drones are not a one-size-fits-all technology. It is critical to get the spec right to take account of how and where the drone will be used.

'Drone quality for wildfires has to be superb,' argues Lancashire's Tim Murrell. 'We are a coastal brigade, and if we put a cheaper drone up it would be operating way beyond its safe parameters. The new DGIs, for example, look fairly weatherproof, but they can still only fly in winds of up to 12 metres per second. That's nothing. With wildfires on moorland, there are thermals and increased wind speed to deal with, and that's just coming from the fire. So it's really important to invest in the right technology, because if it can't handle high wind speeds it is a waste of money.'

The drone of choice for many fire teams is the Aeryon Skyranger, a military spec product from Canada launched in 2013. It is not cheap – Lancashire Fire and Rescue paid £60,000 (US$78,000), and that's without the add-ons. Then there's the cost of putting a drone unit together. These need two pilots and a liaison officer, as flying the drone creates a massive strain on the eye so regular breaks are important.

Ultimately drones enable fire chiefs to make better decisions, earlier, thereby reducing the number of times crews are sent onto the moors. There's a knock-on effect on resources, as fire services can send fewer appliances and crews if they know exactly what they are up against. For Jordan McKnight in Florida, this potentially means fewer manned flights, reducing costs and eliminating a risk factor.

'Our drone allows us to be more effective,' says Tim Murrell. 'Lancashire had some of the biggest wildfires in the UK a few years ago, and we were up on the moors for weeks on end trying to put out the same fire. We don't need to do that now because the drone has changed the way we operate.'



Interactive wildfire simulator Australis forecasts the progression of widlfires across the landscape. Pictured is Prof. George Milne from the University of Western Australia.

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