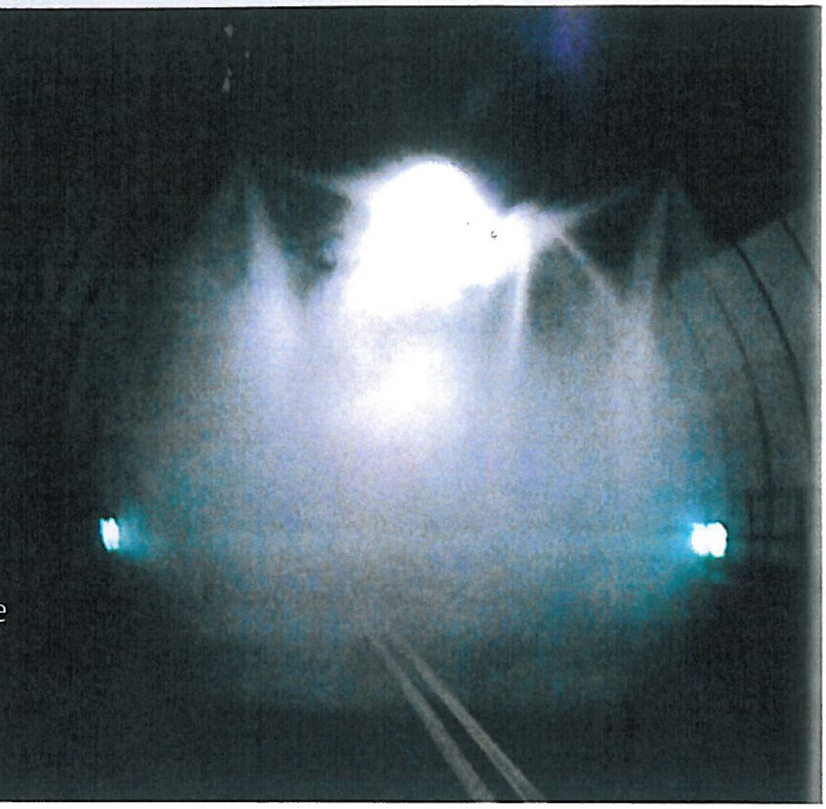
# Rome in the mist



From small to large scale, the growing applications for water-mist suppression systems were in evidence during the International Water Mist Conference that took place in Rome in October, reports Jose Maria Sanchez de Muniain.

The establishment of high-pressure water mist as the preferred technology for bus-engine fire protection in Australia was the focus for Mick Cory of Firestorm, who first introduced the technology in mining vehicles in the country around nine years ago and who has been involved in every major tender for engine-bay protection for buses in Australia ever since.

Cory was first alerted to the concept of using water mist for engine-bay protection by Andreas Svensson, MD of Swedish manufacturer Fogmaker. The system is powered by a piston accumulator, pressurised to around 100 bar; when thermal activity busts a detection tube, the loss of pressure opens a valve that then activates the fire system which leads to the discharge of high-pressure water through stainless steel tubing and through to the misting nozzles. Discharge at the nozzles is typically 0.8lpm to 3.5lpm, consisting of droplets of water only 50 microns in diameter. Discharge also results in activation of a pressure switch that causes an alarm to alert the operator that the system has deployed.

Convinced by the concept, Cory introduced the systems to the underground mining industry, who 'almost immediately' welcomed water mist's compact dimensions. "Typically we could do with four litres of water mist what others would struggle to do with 30 litres of foam on underground machines and 36 litres of water what others struggled to do with 360 litres of foam.

Several hundred systems were installed in only two years on vehicles such as autonomous dozers, large wheel loaders and other mining plant.

At around the same time, a spate of bus fires had pushed the need for a solution to be urgently sought, resulting in the establishment of a bus and coach industry fire mitigation advisory group to establish the risks associated with bus fires and consider ways to reduce that risk. A major recommendation that ensued called for the installation of engine-bay fire suppression systems.

