sprinkler OUTLOOK

issue 1/2021

Focus on quality

Testing & maintenance

Beating corrosion

Regulatory progress

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I am delighted to welcome you to the first edition of Sprinkler Outlook, the only European magazine dedicated to water-based fire protection systems. It seems that every European country has at least one fire magazine and many have several. Yet none are dedicated to sprinklers. Our conferences have shown that there is an appetite for more information about sprinklers, water mist and foam systems, with attendances growing to well over 300 delegates. Nevertheless not everyone is able to go to a conference so there has always been a case for finding a way to make some of the material disseminated more accessible. Sprinkler Outlook is our answer.

Our intention is to publish once a year, so that each edition can be a reference, giving an overview of the industry at that point and containing sufficient material to be worth keeping. To keep costs down and save paper most readers will have received Sprinkler Outlook in electronic form.

Sprinkler markets tend to follow the health of the building industry. After a dip in some countries in the spring of 2020 this has largely recovered and companies in our sector tell me they are busy. There is plenty of progress to report and we have well over 20 articles in this first issue, from authors in 10 countries. Innovation has continued, with new products and technologies being launched. Some of the most important are presented in this issue of Sprinkler Outlook.

Two such innovations are solutions to prevent corrosion, which we know can be a problem, particularly in dry sprinkler systems. In fact quality assurance is a theme running throughout this issue, with articles on how to maintain compliance, how to conduct inspections and how to ensure systems are properly maintained. Related to that is an article about the SIN system, which was introduced 20 years ago to help identify old sprinklers, a problem discussed in another article.

Standards help define what is a good fire protection system. Online meetings to develop standards work surprisingly well and travel restrictions have made everyone more available to participate. Two articles summarise recent progress with sprinkler and water mist standards.

Some applications need special protection solutions whose effectiveness must be proven by testing. Two articles describe how to protect road tunnels, one using a specially designed sprinkler, the other applying low pressure water mist. Distilled spirits in wooden barrels present a unique fire protection challenge but extensive fire testing has given us sprinkler design criteria for this risk.

A large part of the cost of a sprinkler system is onsite labour. This issue presents the latest innovation to reduce installation time. Cost is hugely important since where their use is optional, sprinklers must be competitive with other fire safety technologies. Sometimes their cost can be offset if sprinklers can justify relaxations in other measures. An Italian fire engineering analysis does this for structural fire resistance, while a cost-benefit analysis justifies sprinklers in a Swedish underground military facility.

Building codes in Europe do not generally require sprinklers and it is the EFSN's mission to change that. Sprinkler Outlook presents recent progress in France, The Netherlands and UK. In Poland a recent fire supports the case for car park sprinkler protection, while in Spain and other countries interest is growing in residential sprinklers. Finally, after well over 100 years the tremendous contribution that sprinklers have made in protecting lives, property and the environment will soon be recognised with the erection of a sprinkler monument in Spain.

This is our first issue of Sprinkler Outlook. I hope you enjoy it and look forward to your feedback.

Alan Brinson
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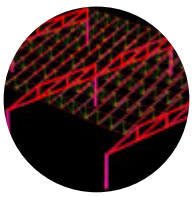
Alan Brinson

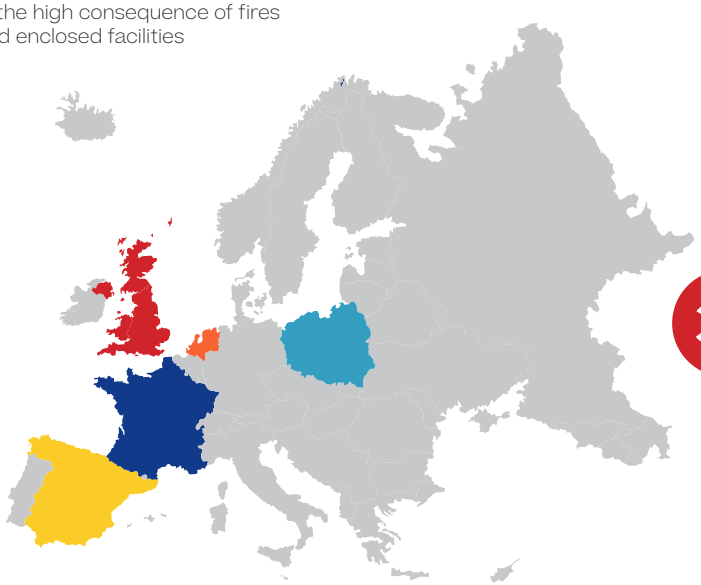
EUROPEAN FIRE
SPRINKLER NETWORK

OUTLOOK

ISSUE 1



REGIONAL REPORTS



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A word from the Chairman of the European Fire Sprinkler Network

Europe's sprinkler market is measured in billions of Euros and employs tens of thousands of people. It is surprising that such a large industry did not yet have a dedicated magazine.

The EFSN has now fixed that and Sprinkler Outlook is one of the good things to come out of this pandemic. There is something for everyone in this first edition and I fully support this initiative.

Volker Bechtloff
Minimax

World's first international sprinkler monument

A two-metre-high bronze sprinkler will be the world's first international sprinkler monument. At the centre of a roundabout on what will be called 'Plaza del Sprinkler' it will greet visitors to Alcobendas, Spain's third largest business city. Alcobendas is just north of Madrid and is the Spanish home to many major multinational companies.

Anselmo Iglesias Poli, a famous sculptor whose monuments are found across Spain, will create the sprinkler. Emilio Rodriguez, owner of Pacisa, a leading sprinkler installer, has secured all the approvals. While he will guarantee the project, this monument will help to publicise the sprinkler concept and as such should ideally be a broad sprinkler initiative funded by as many parties as possible, all of whom will be recognised on the sculpture.

For more details please contact Emilio.Rodriguez@pacisa.es

Fire protection for distilled spirits in wooden barrels

Distilled spirits are produced in a vast array of styles, flavours, and alcohol concentrations. Whether they are created for immediate consumption or a collector's shelves, they are all stored in warehouses at some point. Failure to adequately protect these warehouses against fire could cost the manufacturer not just the value of the building's contents, but customers as well.

In this article John LeBlanc describes an FM Global test programme which determined adequate water-based fire protection for distilled spirits stored in wooden barrels. Storage arrangements included palletised and rack storage of wooden barrels filled with high-proof alcohol.

What is the Hazard?

When evaluating the hazard created by the storage of an ignitable liquid (e.g., alcohol), three things must be considered:

1. The fire properties of the stored liquid.
Ethanol is a water miscible ignitable liquid that will burn. At near 100% concentration, it has a flash point below 38°C, which means (1) even at room temperature, a relatively weak ignition source can easily ignite a spill, and (2), once ignited, the fire will quickly spread across the entire surface of the spill. The heat release rate of a pool fire is in direct proportion to the exposed area of the pool, so a fire will keep growing as more liquid is spilled. In addition, the fire will follow the spill. Automatic sprinkler systems are not designed to fight fires that move away from operating sprinklers. If the amount of liquid released cannot be controlled, the only effective protection option is a deluge sprinkler system. Water miscible ignitable liquids can be extinguished with sprinkler water, but it takes time.

2. The storage container.
Distilled spirits are commonly stored in wooden barrels. The barrels have thick wooden walls. It actually takes quite a bit of time for fire to cause the wood to fail, but the barrels are held together with metal hoops. Unless enough water is flowed onto the hoops, the heat of the fire will cause them to expand and allow the alcohol to leak out.

3. The storage arrangement.
The storage arrangement can affect fire development and the ability of a sprinkler system to get water to the fire. Barrels can be stored on-end and on-side in palletised arrays and rack arrays. Racks allow for rapid fire growth due to open flue spaces and plenty of air access. They also allow sprinkler water to quickly flow through the storage. Palletised arrays are more tightly spaced, limiting ventilation and slowing fire growth, but they also limit water flow through the array. Barrels on-end act like open top containers early in a fire, collecting water in the barrel heads. Barrels on-side allow water to flow freely over the barrel.

Figure 1. Barrel failure mode testing for on-end storage

FM Global Testing Programme

FM Global's programme to determine adequate fire protection for distilled spirits stored in wooden barrels lasted several years and consisted of limited, intermediate, and large-scale fire testing. It also included water transport testing to better define how quickly water from a sprinkler got to the base of the storage array.

Barrels were tested to determine how they would fail in a fire (Figure 1). All testing showed the primary failure mode for wooden barrels was due to expansion of the metal hoops. The hotter the hoops got; the more liquid escaped from the barrel.

Palletised, On-End Barrel Storage / 7 Pallets High Under a 9 m Ceiling

Water transport testing demonstrated that a lack of flue spaces limits the ability of ceiling sprinklers to get water to the fire. The concept of defining an open area fraction for a storage array was developed to support future testing and standards development. The concept provides a measure of how "open" a storage array is for sprinkler water delivery to the base of the array. Common palletised arrays have only a 7% open area fraction. A modified array, with flue spaces, has a 17% open area fraction. Figure 2 depicts the open area fraction for a palletised storage array with flue spaces provided (the black areas are open water paths).

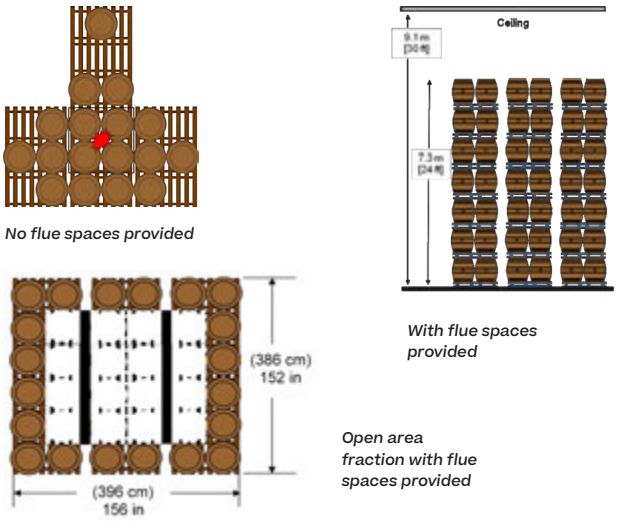


Figure 2. Palletised storage arrays with and without flue spaces

The final test in the palletised test series used 32 wooden barrels filled with a 75% alcohol, 25% water mixture (Figure 3). Protection at the ceiling consisted of K200, pendent, quick response, 68°C rated sprinklers arranged to deliver a discharge pressure of 1.25 bar or a flow of 230 L/min per sprinkler.

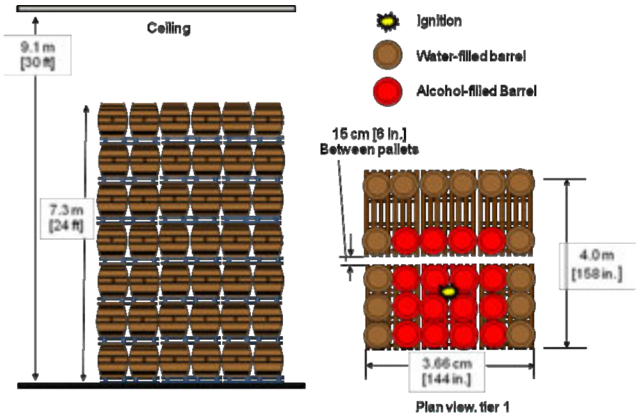


Figure 3. Palletised storage array with alcohol-filled barrels

Five ceiling sprinklers operated during the test and the array did not collapse. Alcohol leakage did occur, but the pool fire was limited, and the open flue space allowed ceiling sprinkler water to quickly dilute the spilled alcohol (Figure 4).

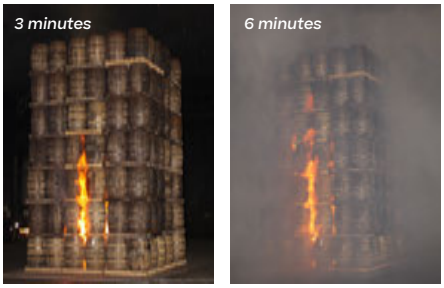


Figure 4. Final palletised fire test with flue spaces and alcohol-filled barrels

Protecting the storage footprint is not the only fire scenario to consider. In the USA, many palletised warehouses have a central loading aisle with palletised storage on each side (Figure 5). This creates the potential for a spill of several drums to produce a large, unobstructed pool fire. Such an event would operate a great many quick response sprinklers. It is critical to address this fire scenario either by using a separate sprinkler system over the loading aisle, or by securing the barrels on the pallets to minimize the potential for a large spill.

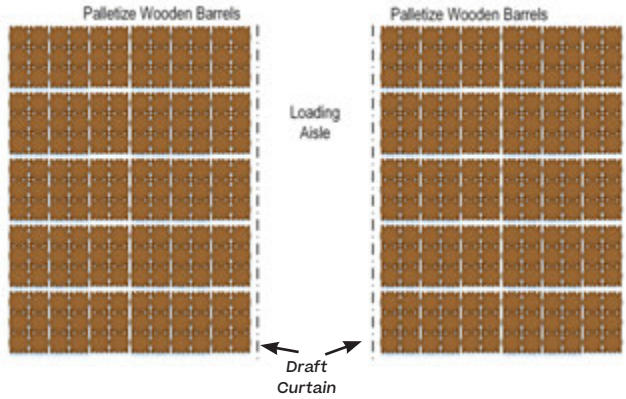


Figure 5. Palletised array with loading aisle

Rack Storage of On-Side Barrels / 9 Tiers High in a 12 m Building

Rack storage testing investigated a ceiling-only sprinkler design and a ceiling plus in-rack sprinkler arrangement. In addition, wet and dry sprinkler systems were evaluated. Three full-scale fire tests were planned. A steel rack array was constructed and used for all tests (Figure 6). The planned rack layout had a similar open area fraction (17%) to the palletised array with flue spaces. The array was filled with roughly 14,000 L of a 75% alcohol, 25% water mixture. Barrels outside the expected fire area were left empty.

All tests were ignited using a 1.8 m x 1.8 m pan filled with 76 L of ethanol. This exposure fire was small enough to prevent ceiling or in-rack sprinkler operation, but large enough to ignite the wooden barrels and initiate vertical fire spread.

Test 1 looked at a ceiling only wet sprinkler system with K200 pendent, quick response, 74°C rated automatic sprinklers arranged to provide a discharge pressure of 2.6 bar or a flow of 322 L/min per sprinkler. A total of four sprinklers operated. The fire was limited to the area with alcohol-filled barrels, and a pool fire did not occur. The fire was controlled, and the test ended at 30 minutes after ignition.

Test 2 looked at a ceiling-only dry sprinkler system with K240, upright, standard response, 141°C rated sprinklers arranged to provide a discharge pressure of 1.7 bar or a flow of 322 L/min per sprinkler. Water delivery was delayed for 40 seconds after activation of the first sprinkler to simulate a typical dry sprinkler system. A total of 15 sprinklers operated and the fire was extinguished at 10 minutes after ignition. As in Test 1, a pool fire did not form, and the fire was contained to the alcohol-filled barrels.

Test 3 used a combination of ceiling and in-rack sprinklers. It also simulated a dry sprinkler system, with a 40-second water delivery delay for the ceiling and in-rack sprinklers. The ceiling protection consisted of K160, upright, standard response, 141°C rated sprinklers arranged to provide a discharge pressure of 0.5 bar or a flow of 110 L/min per sprinkler. A single level of in-rack sprinklers was installed at the top of the 8th tier of barrels within the rack (Figure 7). The in-rack system used K115, upright, quick response 68°C rated automatic sprinklers arranged to provide a discharge pressure of 2.2 bar or a flow of 170 L/min per sprinkler. A total of three in-rack sprinklers operated during the test. The fire was extinguished at 12 minutes after ignition. A pool fire did not develop. The fire stayed within the alcohol-filled barrels.

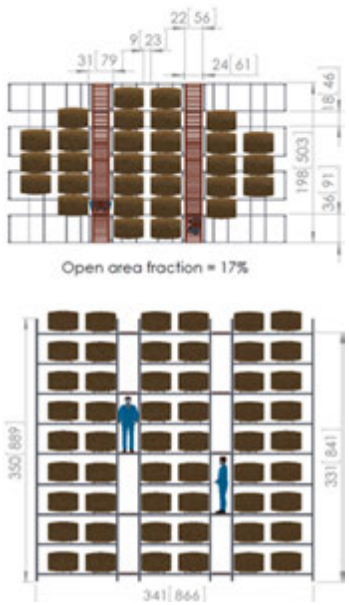


Figure 6. Fire testing rack array

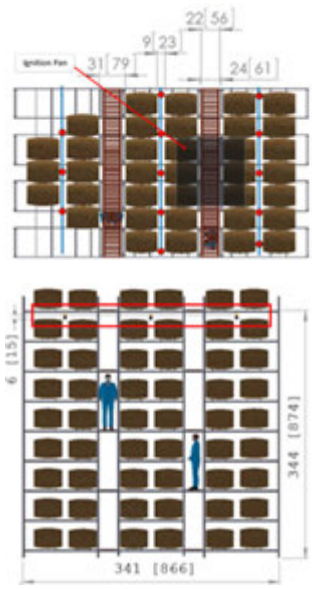


Figure 7. Test 3 in-rack sprinkler layout

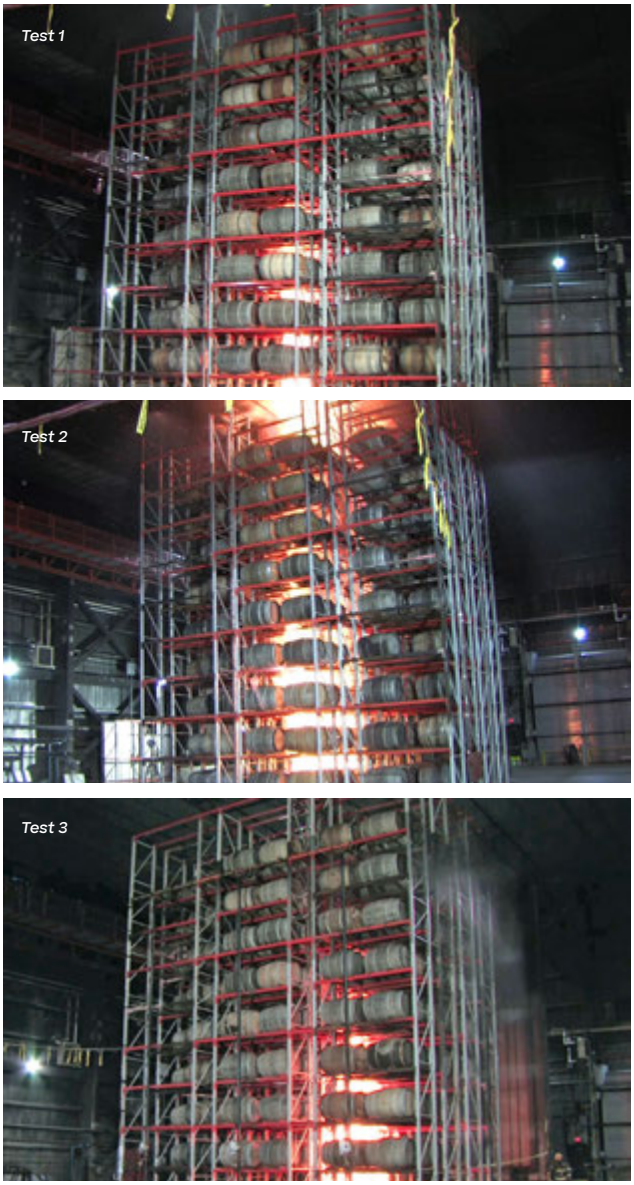


Figure 8. Images from Tests 1, 2, and 3 at water delivery

Figure 8 provides images from all three fire tests at water delivery from the sprinklers.

Conclusion

This FM Global fire test programme used modern sprinkler technology to develop water only automatic sprinkler protection for palletised on-end barrel storage and rack storage of on-side barrels of distilled spirits. The criteria apply to alcohol mixtures up to 75% alcohol. This testing demonstrated the need for clear flue spaces within palletised arrays to ensure sprinkler discharge can get to the bottom of the array. In addition, criteria for wet and dry automatic sprinkler systems were defined.

The water only fire protection criteria developed by this programme is available in FM Global Property Loss Prevention Data Sheet 7-29, Ignitable Liquid Storage in Portable Containers : https://www.fmglobal.com/research-and-resources/fm-global-data-sheets

These criteria have been made available to code/standard development groups in Europe and the United States as well as the Distilled Spirits Council of the United States.

Tackling corrosion in active fire protection systems

Corrosion is a topic of growing concern in the active fire protection industry. There is mounting evidence that the performance of galvanised pipes traditionally used to combat increased corrosion activity is not as expected. Here Chris Gill, Product Manager – Water, Viking SA, Luxembourg introduces the new Fendium piping technology with significantly improved corrosion protection and improved hydraulics compared to standard black steel and galvanised steel pipe networks.

Corrosion is a significant issue in sprinkler and water mist systems, particularly in dry, pre-action or deluge systems where oxygen and water are freely in contact with the pipe, with leaks causing damage and the potential to cause significant business interruption. In addition, the products of corrosion could prevent the proper and effective function of a system by restricting or even completely blocking the flow of water.

The biggest challenge is that corrosion progress cannot easily be predicted or monitored, in most cases the situation inside the pipes is not visible from the outside. In fact, there is a considerable risk that the function of the system will be significantly impaired or disrupted without being discovered and thereby impacting the ability of the system to control a fire.

More recently independent research and testing as well as field experience has cast some doubt on the ability of galvanised pipes to withstand corrosion as much as we had previously thought. In addition, there have been some worrying instances of explosions in galvanised systems due to hydrogen formation and so this has led to a reduction in scope of use for galvanised pipes. For example, the next edition of EN 12845 will not recommend galvanised pipes for either wet or dry systems and both FM and VdS do not allow the use of galvanised pipes for wet pipe systems. This leaves a significant gap for water mist in particular which requires something more corrosion resistant than black steel.

Stainless steel pipes do of course provide excellent corrosion resistance but this comes at a

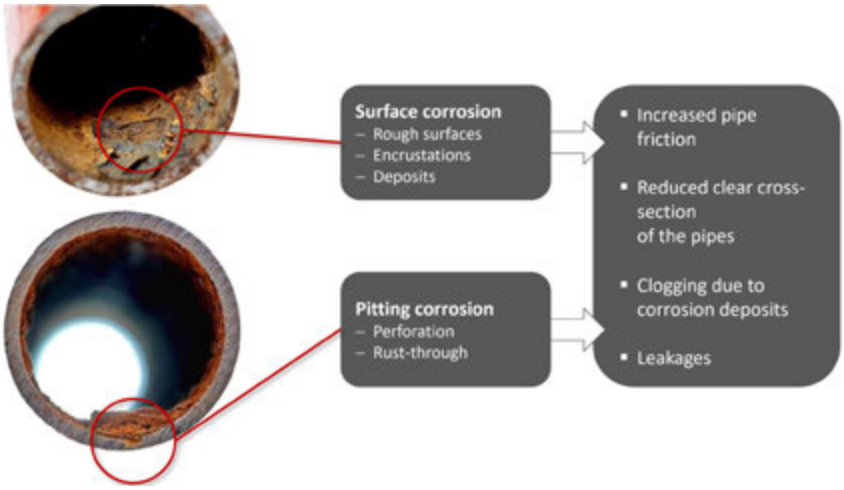
significant price premium. In addition, the contractor often has to use specialist fittings and tools. CPVC is certainly the product of choice for residential and light hazard and has excellent corrosion resistance but cannot be used in many commercial applications, and any storage or industrial risks.

Viking has now launched their new Fendium piping technology, which is a patented process adapting technology from the automotive industry with a long and proven track record in providing excellent corrosion protection under harsh environmental conditions. This technology provides a polymer protection which is permanently bonded with the steel surface, both on the exterior and on the interior of the pipes.