Engine-bay protection for heavy industry vehicles is, however, quite different to that for commercial vehicles, emphasised Cory. Mining industry vehicles are made of heavy steel, with typically one occupant on board, the machines were built with fire mitigation standards such as fuel and heat segregation in place; in addition, the environment they work in is generally not exposed to other traffic influences. Buses, on the other hand, contain flammable structures of fibreglass, textiles and plastics with human cargo. Moreover, said Cory, "The bus industry lacked some basic segregation techniques and fire suppression systems were not widely accepted."

Next year's IWMC will take place in London, 19-20 September. Top: testing the water-mist system in the Dartford Tunnel, London.

Buses continued to burn at an alarming rate, said Cory, and in 2010 the Western Australian government issued a tender for the first major retrofit of high-pressure water-mist systems, to be installed on 475 compressed natural gas-driven buses. Another tender followed in 2011 for 250 buses in Sydney, and another again for Sydney in 2015, for 1,300 buses, this time with a preference for fire systems listed under Rise's P-mark.

Having been awarded all these contracts, Cory outlined some of the challenges presented by retrofitting 14 different bus designs over 1,300 buses in a 12-month period. One significant hurdle was the alignment between Firestorms' processes in design, engineering and installation, which were in accordance with the Australian standard AS 5062-2006 Fire protection for mobile and transportable equipment, and those stipulated by the P-mark, which call for more extinguishing agent and more nozzles. "This, in my opinion, is a good thing, as personally, I felt more comfortable with more agent and more nozzles to satisfy the additional risks."

The pressure on Firestorm increased further when, with over 1,100 bus installations completed, a bus caught fire on the famous Sydney Harbour Bridge during peak-time traffic. The fire, which involved one of the yet-to-be-protected buses, moved the government to issue the largest fire tender on buses in Australia, a 2,250-bus retrofit project, again under the P-mark, and with a 10-month completion time. The challenging retrofit required over 250 different types of system design, excluding an additional 100 additional designs for 'orphan buses' with one-off designs. "The biggest challenge was the insane time frame. We had minimal stock in Australia so we put our Swedish comrades to work producing monthly shipments by air and sea." At the peak of the project, Firestorm would install 300-plus fire systems per month to satisfy the timeline. The project was eventually completed ahead of schedule.

Notwithstanding these efforts, a report issued by the Office of Transport Safety Investigations in 2016 showed that the number of bus fires and thermal events was continuing to increase. "In my experience, there are many reasons for this; they may include poor maintenance, ageing fleets, poor practices, a failure to recognise potential fire risks, minimal or no fire risk segregation, higher pressures and myriad of other reasons. Place all this underneath a combustible body, and you have a recipe for disaster. It is an ongoing challenge to ensure our buses are safe from fire, but it will take more than a fire system to achieve this. It is a holistic approach which everyone in the bus industry is working hard on!"

Concluding, Cory mentioned that he was awaiting news on a further tender for 2,600 fire systems on buses in New South Wales, which reiterated the acceptance of high-pressure water mist as the preferred technology for bus-engine fire protection. "The future of water mist fire protection in Australia is bright."

Witness and proving testing for water mist systems was the subject of the presentation by Gary Howe, senior fire protection engineer at Zurich Risk Engineering. The importance of proving testing was quickly realised by Gary Howe when he first started working with water systems over five years ago when he was witnessing a 90% failure rate of systems. "Seeing pipework blowing apart, deluge valves not operating, detection and solenoids failing to operate. Multiple areas that eventually resulted in failure to deliver water at the correct pressure and flow out of the nozzles."

Commonly, at the final stage of system commissioning, the authority having jurisdiction takes at face value that a water-mist system is fit for purpose. "Their level of involvement and mine are poles apart as regards what I deem to be acceptable sign-off criteria."

Zurich's process to assess any water mist in the field consists of seeking answers to three questions: is the system in service? Will it work? Is it designed right?

The answers are not as straightforward as they may appear. Site visits commonly reveal poor installation practice, valves closed, as well as incompetent contractors and incorrect designs, amongst others things. "And I wish I had a pound for every time I've been told not to worry and that everything has been signed off by the contractor and that you will find nothing wrong!" said Howe.