These Fendium polymer-enhanced pipes prevent the contact of water with the steel, significantly reducing the effects of corrosion. This has several positive impacts:

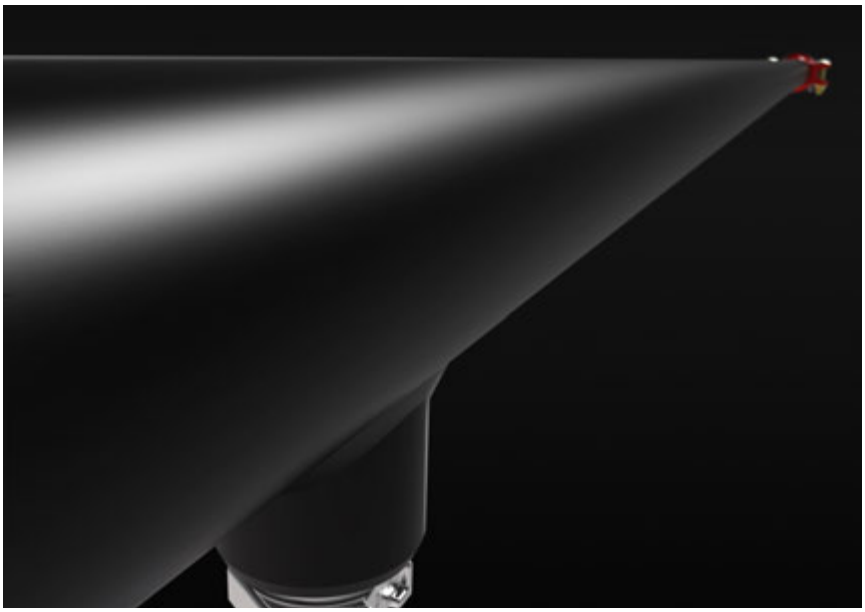
- Reduced possibility of rust-through and leaks
- Reduced production of corrosion products and potential blockages
- Reduced surface corrosion which contributes to friction losses
- By maintaining grooved and threaded end connections, standard industry grooved and threaded products can be used

Fendium pipes have been thoroughly tested by both FM Approvals and VdS Schadenverhütung to evaluate their corrosion-resistance. Evaluations carried out by the approval agencies included the following:



- Salt-spray ageing tests which compare the corrosion of samples of standard black steel, galvanised and stainless-steel pipes compared to those treated with Fendium, to evaluate the impact of rust through and corrosion products; and
- Comparing the hydraulic performance of different pipe materials vs Fendium to recalculate a C-factor for Fendium pipes.

Fendium pipes have been shown to out-perform both black steel and galvanised pipes in terms of corrosion performance allowing them to be used in wet, dry, deluge, water mist and other similar systems. Both FM and VdS have not only approved Fendium for these applications but have also approved the completely new, purpose-built factory in Wittenberge, Germany.



This is now the world's largest facility dedicated to producing prefabricated pipes for the fire protection market.

One important additional benefit of the Fendium treatment and the reduction in corrosion is that the hydraulic performance of Fendium systems is improved. The smooth pipes, which are much less roughened with age, allow the water to flow through with reduced frictional losses. This may allow for a reduction in pump sizing which can result in cost saving for the contractor and the end-user. Alternatively there is the possibility to reduce certain pipes sizes within the system and still retain the same pump size – reduced pipe size reduce installation time and can also lower associated costs as smaller pipes mean smaller grooved fittings and fixing materials.

This performance improvement is recognised by FM and VdS with the allowance for the system designer to use a C-factor of 140 in hydraulic calculations.

Corrosion can have several detrimental effects on the performance of water-based fire protection systems. The products of the corrosion process can restrict or even completely block the flow of water through the system, rust-through can cause costly damage and business interruption, and the roughness can reduce the hydraulic performance of the system over time.

As our industry grapples with corrosion, Fendium now offers better protection against corrosion and improves the system hydraulics when compared to traditional black steel or galvanised pipes.

VIKING SA
viking-emea.com
fendium.com

Maintaining compliance in the life safety industry

For manufacturers of fire safety products and systems, the initial design qualification and agency certifications are only the beginning of a long-term commitment to quality and consistency explains Len Swantek, Director of Global Regulatory Compliance at Victaulic.

Throughout the long history of fire safety product development, manufacturers are constantly challenged to create the safest and most reliable components, products and systems that sit quietly for years behind walls and ceilings and remain ready to provide their rated performance in the event of a real fire situation.

However, factors such as an ever-changing global economy and competitive market pressure can force producers to seek lower-cost manufacturing and production efficiency options, including the use of outsourced components and/or complete finished assemblies. This is where the fire safety Certifying Bodies like UL, FM, VdS and LPCB employ some of the industry's most rigorous surveillance programmes to ensure production uniformity and fit-for-purpose are being maintained throughout the manufacturing process and irrespective of the production location.

Governing Standards

Manufacturers in the fire protection industry are governed by building codes and specifications, insurance regulations, product testing and installation standards and a wide range of compliance auditing criteria. While regional codes and standards may vary to some degree, the overall objective is to ensure the correct product is placed in the end use application, is installed correctly and provides its full rated performance on-time and every time.

It is very important to note here, that in parallel with the external code compliance and mandated regulations manufacturers must follow, they themselves also have internal systems, production processes and controls, quality assurance requirements and procedures. Each of these systems produce tremendous amounts of data and records annually that must be maintained for routine examination by the certifying agency. Any changes to these procedures and controls are tracked through a documented revision history that will be audited to the standards and protocol established by the agency and their accreditation body.

Additionally, manufacturers of fire safety products and systems are required to notify the certification body(s) of changes in their product design, materials of construction, method of manufacturing, supplier processes and especially the location of the final assembly, testing and placement of the certification marks. These requirements are set forth through signed agreements between the manufacturer and the certification body.

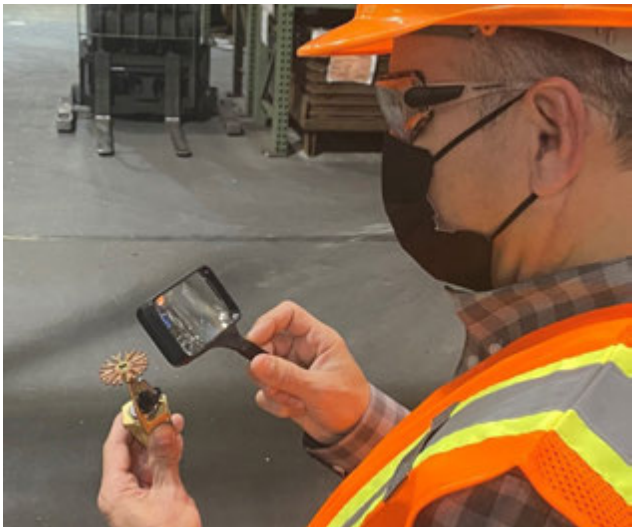
The Auditing Process

For the testing and certification bodies, their work is two-fold;

1. Qualify and certify the components and systems to an established set of exacting standards
2. Ensure these same products are being produced consistently without undocumented change to form, fit or function.

The latter is far more challenging considering the vast number of producers globally, the extensive number of products and configurations that each has placed on the market and the number of secondary suppliers who must also be surveyed on a routine schedule to the same standards and protocol as the OEM producer.

Surveillance audits are necessary to ensure the product being placed onto the market is of the same materials and performance specifications as the original samples submitted for qualification testing.



An auditor inspects agency markings on a sprinkler deflector

This is critically important with life-safety devices such as fire sprinklers, detection systems, alarm valve stations and other such products that must perform perfectly when called to action in a real fire event. As such, it makes perfect sense that the level of scrutiny and the frequency of such factory inspections would also be set at a higher level based on the criticality of the component or system and the reliance of these products to provide a dependable measure of protection for the building and its occupants.

A large part of the auditor's survey is determining if any critical changes have been made since the previous audit and especially in any of the following areas:

- Product Design
- Materials of Construction
- Manufacturing Processes
- Manufacturing Locations
- Product Performance Ratings
- Supplier / Sub-supplier Processes
- Agency-Required Markings
- Packaging and Literature

Managing Change

Throughout the product life-cycle manufacturers may need to implement changes in any number of the areas noted previously to remain both competitive and compliant. Simple changes such as a product marking can impact the manufacturer's ability to maintain production and distribution while the certification body evaluates the revised marking and method of application.

On a more complex scale, a manufacturer may need to provide multiple configurations of a single model that involve differing materials, wiring configurations, pressure ratings and packaging to meet customer demands concurrently in a range of markets or geographic regions. In this case, a more detailed examination will be conducted by the certification body. When critical components are involved, additional performance testing and qualification will be undertaken to ensure all configurations will comply with the governing standards. When the testing and requalification is successfully completed, the audit programmes will resume on their prescribed schedules.

Suppliers or their sub-contractors who implement process or material changes must also be surveyed if they are supplying an agency-certified component or assembly. These types of changes can be more

challenging to manage when sub-contractors are not fully aware of the regulations and governing standards. An example of this involves the application of the "CE" mark in accordance with the Construction Products Regulation (CPR). While the OEM producer often has sole responsibility for the design, materials and rated performance of the final product, their ability to track supplier changes is also critically important. These records will be examined as part of the auditor's survey, and in some cases, an additional review at the supplier's location may also be warranted.

Additionally, if the manufacturer establishes regional production sites, each of these will be individually audited for product consistency. It is therefore to the manufacturer's advantage to utilise a single quality system and internal process control procedures, as well as replicated manufacturing methods at all production locations. This makes the audit process much easier to manage for both the manufacturer and the auditor.

Making the Grade

While manufacturers strive for the highest quality products that utilise optimal production systems and process controls, occasionally an audit may result in a less than perfect report of compliance with the certification body's requirements. From time to time, auditors may find non-conformances (NCs) by way of the in-depth survey of the design, manufacturing and quality systems.

In the event of such findings, the manufacturer must provide clear and documented root cause analysis, as well as a detailed plan for corrective action moving forward. The internal study may involve a review of both complete assemblies and individual components including performance tests, material property studies and production tooling reviews to validate dimensional compliance, as well as a full review of all relevant design data (drawings, formulations, standards & specifications, production controls, quality plans and procedures).

During this process, it is critically important that the manufacturer responds quickly and concisely to avoid any disruption in the supply of product to their customers. Depending on the severity of the audit finding, the producer may need to place inventory in a hold position until all aspects of the NC are fully satisfied. This type of scenario can have far reaching implications involving the disposition of finished goods; rework, discarding of material, and restarting / requalifying the manufacturing process including the retesting of product before the material is released for sale and distribution.

Clear communication with all stakeholders and resources is vitally important to ensure the proposed corrective actions are checked for technical and manufacturing feasibility, while also maintaining previously established commercial and market objectives. While the certification body and their auditors are checking for compliance to the governing standards, other factors such as cultural differences, interpretation of requirements or general unfamiliarity with the relevant process / technology can delay the final resolution and acceptance of the corrective action plan.

Continuous Improvement

It is very important to note here, that NCs are also new opportunities for process and/or product improvement. It is through these agency-driven reviews that corrective actions afford the greatest opportunity to make visible changes in a wide range of factory processes, guiding procedures, and internal specifications.

The ongoing audit process is also a necessary investment and an obligation of manufacturers to their customers as a supplier of fire safety products and systems. Ensuring the end customer is equipped with certified products, made to exacting standards, using the best quality materials and processes, and consistently maintaining compliance of all relevant systems is an important responsibility.

There are countless examples globally where fire safety products and systems provide their full rated performance in protecting lives and property when the producers make the effort and investment in agency certifications and follow-up surveillance audits of their processes. There is no doubt that the audit process plays a major role in driving continuous improvement in quality and consistency throughout the product life-cycle.

POLAND

A growing need for sprinklers in car parks

Historically car parks and parking structures were considered a relatively safe occupancy in terms of fire risk. Consequently many countries required minimal forms of mandatory fire protection in those occupancies. However as Piotr Tofilo, EFSN's representative in Poland, notes in recent years a strong trend can be seen in the occurrence of high consequence fires in car parks and parking structures both open and enclosed.

Car parks were considered a low fire risk due to some long-standing beliefs. One of them being car fires don't spread easily and therefore the fire is limited to a single car. This assumption may be considered as supported by experience and data from 20-40 years ago. Another belief was that smoke and heat ventilation is sufficient to provide adequate conditions for the fire brigade's intervention. Again, with a single car fire assumption and quick fire brigade response it may be true in most cases that a conventional mechanical ventilation system may be a sufficient fire protection solution since it only has to remove a limited quantity of smoke and heat so the fire brigade can easily approach the fire and extinguish it.

The third long-standing belief was that open opposite walls in open car parks offer sufficient natural ventilation during a fire to allow successful fire brigade intervention. With a very limited number of examples of bigger fires that challenged this belief it was also considered an adequate solution for many years. And since there were no big fires and no casualties car parks were considered low fire risk, meaning low life risk and low fire protection requirements.

It is important to remember that regulations only cover life risk and require minimum provisions commensurate with the life risk. In simple words it is acceptable if the building burns down, as long as nobody was hurt and the fire has not spread to a neighbouring property. Other risks, especially those related to property protection and business continuity, have to be addressed by the owner of the building, not the regulations.

Current challenges

Cars have changed - they are bigger, contain significantly more plastic and even utilise plastic fuel tanks which can leak petrol during a fire. Then we have electric cars containing batteries which also burn with high intensity. Car parks are changing too as they get ever bigger in area and deeper underground and often contain automated parking solutions, stacking systems etc. As a result of car evolution fires now spread much faster, even in open air car parks, and are more challenging to extinguish.

Fire brigades often face real difficulties in approaching the fire due to high temperature and radiation and struggle with limited water. In some cases it is because open car parks typically have no detection system hence delayed intervention and a large fire, Wind can also be a factor in spreading the fire in open car parks.

The low fire risk concept for car parks may be still valid in terms of life risk but fires in car parks have

The biggest losses in terms of numbers of cars are in open car parks, which typically are not equipped with any fire protection system (arguably the main cause for such large losses). Enclosed and underground car parks which are usually better protected have not experienced such large fires but their overall consequences can be also very serious.

Building/Location	Year	Cars	Type	Comments
Apartment Building, Warsaw, Poland	2020	50	Underground	Significant structural damage to the floor slab and walls. 150 people / 68 families were forced to leave the building for months. No insurance coverage for such a scenario was in place.
Stavanger Airport, Norway	2020	300	Open	Fire caused a temporary closure of the airport.
Douglas Shopping Centre, Cork, Ireland	2019	60	Open	Structure to be demolished and rebuilt. €30 million loss.
King's Dock, Echo Arena, Liverpool, UK	2017	1300	Open	Building had to be demolished.
Edouard VII, Paris, France	2014	50	Underground	Busy road was closed for hours. Part of the city centre was affected by thick, choking smoke.
Monica Wills House, Bristol, UK	2006	22	Underground	Garage under home for the elderly. One person died as a result of smoke inhalation. The residential part was equipped with a sprinkler system which saved the building from greater losses.
Gretchenbach, Switzerland	2004	?	Underground	The floor slab has collapsed due to structural damage by fire. 7 firefighters died.

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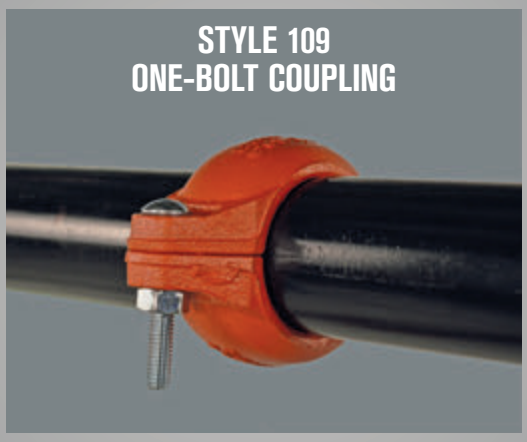

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serious consequences for building owners, occupants, businesses and local communities.

Understanding systems

Many countries are currently in the process of reviewing and reassessing the requirements for car parks, both open and enclosed. In some countries the changes are happening without changes to regulations but rather due to the change of risk perception by the fire brigade, as for instance currently in the Netherlands. Fire brigades are consulted there on projects during design and nowadays they often express their lack of trust in some fire protection strategies such as those purely based on smoke venting. It is a slow paradigm shift based on fire brigade lessons from real events and good understanding of fire protection systems and their performance. This is very important because one of the problems still seen in the fire and regulatory communities in some countries is only partial understanding of the most common solutions for the protection of car parks i.e. sprinkler systems and SHEVS (smoke and heat exhaust ventilation systems).

General fire performance of fire protection systems used in car parks

Although both systems may be beneficial to a varying degree in typical car park fire scenarios, sprinkler systems provide a more universal fire protection with more benefits and fewer weaknesses than smoke and heat venting systems acting alone. However due to various reasons (economical, functional, historical) numerous combinations of both systems are required in various countries.

Fire protection requirements for enclosed car parks in selected countries.

The UK and USA are clearly different in their approach with the USA emphasising the leading role of sprinklers and the UK still believing that smoke and heat ventilation is a sufficient solution for enclosed car parks. In Belgium requirements are quite flexible for small and medium car parks in terms of the type of system with additional relaxation of the sprinkler system hazard category for small car parks. This is a very convenient situation for the designers who can choose the protection option based on design circumstances.

In Poland sprinklers are currently not treated as equivalent and therefore many car parks of 1500-5000 m2 are protected only with smoke ventilation systems and smaller ones have no system in place (likely the main cause of the recent car park fire in Poland).

The design of smoke ventilation systems is quite inconsistent without official national guidelines as almost every case is now supported using CFD methodology with varying and usually quite unchallenging design fires, arbitrary fire scenarios and questionable verification. It is a long-standing view that smoke venting is often an extension of the mandatory air pollution control system in the car park and therefore some countries see this as an adequate and cost-effective measure compared to a sprinkler system, which may be considered as an additional and substantial expense. This view has to be challenged because there is evidence showing that the overall cost of the smoke venting system with its numerous implications to the building design (e.g. loss of space due to large shafts) can be quite comparable to the cost of the sprinkler system.

Upkeep costs

There are reports from residential developments which complain of high electricity bills due to inevitable idle operation of jet fans. Belgian solutions offer one additional aspect which is also voiced in Poland. It is the reduction of hazard class of the sprinkler system to OH1 which makes the system significantly cheaper. It follows the assumption that the balance in fire protection in smaller car parks can be moved slightly towards the fire brigade while maintaining the benefit of early fire suppression by sprinklers. This also allows in some cases the sprinkler system to be fed straight from the city mains without the need for a pump. It sometimes raises the issue of responsibility for insufficient water pressure and adequate protection of city water but these issues can be solved. This cost-saving idea, which is also used in other countries like Czech Republic, has its counter-arguments.

Sprinkler standards classify car parks as Ordinary Hazard (OH1 in NFPA, OH2 in EN) but the 2022 edition of NFPA 13 will increase this to OH2 because of the increased risk with larger cars, higher plastic contents and fears about electric vehicles. Fire research to

USA (NFPA 88A)	Sprinklers are required in underground floors and when the car park is a part of or below another occupancy. Fire detection and mechanical ventilation is required with approximately 6-7.5 air changes / hour.
UK (AD B)	Sprinklers are not required in enclosed car parks. Enclosed car parks must be ventilated naturally (open sided or natural ceiling vents) or mechanically with 10 air changes / hour.
Belgium (HR 1632 N)	Sprinklers are required together with smoke ventilation systems in larger and deeper car parks e.g. larger than 5000 m2 and those deeper than 18m underground. In smaller and shallower car parks sprinklers can be used interchangeably with smoke ventilation systems. In car parks up to 1250 m^2 and up to 6 m deep a reduced sprinkler system is allowed with OH1 instead of OH2 (EN12845). Alternatively, reduced smoke venting solutions are also allowed in those car parks. Fire detection is required in car parks larger than 250 m2 (in some cases 500 m2 or 625 m2).
Poland (Tech. Req. for Buildings)	Sprinklers are required in car parks larger than 5000 m2 and those with at least three underground floors. Smoke ventilation and fire detection systems are required in car parks larger than 1500 m2. Required performance is expressed as conditions tenable for escape and safe approach for firefighting. Typical fire brigade turnout time in cities is assumed at 15 minutes.

Fire protection requirements for enclosed car parks in selected countries.

	Sprinkler systems	Smoke and heat exhaust ventilation systems (SHEVS)
Goals	Reduce heat release rate, prevent fire spread between cars, provide tenable access for the fire brigade	Remove part of heat and smoke, provide tenable access for the fire brigade, provide tenable escape conditions (sometimes)
Fire detection	Sprinklers detect fires so the fire brigade can arrive sooner and they do not generate false alarms. No alarm confirmation is needed.	Smoke detection system is needed. Typically it is more prone to false alarms than sprinklers. Quick detection is often prolonged by alarm confirmation procedures.
Fire spread	Fire spread is typically limited to a single car. Petrol leakage is not considered a significant risk. Cars have plastic fuel tanks that can fail and spread liquid fuel, accelerating fire spread. Sprinklers cool the area and can usually stop fuel tank failure. They will cool any fuel that is released and cool any other vehicles exposed to a liquid fuel fire.	Fire spread to multiple cars is likely and it can be accelerated by high air velocity. Petrol leakage is a significant risk.
Heat release rate	Amount of heat released is limited to that of a single car (several megawatts).	Amount of heat released from multiple cars can be very high and it can easily overcome the smoke exhaust system if the intervention is not quick enough.
Fire brigade intervention	Temperature is typically tenable for firefighting. Intervention is relatively safe. Often it is only needed for the final extinguishment	Quick response is critical. Safety of intervention may be jeopardised if fire spread is quick and intervention is not quick enough.
Structural safety	Structure is not subjected to high temperatures. Duration of fire is limited. Delayed intervention is not critical.	Safety of the structure may be jeopardised if fire spread is quick and intervention is not fast enough or difficult due to high temperature and thermal radiation. The fire can then become so large that it weakens the structure. This is still a risk hours after the fire is extinguished as stresses occur when concrete cools. Concrete can spall explosively when exposed to extreme heat, potentially injuring firefighters.
Impact on other fire systems	Insignificant	Ventilation system with high air velocities can affect the timely activation of the sprinkler system (if present). In such cases ventilation must be activated with a significant time delay. Ideally it should be activated manually by the fire brigade on their arrival.
System reliability	Sprinkler systems are the most reliable fire protection systems, largely due to their simplicity.	Smoke and heat exhaust systems linked with smoke detection systems are relatively complex systems often designed using CFD modelling with assumed design fires and numerous scenarios of operation. The uncertainty of adequate response, especially considering modern cars, is significant.
Property protection and business continuity	Sprinkler systems reduce fire losses and financial losses to a minimum. A sprinklered fire does not put a significant burden on business continuity.	SHEVS cannot guarantee minimal losses because they do not extinguish fires and their success relies significantly on the timely response of the fire brigade. In some cases fire losses can be very high and business continuity may be significantly affected.

confirm what design should be applied for today's cars is expected to be conducted over the next year. Increased water demands make sprinkler systems harder to supply from the water main and the cost of a pump and tank can be prohibitive for a small car park, so it is important not to overdesign systems.

Summary

I believe Poland could benefit from a thorough review of its car park fire protection rules and Belgian requirements could be used as a good reference in terms of flexibility and equivalence.

There is evidence from various countries that the use of sprinklers in car parks will grow. There are some important challenges for a quicker and wider use of sprinkler systems in car parks in some other countries. One of the biggest are probably the inertia of the fire regulatory system and the scarcity of well-prepared technical and economic reports which are needed to convince regulators, amongst whom there is a lot of confusion.

Many smoke and heat ventilation systems designed with old assumptions of a 1-2 burning cars scenario will not be able to provide sufficient protection considering a more rapid fire spread of currently produced cars, especially electric ones which are characterized by a very rapid fire growth and steep heat release curve. In some cities electric cars are already prohibited from entering enclosed car parks. Sprinklers in such cases can reassure local firefighters.

Car park fires cause serious consequences for building residents, users, local community, businesses, towns, firefighters. Car parks bring people into city centres, without them shops, restaurants and other businesses see less trade. If a car park fire weakens a structure, people living above it can lose their homes. Sprinklers can prevent all of this and have proven effective in real car park fires. They are not expensive and can often be supplied from the city water main.

In terms of fire resilience goals for many standalone car parks and buildings incorporating car parks sprinkler systems are simply a better and more reliable and future-proof option than smoke and heat venting systems used alone. In many cases sprinklers are an absolute necessity.