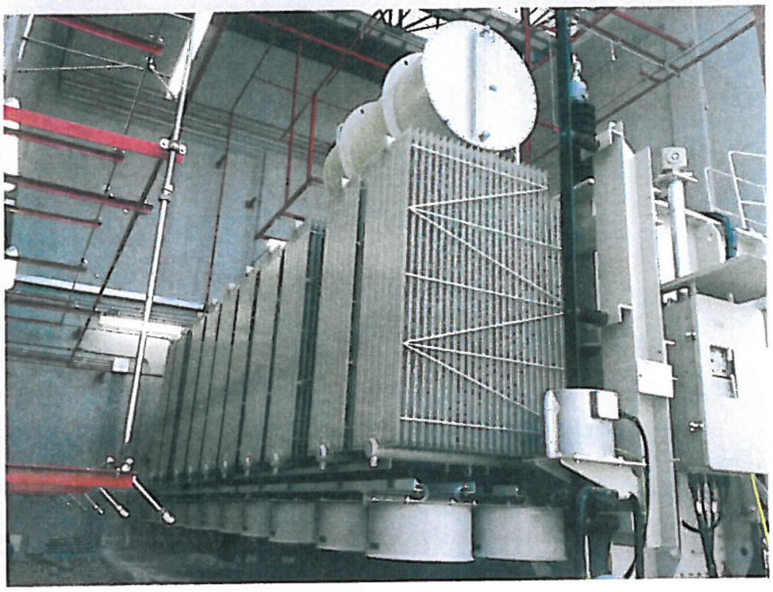
A satisfactory answer to whether a system will work or not can not be provided by paperwork, emphasised Howe, the system has to be functionally witness-tested and proven as fit for purpose, however inconvenient that may be. "Will it work doesn't just mean looking at a plethora of commissioning certificates issued by the contractor." These provide a false sense of security and prove nothing.

The third question 'is it designed right?' is answered by looking at the system's design, installation and operation manual and whether it is underpinned by independent specific performance-based fire tests.

This approach was demonstrated in the context of a number of projects, including a major tunnel on one of the busiest highways in Europe, the M25 motorway around


Mick Cory introduced the use of water mist systems for engine-bay protection in Australia's buses.

Gary Howe (left) carries out functional testing to answer one of three key questions: will the system work?



One of DEWA's transformers fitted with a high-pressure water-mist system.

London, whose water-mist system had never been tested by an authority having jurisdiction before.

Howe secured the closure of the M25 for two hours so that the system, which is designed to operate in three 25m-long zones, could be tested at different ventilation rates. The condition of the nozzles at ceiling height was also ascertained using a basket crane, "so that we could advise the customer of the correct maintenance, inspection and frequency of nozzle replacement and testing." Three months later a car fire occurred in the tunnel, closing off the tunnel for a few hours. "The water mist system put the car fire out without any problems whatsoever."

As well as in tunnels, water mist systems are increasingly being installed for the protection of industrial oil cookers. Food manufacturers, explained Howe, were increasingly moving all their facilities to a single location which meant that the pressure was on to mitigate business interruption in the event of a fire.

Howe had recently visited a project where 17 such systems had been installed in one factory. "At this particular food factory in the UK, we tested the systems for all 17 fryers. Every single system was discharged and tested functionally, as well as all heat detectors in the filter boxes, under hoods and this also involved testing of the cause and effect matrix including associated conveyor shut downs." All worked according to plan. "The most failures I see related to industrial cookers are down to contractor incompetence."

A number of areas for improvement on the part of owners, manufacturers and installers were also covered. Over-reliance on commissioning paperwork remains all-too-common; design, operational and maintenance manual water mist systems do not take a proactive stance around functional testing at commissioning stage; a joined-up approach is needed in terms of fire detection and suppression. "At a site with a pre-action system where aspirating fire detection operated the deluge valve, one manufacturer said to me: 'It's someone else's problem, the detection side is nothing to do with us.' It's very important that the two sides are joined up [mechanical and electrical], because unless we test the detection we don't know the water mist will work."

Ultimately, whatever choice of fire protection system is designed and selected to protect a risk, it is wise to consult the insurer at the earliest possible stage with details of the proposed system. Most insurers have specialist fire protection engineers who can be contacted for support and advice. Also, property insurers may have additional operational criteria to satisfy their requirements for dependability and performance verification, such as power supply connections, water supply stipulations and periodic test facilities before they accept the complete system for property protection purposes.

"It is important to feel confident that when your fire protection system is called upon in a fire it will work as intended? Perhaps it is time to ask the question of your fire protection system: is it in service? Will it work? And is designed right? If you cannot confidently answer these three questions it is good practice advice to appoint a competent person or registered engineer who has the confidence, knowledge, experience and commitment to take responsibility for undertaking proving and witness testing both at project completion and as part of the periodic maintenance regime."

Ensuring that a water mist system would work on a critical infrastructure project was the subject of the presentation by Ruediger Kopp of Fogtec.

While water mist systems have been protecting transformers for over 20 years, the increasing size of


Fire-test rig built by Fogtec to prove the effectiveness of water mist for Dubai's new large-scale substations.

transformer installations requires a corresponding system to be tested and formally validated. Such an approach was required for Dubai Electricity and Water Authority, whose planned new 132kV and 400kV substations were of such a size that existing certification did not cover them. Consequently, a test protocol was developed for the risk, based on existing protocols from VDS, and with references to NFPA 750 and CEN/TS 14972. To independently validate the system performance following the developed protocol, the testing was conducted by IFAB, an ISO 17025-accredited fire test laboratory, in the fire test facilities of MPA Dresden, with the results assessed by MPA and TUV, both of which are listed by Dubai Civil Defense as accreditation bodies.

A large mock-up rig was constructed to replicate the characteristics and size of the transformers to be protected, consisting of three 7.5m-high surrounding walls and an open, mesh-type front fence and an open top. The mesh fence provided a 60% opening grade to ensure realistic wind conditions of 4-5mps being realised by the two ventilators, as specified by DEWA. The performance criteria defined that all fires had to be extinguished in a maximum of 15 minutes; after another 15 minutes, there should be no re-ignition.

Three risk scenarios were identified for the test: an upper pool fire, representing a spillage of transformer oil at the top of the transformer, simulated with a 4MW pool fire of diesel oil; a lower pool fire, representing a spillage of oil onto the grit soil beneath the transformer, simulated by a 2MW pool fire; and fire flowing from the top to the bottom, a worst-case scenario generating a heat release rate of around 10MW. The upper pool fire was extinguished in 4 minutes, the lower pool fire in 40 seconds, and the flowing fire in less than 12 minutes.

"The third part was the most challenging," said Kopp. "It finally extinguished in 12 minutes. This test was repeated a number of times, without re-ignition. So finally all three tests were passed and the system gained acceptance by the third parties."

Describing DEWA's protection concept, Kopp explained how the high-pressure system acts as a deluge system ie with open nozzles, but it is not automatically activated by the accompanying flame detection system. The trigger for the system is via thermally activated glass bulb elements that connect to the section valve via a hydraulic sensor line. "The section valve opens when the glass bulb breaks, activating the high-pressure pump in the central section of the substation." The section valve can also be activated by a push-button that is routed to the fire alarm panel, or by a manual over-ride fitted to the section valves. The safety concept plans for activation of one transformer fire extinguishing system at a time.

For the first part of DEWA's sub-stations, the high-pressure water is supplied by six pump stations located in the sprinkler pump room, consisting of 4x120 lpm pump units with 100% diesel redundancy. The water is held in 120m$^3$ tanks, of which 15m$^3$ provides 30 minutes of system operation.

The system has been installed on 42 transformers in six new substations. "At the end of the installation a discharge test was carried out for each transformer to demonstrate how the water mist fills the whole space and to reassess whether the whole area under ventilation, is rapidly filed by water mist," said Kopp. He concluded by reiterating that high-pressure water mist was a proven certified solution for ventilated transformers, even on a large scale, and that it provided effective protection but also assured business continuity for the power network and its customers.