All recent big car parks which have burnt down and suffered large losses are being rebuilt with sprinkler systems. Owners simply cannot continue to underestimate the risk of high losses and often must protect their public image. These examples should be a sufficient incentive for most investors and decision makers.

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2 Modern Vehicle Hazards in Parking Structures and Vehicle Carriers, NFPA, 2020, Fire Protection Research Foundation
3 Evaluation of fire in Stavanger airport car park 7 January 2020, RISE Report
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CEN water mist standards

Although water mist is the system of choice for shipping, with test protocols available from the International Maritime Organisation (IMO), the IMO standards are not usually accepted for shore-based applications thus, confirms Alan Brinson, Executive Director of EFSN, water mist has to develop suitable standards.

When water mist first appeared on the fire protection scene 30 years ago it was being proposed as an alternative to halon and as a system that weighed less than sprinklers to protect shipping. To be accepted it had to prove its performance in those applications. When it came to cruise ship and ship machinery space protection, this was done by first establishing what performance sprinklers deliver, then showing that water mist could match or better it. These applications are now well-defined and water mist is the system of choice for shipping, with test protocols available from the IMO but these standards are not usually recognised for land-based applications so to compete with sprinklers in this much larger market, water mist had to develop appropriate standards.

CEN Technical Committee 191, Working Group 10 is responsible for drafting water mist standards. It has divided its work into three parts: a design, installation and maintenance standard; fire test protocol standards and component standards.

Design, installation and maintenance

EN 14972-1 is the design, installation and maintenance standard for water mist systems. It was recently published and provides general guidance but is not as detailed as the sprinkler system design standard. This is because the characteristics and hardware of water mist systems from different manufacturers differ so much that many design criteria could not be standardised in a prescriptive manner. Instead, as for IMO, acceptable performance must be verified in representative full scale fire tests and, hence, fire test protocols for different water mist applications are being standardised. The different fire test protocols form the rest of the EN 14972 series and the results are linked to EN 14972-1 to set minimum design criteria.

EN 14972-1 also has requirements for acceptable water supplies, alarms and facilities for periodic testing of the system. As well as design guidance for water mist systems that are alternatives to automatic sprinkler systems, EN 14972-1 covers deluge applications and the design of water mist as an alternative to gaseous extinguishing systems.

In many areas EN 14972-1 refers to the manufacturer's design installation, operation and maintenance (DIOM) manual. This term is used over 90 times in the standard and among other things the DIOM manual should set out design criteria for minimum operating pressure and nozzle pressures, nozzle spacing and orientation, maximum room dimensions, obstruction criteria, water quality and hydraulic calculations. These are essential inputs to the performance of the system. As they are not in EN 14972-1, the DIOM manual should be verified and approved by an independent third-party laboratory which has expertise in water-based fire protection systems. It is against CEN (and ISO) rules to call for third party approvals in a standard but such approvals greatly increase acceptance of a technology, particularly by insurers and help to open up markets to it.

Fire test protocols

While performance-based fire tests exist for sprinklers in storage applications, sprinklers have historically not been put through full-scale fire testing for most less challenging applications, so the first step for water mist was to devise a set of fire tests representative of the application and run them with sprinklers. In deluge applications there was no need to compare with sprinklers so absolute rather than relative performance criteria were established. Each fire test protocol includes full-scale tests devised to be representative of the application to be protected, while also being repeatable and reproducible.

WG10 decided not to reinvent the wheel so most of the 16 fire test protocols now published or planned are based on existing protocols from FM Approvals (seven protocols), VdS (five protocols), BS (two protocols) or UL (one protocol). Only one protocol is completely new.

So far three water mist fire test application protocols have been published:

- EN 14972-16 for industrial oil cookers
- EN 14972-8 for machinery spaces exceeding 260 m^3
- EN 14972-9 for machinery spaces up to 260 m^3

These are deluge system applications, representing relatively small markets. By contrast EN 14972-3, a fire

test protocol for water mist systems to protect offices, school classrooms and hotels could open water mist to many more projects. This standard is about to be published. Interestingly, WG10 could not agree on whether to use the British Standard, FM Approvals or VdS test protocol as the basis for this standard, so all three are offered as alternatives in this standard, with the market invited to decide which to use.

Three further fire test protocol standards are currently at the CEN formal vote stage. Each is expected to pass and be published this summer:

- EN 14972-10 for atrium protection with open water mist sidewall nozzles
- EN 14972-14 for combustion turbine spaces exceeding 260 m^3
- EN 14972-15 for combustion turbine spaces up to 260 m^3

With the above unpublished standards all at or past the formal vote stage WG10 has completed its work on them. It will now start work on further fire test protocols, most probably beginning with EN 14972-6 for false floors and ceilings and EN 14972-11 for cable tunnels.

Component standards

To be accepted as an alternative to sprinklers water mist must not only show that it performs well in relevant fire tests; systems must also be reliable and ready to suppress fires decades after installation. Various factors affect system reliability, one being the design and materials used for the key system components. This must therefore also be established by testing against standards, as is done for sprinkler components.

WG10 is working on five component standards, none of which can be harmonised because water mist is not included in the CEN TC/191 M/109 mandate (which was last updated in 2001). The first, EN 17450-1, product characteristics and test methods for water mist system strainer and filter components, has been published. The next priority in this series of component standards is the water mist nozzle standard.

Given how crucial the components – and nozzles in particular – are to the long-term performance and reliability of water mist systems, they should also be tested to complement the fire tests of the suppression performance of the system. Looking ahead, the intention is that water mist systems should comply with the EN 14972 series and water mist components should comply with the EN 17450 series, with EN 14972-1 referencing the EN 17450 standards. Until the EN 17450 standards become available, the best way to ensure long-term performance is to rely on type-approved water mist systems, since type approvals also cover component approvals.

Summary

Although water mist systems have been sold for 30 years, when it comes to standards for land-based applications the technology is still poorly regulated. CEN started to work on water mist standardisation in the late 1990's and published the first CEN/TS in 2008. In recent years progress has been more rapid, with standards published for system design, fire test protocols and key components.

These standards will help to define good quality water mist systems and strengthen their claim to be a viable alternative to automatic sprinkler systems, water spray systems and gaseous extinguishing systems.

Fire safety is a choice

More and more Dutch clients are aware that they should make choices when it comes to fire safety, reflects John Van Lierop of VSI & EFSN. They see that the building regulations requirements limit themselves to enabling safe escape and the protection of neighbouring buildings.

There is a growing understanding among Dutch clients that the selection of measures to protect property, safeguard business continuity and prevent reputational damage is their own responsibility. Project developers can set an example by highlighting the options more explicitly, for example, by linking the options to fire scenarios. The future building user must know what consequences fire can have.

Awareness to conscious choice

Every organisation is different and has to deal with specific risks. Experts from the fire brigade, consultancies and insurers can contribute to solving fire safety issues and making conscious choices.

Fortunately, more and more of the parties also have a wider knowledge of active extinguishing systems, such as sprinklers. This allows them to advise clients even better and helps them make better choices.

A sensible client consciously chooses which consequences of fire are acceptable and which are not. This often turns out not to be easy, because the financial consequences can be unclear. In making choices, it is important to consider what influence fire has on direct or indirect damage, business continuity, liability and, however macabre, the number of victims. Knowledge is also needed about the performance, reliability and costs of measures.

Recording the choices in a fire safety concept is evidence of a purposeful and responsible business. These choices must then be translated into a mix of passive, active and organisational measures that suit the client and, when combined, yield the desired fire safety level. Key criteria for those measures are recorded in a schedule of requirements. In the Netherlands, we have a certification scheme for those who prepare this schedule of requirements which, among other things, sets out what qualifications these advisers must carry.

Quality assurance

According to the 2012 Building Decree, the user of a building in the Netherlands is responsible for the building's fire safety. In the Netherlands, it was decided in most cases to assure the quality of equivalent solutions (those not in the Building Decree) through mandatory inspection. Fire protection systems, passive fire protection and organisational measures combine to provide the necessary level of fire safety. Inspection checks whether the various measures are properly coordinated with each other. The inspector checks whether the objective set out in the schedule of requirements is being met.

To assure quality and to save costs, the client usually opts to have sprinkler systems installed and maintained by a third-party accredited installer. Inspection bodies can conduct simpler and cheaper annual inspections when a third-party accredited installer provides a maintenance certificate. Accredited sprinkler installers are audited annually and thus prove that they install and / or maintain good sprinkler systems. This offers the client, fire brigade and insurer certainty that the system is in good working order.

The choice for sprinklers

Clients are increasingly choosing to use sprinklers. A sustainable choice, because a building fitted with a sprinkler system cannot burn down. A sprinkler detects and fights a fire in its early stages fully automatically, without human intervention. In many cases the fire is already extinguished when the fire brigade arrives, so the consequences of the fire are very limited. This creates a level of fire safety that is higher than our legislation and regulator require: instead of limiting the fire to the fire compartment in which the fire starts, the fire is limited to the object that burns.

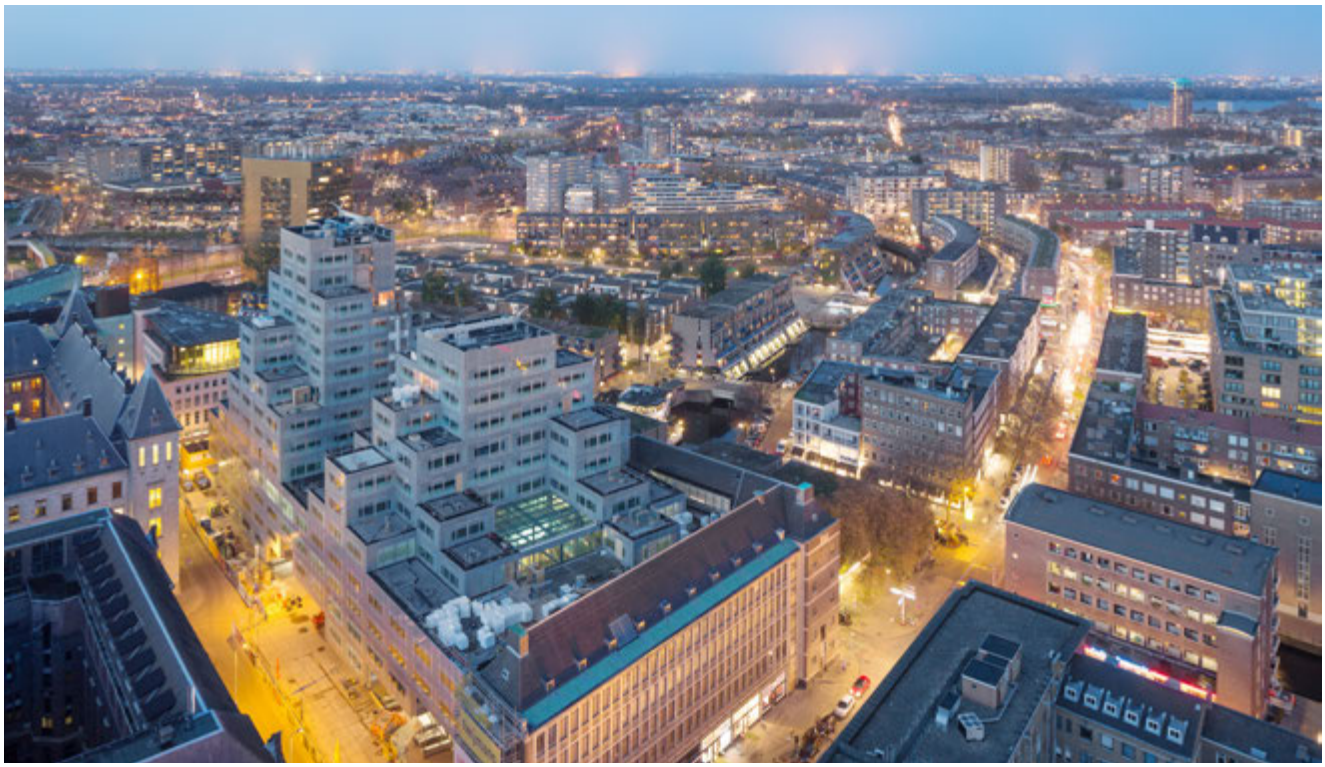
Except where fireworks are stored, sprinklers are currently not required in Dutch buildings. In the Netherlands, a permit to build is issued by the local competent authority, the municipality, often advised by the fire brigade. For each project where they are used, clients in the Netherlands must justify that sprinklers offer an equivalent solution. The municipality assesses whether the client's consultant has provided sufficient argumentation.

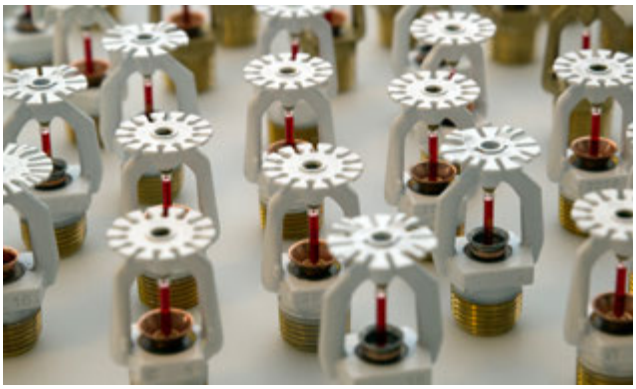
Equivalence and valuation of sprinklers

Certified sprinkler systems are widely accepted in the Netherlands as an equivalent solution for, among other things, the enlargement of fire compartments, the extension of escape routes and lighter building construction. With sufficient knowledge about the operation and effectiveness of a sprinkler system, it is more than likely that the specific requirements are met. When a sprinkler installation is used as a solution outside of the above examples, there is not always consensus. The fire brigade, acting as an advisor to the municipality, assesses the building permit, must have sufficient knowledge to accept the solution.

Raising the level of knowledge

The United Sprinkler Industry (VSI) represents the interests of the Dutch sprinkler industry and is part of the trade association Federatie Veilig Nederland. The VSI works on raising the level of knowledge about sprinklers and in recent years has mainly focused on issues such as safety, reduction of structural fire protection with sprinklers, corrosion prevention in sprinkler systems, sprinklers as a means to improve sustainability and the need for sprinklers in car parks.





Guideline for reduction of fire resistance

Developers and contractors can produce safer buildings with sprinklers. In addition, the choice of sprinklers is often economically more advantageous, because less investment in the structure is required. DGMR and Efectis, commissioned by Bouwen met Staal and the VSI, drew up a guideline that permits a reduction of the fire resistance of steel supporting structures if the structure is fitted with a certified sprinkler system. By limiting the heat load on a building with a sprinkler system, a building with a lower fire resistance can still meet the regulatory requirements.

The guideline should ensure that advisers and municipalities are assisted in creating and assessing solutions where sprinklers are used to justify reduced structural fire resistance. The first edition of the guideline was very conservative and in 2021 work will be carried out for a second edition, which should widen the application of this concept.

Life safety

One of the main goals of Dutch legislation and regulations is to limit the numbers of fire casualties. For economic and practical reasons, clients sometimes want fewer and / or longer escape routes than required by the Building Decree. In addition to property and business continuity protection, sprinklers also contribute to the life safety of building users. However, consultants are reluctant to use sprinklers for life safety. This was the reason for the VSI to commission a study by Nieman / Eindhoven University of Technology into the contribution that sprinklers can make to personal safety.

The research report provides tools for making better choices. Simulations were performed for three common scenarios to provide insight into the impact of fire and smoke. The study concluded that sprinklers make a positive contribution to reducing fire development. In large, high rooms it appears that escape is sometimes not necessary. By contrast a fire in a room adjacent to a corridor that is used as an escape route can quickly render the corridor unusable if the building is not protected with sprinklers. Sprinklers also have the advantage that when activated, not only does the rate of smoke production fall but gases cool and contract, so pressure drops and less smoke is spread. Perhaps that is their greatest life safety benefit.

Stay-in-place strategy

Building regulations have been amended in response to a number of fatal incidents. The regulations now set requirements for the minimum number of trained people to be present to assist in emergencies. Sprinklers can be used as a compensatory measure to limit these numbers. This results in significant savings in staff costs, so that the investment quickly pays for itself. In line with this, the VSI also stimulates the use of sprinklers in buildings where evacuation is complicated, difficult and sometimes dangerous. The “stay-in-place” strategy is only safe and possible with sprinklers. Recently conducted research by the Fire Service Academy into the spread of smoke also makes it clear that in buildings where vulnerable people live, it is necessary to use automatic firefighting systems.

Sprinklers in car parks

Since 2016 a Dutch standards committee working group has been drafting a standard for car parks on behalf of the government. An important finding of the working group is that sprinklers offer by far the safest solution in the event of a fire. A series of incidents involving fires in car parks, combined with the rise of electric vehicles is providing new insights to the government. The Dutch government recognises the need to require sprinklers in car parks below buildings where people sleep, such as apartments, care institutions and hospitals. It is working on the details and the requirement is likely to take effect from January 2022.

Residential sprinklers

The Dutch residential sprinkler market is developing slowly. To stimulate the market, the standards committee has translated the European residential sprinkler standard, EN 16925, and a connection has been made with the terminology in the building regulations in the Dutch appendix. The first Dutch standard will therefore lapse. A revised CCV certification scheme for home sprinkler installations has been in effect since 1 January 2021. Accredited residential sprinkler installers can now supply the installations with a certificate, based on NEN-EN 16925 + NB. Compared to the first version, the scope has been broadened and, for example, the qualifications for residential sprinkler engineers have been tightened. Residential sprinkler installers, fire brigades, consultancies and certification bodies contributed to the new version.

The latest important development is the publication of the “Appraisal of residential sprinkler installations”.

The working group, consisting of the fire brigades, consultants, suppliers and installers, published a draft for public comment in February 2021. The main aim of the publication is to create more clarity about the role of residential sprinkler installations. The document contains an overview of possible functions and compensatory measures for residential sprinkler installations. Another aim of the document is to create more awareness among developers and homeowners about improving fire safety with residential sprinklers. One can limit oneself to meeting the legal minimum level or consciously strive for a higher fire safety level.

The correct choices

The VSI stimulates continuous research and ensures that knowledge about the possibilities of sprinklers is made available. This allows clients, advisers, the fire brigade and other stakeholders to make more informed choices. Every construction project is unique, but a clear valuation method can help all stakeholders make the right choices, with the aim of a more fire-safe society.

Don’t give fire a chance!

John van Lierop works for the VSI and EFSN.

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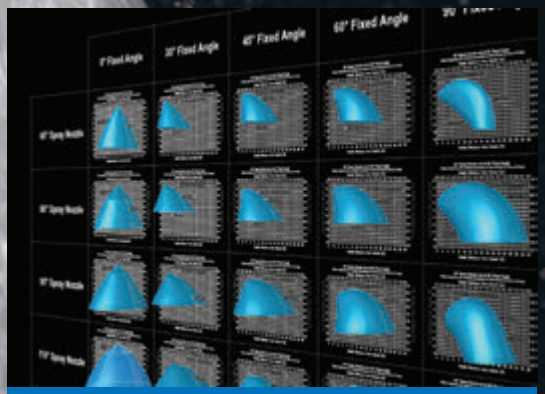
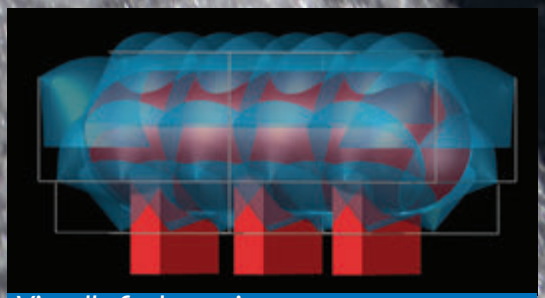


72 3D nozzle spray pattern blocks



Visually find gaps in coverage area. Know before you flow!

The complete set of 72 Medium Velocity Nozzle spray patterns reflects nine discharge orientations and eight nozzle deflector options.

MV Nozzles, used primarily per NFPA 15, provide exposure protection and help prevent structural damage. The small droplet size cools and prevents excessive absorption of heat from an external fire.

See Bulletin 106 for complete information.

reliablesprinkler.com/mvnozzles

European sprinkler standards

To increase the acceptance of sprinklers by regulators across Europe we need national standards to which they can refer. Bjorn Schaumberg, EFSN's standards expert, recognises that great progress has been made in recent years.

When regulators adopt a new requirement or incentive to fit sprinklers in a building code they need standards to which they can refer, so it is clear what is meant by a sprinkler system and its key components, such as the sprinklers themselves. Regulatory references are always to national standards. While other standards, such as NFPA or FM data sheets, are usually accepted, it has to be argued that they are equivalent alternatives. Standards, as their name suggests, set a level of performance which must be achieved by everyone. In this way they help to create a fair market. We already have some sprinkler component standards in the EN 12259 series but there are gaps, while the installation standard, EN 12845, does not include some useful innovations.

For over a decade CEN Technical Committee 191, Working Group 5, did not have professional secretariat support. This was because no national standards body was prepared to fund someone to take on this role and that lack of support considerably slowed the process. In autumn 2018, thanks to additional contributions from certain of its members, EFSN appointed me as an expert on CEN standards rules, and I am glad to report that together we are now making much faster progress.

Within WG5 we have formed informal task groups to divide up the work and help us focus on the different activities. Currently TG1 drafts most component standards, TG2 works on EN 12845 and TG4 on pump sets.

Existing sprinkler standards

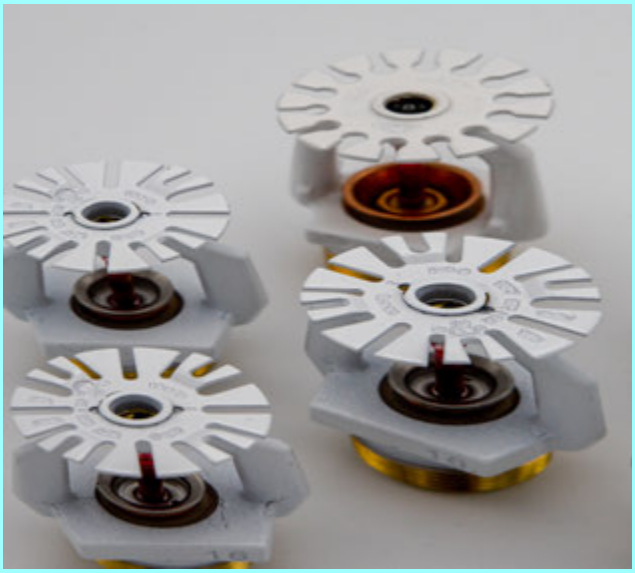
EN 12259-1 is a component standard for K57, K80 and K115 sprinklers. It includes test protocols and acceptance criteria, as well as defining certain other aspects. The scope extends to conventional, upright and pendent spray, flat spray, dry, sidewall and concealed sprinklers. Like most of the other standards in the EN 12259 series, it was written about 20 years ago under the legal framework of the Construction Products Directive, CPD. It was published by the European Commission, EC, in the Official Journal of the European Union, OJEU, which makes it a harmonised standard and one that can be used for CE-marking of the sprinklers within its scope. Other sprinklers cannot be CE-marked using this standard.

EN 12259-2 and EN 12259-3 are component standards for wet and dry alarm valve assemblies respectively, while EN 12259-4 covers water motor alarms (the gong) and EN 12259-5 specifies the performance to be achieved by flow switches. All these standards were also written under the CPD and can be used for CE-marking.

By contrast EN 12259-9, a component standard for deluge valves, was published in 2019 under the legal basis of the Construction Products Regulation, CPR. It has not been harmonised by the EC (cited in the OJEU) and cannot be used for CE-marking. However, it can be referenced by authorities, consultants and others.

Similarly EN 12259-14, a component standard for residential sprinklers, was published in 2020 and is also not harmonised but is available as a reference. Its scope is being amended to exclude the use of o-ring seals, which tend to stick and prevent water release when the sprinkler operates. UL has found that the laboratory test for these seals in the 2020 edition does not predict satisfactory field performance.

Non-harmonised component standards can be referenced in the two design, installation and maintenance standards, EN 12845 for systems for the protection of commercial and industrial risks, and EN 16925 for residential risks. The first of these standards was last updated in 2015 and is now being reviewed, while the second is more recent, being published by most countries in 2019. These standards refer to the relevant product standards above.



Gaps remain

While this list is a good start there are some major gaps, such as standards for pumps, pump sets and ESFR sprinklers. The EC has informed TC/191 that before it accepts more harmonised standards it must first provide TC/191 with a new mandate. Unfortunately, in a survey conducted by the EC the Member States of the European Union did not consider firefighting systems a priority (it was ranked 11th), so the EC will not currently accept a request for a new mandate.

The CPR offers an alternative route to CE-marking. A manufacturer can ask one of the laboratories that is a member of the European Organisation for Technical Assessment to conduct a European Technical Assessment, ETA. That in turn requires the laboratory to create a European Assessment Document, EAD, which is similar to a harmonised standard and also has to be cited in the OJEU to be valid. The ETA route is confidential between the manufacturer and laboratory, unlike the CEN process which is open to broad participation. As yet no EADs have been published for sprinkler components, although three are in development.

Those familiar with EN 12845 will be aware that it does not cover many of the storage solutions introduced over the past decade, nor other innovations that help to make sprinkler systems more effective and competitive with other fire protection measures. EN 12845 is also silent on seismic bracing, despite there being many parts of Europe that are vulnerable to earthquake activity.

Sprinkler standards in development

TS 17551 Fixed firefighting systems – Automatic sprinkler systems – Guidance for earthquake bracing was recently published and will fill one the above gaps. This technical specification provides design guidance for seismic bracing for sprinkler systems and while it does not have the status of a standard, authorities and others can refer to it as state of the art. Europe needs guidance now and it was faster to produce a standalone Technical Specification than wait until the guidance could be published in the next edition of EN 12845. In the medium term it is the intention that it will either become a full standard or be incorporated into EN 12845.

EN 12259-12 will be a standard for pumps for sprinkler and water spray systems, i.e. for the bare pump without its driver or controller. We have been working on this standard for many years and expect in a few months to send the draft to CEN for translation and circulation to its members for comments (this is known as the CEN enquiry). Previous CEN enquiries have unearthed all the points of contention so there should not be many comments and we are aiming for this standard to be published in the summer of 2022.

EN 17451 is an installation standard that defines the performance of assemblies of sprinkler pumps, drivers and controllers. It references EN 12259-12 as an assembly component. During drafting it became clear that different countries use different technologies, for example variable frequency drives and circuit-breakers in motor controllers are common in some countries but not in others. We therefore recently decided to take more time to include all viable technologies and draft suitable guidance for them. As a result this standard is scheduled to be circulated for the CEN enquiry after EN 12259-12. This is appropriate anyway as with EN 17451 referencing EN 12259-12 we need EN 12259-12 to be published first.

EN 12259-13 is a test standard for ESFR sprinklers. It has gone through numerous drafts within CEN TC/191/WG5 and now includes all the ESFRs commonly seen in the field. It is about to be circulated for the CEN enquiry. We do not expect many comments and are aiming for this standard to be published in Q4 2021 or Q1 2022. We would then refer to it in EN 12845, while a manufacturer could obtain CE-marking using the ETA route described above.

EN 12845

We have been working on a new edition of EN 12845 for many years and are finally about to send it to CEN to begin the enquiry. In reaching this point we first addressed all the comments received on the 2015 edition. Next we reordered the chapters in the standard to match the steps taken during design. We then divided the document into sections which were worked on by different teams of TG2 delegates, before going through our combined draft together. Many good ideas were introduced but they made the draft longer and longer. We know that some areas change less often than others and therefore decided to split the document in two, with EN 12845-1 being the standard applicable for all systems and including all control-mode density area designs, while EN 12845-2 will be a complementary standard for ESFR and control mode special application designs. Given the rapid pace of innovation in warehousing technology, we anticipate that EN 12845-2 will need regular revision to provide corresponding protection solutions.

Our aim is that EN 12845 will be state of the art, containing solutions we currently only find in NFPA 13 and FM data sheets. To facilitate it, we have revised the hazard analysis section to align with that approach, at the same time reducing the number of hazard classifications. We have also drawn on material in CEA 4001 and in national documents from several European countries. CPVC piping, press-fit connections, polymer-enhanced pipe, nitrogen generators and foam sprinkler systems are in the draft, as are greatly expanded sections on inspection, testing and maintenance. There is guidance for flammable liquids protection and an entire annex on protection of distilled spirits in wooden barrels.

Since autumn 2018 for this standard alone we have held over 50 days of meetings at which we have discussed over 200 documents. In between, the delegates have drafted those documents for discussion and checked the complete draft standard for obvious errors and self-consistency.

We hope you recognise the progress that has been made and look forward to addressing your comments on EN 12845-1 later this year.

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Developments, promotion & progress

Despite the impact of COVID 19 on our lives and our health, adoption and recognition of sprinkler systems in France continues to progress favourably, either through continuous, proactive and adapted insurance pressure, or by the opening created by article 49 of the ESSOC law. Also, reflects Youcef Ouammou EFSN's representative in France, thanks to the new regulatory constraints introduced following the Lubrizol fire in 2020 and ultimately in a growing principle of selection of efficient and active systems for the protection of people and goods in an innovative and evolving French construction context - new wooden buildings.

Fresh opportunities
Residential sector : new wooden buildings

The associated major challenges in terms of timber framed buildings, fire prevention and firefighting have led to the creation of a working group. The initiative of the woodworkers' union (ADIVBOIS - CODIFAB), brings together expert representatives of the supervisory authorities (BSPP, SDIS) as well as specialised laboratories (EFECTIS, CNPP) and has resulted in a "Guide for Construction with Wood" whose main focuses are as follows:

- 8 to 28 m building: possible choice between sprinklers, water mist or a fire engineering building stability study.
- Building> 28 m: residential sprinklers, commercial sprinklers or water mist sprinkler compulsory.

The Department of Housing, Urbanism and Landscapes (DHUP), within the Ministry of Ecological and Solidarity Transition, which develops, coordinates and evaluates policies for town planning; construction; housing; landscapes; biodiversity; water and non-energy mineral substances is also starting to take an interest in residential sprinklers, in conjunction with the Ministry of the Interior. In particular within the framework of the project to revise the 1986 decree on the Construction and Housing Code.

The sprinkler protection project for "La Viste", three residential towers in Marseilles, designed by one of our members (SPK Engineering - Brice Franc), will also promote a system that is as efficient as it is economical, the valuation of which contributes to the principle of a policy of fire prevention and automatic water extinguishing (high land valuation). This is the first residential sprinkler project in France in the housing sector implemented as part of a voluntary initiative by the client.

Insurance

The advent of the new APSAD IF1 / E1 certification benchmarks and the R1-2020 benchmark and in particular of its appendix 4 "Residential Sprinklers", now

makes it possible to obtain an N1 certificate for the entire residential domain, facilitating the insurability of sites which therefore benefit from the insurance leverage allowed by the members of the FFA (French Federation of Insurance).

As such, several nursing homes will obtain the N1 Certificate of Conformity this year.

Regulation

The draft French annex to EN16925, specifying the framework for the application of residential sprinkler systems in the French context, was finalised last year and the final comments were addressed in March. AFNOR will be able to publish this "NF EN 16925" standard at the end of the first half of 2021.

Challenges in the industrial sector

The LUBRIZOL fire also led to a tightening of the regulatory controls by the regional directorates of the Environment, Planning and Housing, under the joint supervision of the Ministry of Ecological and Inclusive Transition and the Ministry of Cohesion of the Territories (DREAL / DRIEA / DRIEE). This action forced a major increase in the compliance of sprinkler systems, mainly in logistics warehouses and factories, going as far as formal notices and ultimately obligations to upgrade installations when they are inadequate due to changes in risks.

In installations classed to protect the environment (ICPE), storage warehouses, the height of which keeps increasing, can now be protected to 16.8 m using the new ESFR VIKING K28 and TYCO K34 heads (presentations of these new applications were given to the Sprinkler Working Group of the French Insurance Federation in 2019 and 2020).

Automated, robotic storage systems, which are increasingly present in these high-rise buildings, also require protection, which is available using international standards such as DS FM 8-34 and NFPA 13 or APSAD R1 2020 with the 2021 addendum.

Outlook

We will never forget the fire in Notre Dame which shook the world on April 15, 2019, but which today made it possible to launch the doctrine of automatic water extinguishing in a proportionate, adapted and necessarily consensual and progressive manner.

A first project to create a "Heritage protection guide" is underway, which should take stock of solutions for the prevention and protection of cultural heritage in the event of a disaster. This guide, which will also be based on international experience, will include a component related to automatic water extinguishing with traditional sprinklers, residential sprinklers and low and high pressure water mist, particularly for the protection of structures.

A second ongoing project, linked to the action plan decreed by the President of the Republic, will give rise to a scientific study of the adequacy of a future automatic low pressure water mist system for the future construction of the structural wooden frame for the roof of Notre Dame.

Issues with the current approach

For buildings with public access, particularly care homes (public access building type J), the retroactive security principles imposed by the prevention services of the supervisory authorities are often difficult and costly to apply (additional emergency staircases, rigorous smoke extraction, compartmentation inside sleeping areas, etc.), and their performance remains very contextual.

The currently active approach of so-called "residential sprinkler" fire protection allows a new orientation for the safety of people in an environment where the principles of evacuation come up against the problem of an insufficient number of hospital staff (often only one person at night for a hundred beds), the condition of the residents and the capacity to evacuate them (medical beds are wider than conventional transit units).

The paradigm has changed since the often-utopian principle of horizontal transfer was called into question, to an innovative and pragmatic principle of protecting residents in their rooms. The Nérac nursing home experience is a pioneer in this new approach, with a strong case-law trend in a number of similar cases.

Other types of establishments can claim today to benefit from this system, such as certain small hotels (public access building type O), or residential homes facing the same hazards and costs as care homes, as well as residential buildings with inadequate fire protection.

This performance-based, palliative, even compensatory measure, finds a particular echo in the dynamic framework of the ESSOC law, which should ultimately allow the fire safety doctrine to evolve from a dogmatic canonical basis, towards one more performance-based and pragmatic, combining an alternative solution and an innovative result.

In the housing sector, the development of residential sprinklers can therefore be transposed to all residential buildings, whether tertiary or residential (CCH - Decree

1986), new constructions (ESSOC incentive measures) or existing, which would ensure better protection of people in a relatively erratic regulatory framework in this area.

Studies conducted since 2016 by the SDIS64 (Fire Service for the Pyrenees and Atlantic) on protecting the old town centres of Bayonne and Pau were conducted in accordance with the Architects of French Buildings, who are responsible for cultural heritage. They aim to use residential sprinklers for more effective protection of these historical structures and their occupants.

Beyond care homes, which led to the first study on residential sprinklers in France by CNPP in 2003 (EP_03-09_FFSA_2003), today they are being used to protect people and goods, raising the value of buildings and allowing innovation (social housing buildings in Marseilles are being protected with a residential sprinkler system – Client ERILIA).

In housing, we can therefore now consider the implementation of a consensual approach between the canonical principle of passive protection and the need to implement effective active automatic extinguishing.

Timber construction

In the rapidly developing field of timber construction, the genesis of a new fire safety doctrine in the form of a guide will allow the design of increasingly tall buildings with a specific architecture, addressing the fact that wood is a combustible construction material.

The specific normative and contractual framework of water extinguishing systems in France, the different performance scales of the systems which have different characteristics depending on the technology used (traditional sprinkler, residential sprinkler, water mist), the regulatory requirements depending on the destination of the works, are all parameters to be considered in the analysis of vulnerability to fire risk, applying these fixed automatic water extinguishing systems as a mitigation barrier and defining their use and specifications in wooden buildings.

The purpose of this guide will be to define recommendations for the different classes of risks inherent in timber buildings, when the implementation of fixed automatic water extinguishing systems is deemed necessary and depending on the occupancy of the building (housing, building with public or worker access, high-rise building).

For wooden buildings, better protection with a cost of fire safety (Impact studies: immediate / recurring costs) in line with the new economic challenges, is the credo for this new era of residential sprinklers both within the various regulatory institutions and within the framework of professional corporations in the construction industry.

For special establishments, cultural buildings, museums and religious buildings, the subject of automatic water extinguishing has become contemporary following the fire at Notre Dame Cathedral on 15 April 2019, a date coinciding with the official publication of NF EN16925. This vast area of French heritage is also one of the targets identified for a better approach to active protection, adapted and in harmony with the doctrines of our European colleagues inducing fast, reliable action at the start of the fire, thus requiring smaller quantities of water for the preservation of irreplaceable, invaluable historic buildings.

In conclusion, residential sprinklers are set to develop strongly in France, as part of performance-based solutions reconciling economic and ergonomic constraints, as fire safety doctrines evolve to embrace broader protection of people, property and the environment.

Sprinkler systems in defence facilities

The Swedish Fortifications Agency, which owns and manages Sweden's governmental properties intended for defense purposes, has a responsibility to ensure good resource utilisation and high economic efficiency. To this end, writes Magnus Arvidson, Fire Protection Engineer, with RISE, the agency undertook a cost-benefit analysis which investigated the design, reliability, performance, and cost of a fire sprinkler system for typical underground fortification facilities.

The aim was to study how a sprinkler system for a typical fortification facility underground could be designed, based on relevant risk classes in Swedish sprinkler rules (SS-EN 12845). Then, the installation and operating costs for two fictitious facilities; a small facility with a net area of 1000 m² and a large facility with a 5000 m² net area were calculated. The input on the reliability and efficiency of sprinklers were based on a literature review. The installation and operating costs were also calculated for two different water mist fire protection systems, a commercial low- and high pressure system, respectively. For these systems, however, there is no good basis for assessing reliability, so it was assumed to be equivalent to a traditional sprinkler system. It was also assumed that the performance efficiency at least corresponds to a traditional sprinkler system, which is part of the accepted fire testing methods. Another assumption was that the annual cost for inspection, testing and maintenance was similar for the studied systems. With this information as a basis, a cost-benefit analysis was made.

Estimated installation cost

It was assumed most occupancies in a typical facility, such as accommodation, kitchen, dining rooms and medical rooms could be regarded as OH1 per SS-EN 12845 and for occupancies such as workshops, a design according to OH2 is reasonable. As opposed to stores and other spaces with temporary or permanent storage of materials which require a design according to risk class OH3. The water mist fire protection systems in the study were approved by FM Approvals for Hazard Category 1 (HC-1). The design and installation recommendations of these systems were judged to be acceptable for OH2 occupancies per SS-EN 12845. For storage spaces, the assessment was made that water mist fire protection systems are applicable if a storage room has a maximum floor area of 50 m²; partly because it limits the number of automatic nozzles that can activate and partly because an enclosed room contributes to the efficiency of water mist.

The estimated installation cost for a traditional fire sprinkler system in the smaller type of facility is about SEK 1,3 million and about SEK 3,3 million for the larger facility whereas the installation cost for a high-pressure water mist system is higher than that of a traditional sprinkler system for the smaller type of facility but comparable for the larger facility. A low-pressure water mist system seems to be the least expensive option for both types of facilities, probably because the system, unlike a traditional sprinkler system, requires smaller pipe sizes, smaller water pumps and a smaller water tank and, unlike a high-pressure system, uses normal steel pipes and less expensive centrifugal pumps.

Reduced property damage

In general, it can be stated that the greatest benefit of a sprinkler system is that the property damage is reduced. The expected benefit for personal injury is around a few percent of the total benefit of the sprinkler system. This is of course due to the fact that the risk of death and other injuries in a fire is small in these types of facilities as people can usually reach safety. The real estate is always affected by a fire however, the reduction in property loss was assumed to be 75%, based on the results of the literature review.

It can be pointed out that sprinkler systems can also cause damage costs, primarily due to water damage. This was not directly taken into account in the calculations, mainly because there is no reliable statistical basis for this, and that assessment becomes uncertain. But water damage was handled using a sensitivity analysis. Intuitively, however, the two water mist fire protection systems can be assumed to cause less water damage than the traditional sprinkler system because of the lower water flow rates.

All systems are generally cost-effective

A cost-benefit analysis is based on the cost of a protective measure being compared with the reduced damage that can be expected as a result of the installation. All figures are expressed in monetary terms. The comparison is made on an annual basis; the costs for an investment are distributed over the number of years it is expected to be in operation and taking into account the profit that the invested amount would generate otherwise described in the form of the discount rate. The discount rate for all investment costs was assumed to be 3.5%.

The cost-benefit analysis for the fictitious facilities shows that a fire sprinkler system is cost-effective, especially for the larger facility. But it should be noted that the uncertainty in the data base is quite large, which means that the trends in the result can be used for further analysis, but that the actual values of the benefit ratio should be viewed with some caution. The sprinkler system mainly has an effect to reduce the property loss. The expected benefit for personal injury is around one percent of the total benefit of the sprinkler system. This is because the risk of fatality and injuries in the event of a fire is small, as people can usually put themselves in safety.

The reduction in property loss was assumed to be 75%, and an assumed lowered benefit of sprinklers (50% and 25% property loss reduction, respectively) leads to a lower benefit ratio but for the large type facility the benefit ratio is still above 1,0. A reduced benefit ratio could be expected for example due to the cost for water damage and if the sizes of the fire compartments are reduced. A well-developed passive fire protection system, i.e. where there are many separate fire compartments, will lead to less extensive damage. This further leads to a lesser calculated efficiency of the sprinkler system because the potential damage that a sprinkler can prevent is less. The benefit of sprinklers as a protection system decreases if there is another protection system in place at the same time. The benefit of sprinklers also decreases if the assumed fire frequency is reduced. However, for the larger facility, the calculation shows that there is still a benefit, even if the assumed fire frequency is halved. The same applies if the cost of replacement of expensive equipment is assumed to be half as high.

RISE Report 2020:08 : this project was financed by TUSC - Tunnel and Underground Safety Centre, and is documented in RISE Report 2020:08, "Sprinklersystem i fortifikationsanläggningar under mark: Kostnad och nytta" by Magnus Arvidson and Håkan Frantzich (Lund University).

What price safety?

The withdrawal of the UK from the EU supposedly gave the UK greater control and uniformity over standards within the UK, 'So how is that working out?', asks Keith MacGillivray, Chief Executive of BAFSA.

Some might say we already had those powers; it was just that we had not been using them. Has the withdrawal from the EU helped the standardisation of sprinkler standards and building standards in the UK and is it likely to? As the Prime Minister likes to remind us, we live in a United Kingdom with Northern Ireland, however it is clear that in some parts of this United Kingdom the population are not as well protected as others due to the Building Standards for the inclusion of sprinklers varying greatly from country to country. Part of the reasoning for this, is how our Governments make decisions and how that process was devolved to the four respective nations in the last twenty years.

In 1997 devolution referendums were held in Scotland and Wales and as a result of these the devolution process for Scotland, Wales and Northern Ireland began with the Government of Wales Act 1998, the Scotland Act 1998 and the Belfast (Good Friday) Agreement Northern Ireland Act 1998. Further amendments to these Acts took place throughout the last twelve years and we now have the Scotland Act 2016 and Wales Act 2017. In Northern Ireland we have a power-sharing executive but since 2017 there has been no power-sharing, although talks continue to resume power-sharing. In the case of England this has resulted in some decentralisation of powers, budgets and responsibilities to mayors and

through city deals, however in the main these powers remain within central government.

Devolved Powers

Policy Area	Scotland	Wales	NI
Health & social Care	✓	✓	✓
Education & training	✓	✓	✓
Local Government	✓	✓	✓
Agriculture, forestry & fisheries	✓	✓	✓
Transport	✓	✓	✓
Some taxation	✓	✓	✓
Justice & Policing	✓	✓	✓
Some social security elements	✓	✓	✓
Sports & the arts	✓	✓	✓

In practice how has this worked? Looking at my own experience within Scotland and through our work in Wales it has worked very well for our organisation. It has allowed BAFSA far greater access to the Members of the Scottish Parliament and to the Assembly Members of the Welsh Assembly. This has allowed us to put our case for sprinklers directly to the Members of the respective governments, unfortunately this has not been the case with England and Northern Ireland. This has also allowed the devolved governments of Scotland and Wales to make decisions much quicker and to react to situations with quicker access to local research pertinent to the problem. What we now have is a situation where the standards for construction differ in all four of the devolved or decentralised nations, as I will now explain.

Let us look at Care Homes and Sheltered Housing for example. Sadly it took a significant fatal fire in Scotland to introduce requirements for new built care homes and sheltered housing to be fitted with automatic fire sprinklers. Following the Rosepark Care Home fire in January 2004 in which fourteen elderly residents tragically died, Scottish Government was able to react quickly to the situation and make changes to the Scottish Building Standards with the fitting of automatic fire sprinklers in this type of premises mandatory from 2005.

The Fatal Accident Inquiry into the fire did not report back until 2011, six years after the incident.

In 2014 the Welsh Assembly followed Scotland with a requirement to fit sprinklers or mist in all new built care premises. However, in 2021 we are still waiting to see England and Northern Ireland bring in a similar measure. While there have not been any such major tragedies in care homes since the Rosepark fire, there have been a number of serious and fatal fires occurring in this type of premises. The measure has been successful in both Scotland and Wales and has ensured that a small fire does not become a major tragedy. There is however one shortfall in both Wales and Scotland and that is the measure was not retrospective and there are still numerous care homes and sheltered housing in both countries which have not had water suppression systems fitted.

Recently I had a video conference with colleagues in Australia who wanted to learn about the latest building standard requirements in Scotland whereby automatic fire sprinklers will now be fitted in all new built social housing, all flats, all multi-occupied residential property and all new built student halls of residence. Like Scotland and Wales, Australia also requires sprinklers to be fitted in all new built care homes and sheltered housing however after a serious fire in an existing care home they decided to legislate for existing care homes also to be fitted with sprinklers. This I see as the next step for Wales and Scotland – we cannot have a two-tier safety system in the same country where it is a lottery if you are residing in a care home built after the new legislation was enacted or if you are in an older building built prior that date and your safety from fire may be dependent on that date.

There is also the perverse calculation using cost-benefit analysis, whereby the benefits gained by the installation of such measures over a period must be calculated against the value of a human life in that country. At present in the UK the value of a human life is £1.8m, this compares with $10m (£7.2m) in the USA. Would a better calculation not be that which is used by the NHS, where the amount spent on a person in terms of care costs is valued against Quality Adjusted Years Living due to the measure or treatment? Fortunately, both Scottish and Welsh Governments adjudged that the social benefits of spending money on fire sprinklers in social housing and saving lives were above that of achieving a cost benefit analysis which showed only a cash benefit to the government or housing provider.

The next milestone was for Scotland to require sprinklers in all new built schools after 2010, this again was closely followed by Wales in 2014. Again there is no such requirement in England or Northern Ireland, only a recommendation to carry out a Fire Risk Assessment to see whether the fitting of sprinklers is justified. Only a small percentage of new built schools in England have had sprinklers fitted in the last eight years and yet we see the number of school fires increasing and the insurance costs for replacement rising.

Zurich Municipal Insurance have revealed Home Office data for England has shown that:

- School fires have destroyed the equivalent of 1,100 classrooms in the last five years.
- Fire crews have been called to tackle 2,300 school blazes in England, which completely destroyed 47 primary and secondary school buildings, and seriously damaged 230 others.
- More than 74,000 square metres of teaching facilities, an area equivalent to 10 football pitches, have been damaged by fire in this time.

And Zurich Municipal now estimates 390,000 teaching hours could be lost in the next year as a result of large fires alone, causing disruption for 28,000 children who may already be struggling to catch up following school closures during the pandemic.

The findings – based on Home Office data from all 44 fire authorities in England – have led to renewed calls for sprinklers to be mandated in new and refurbished schools, bringing the country into line with Wales and Scotland where they are already compulsory.

It will take many years for all the schools in Wales and Scotland to be fitted with sprinklers, however

Type	Scotland	Wales	England	NI
Schools	Mandatory in New Build	Mandatory in New Build	If required following FRA	No
Care Homes & Sheltered Housing	Mandatory in New Build	Mandatory in New Build	No	No
Flats	Mandatory in New Build	Mandatory in New Build	Above 11m	No
Student Halls of Residence	Mandatory in New Build	Mandatory in New Build	No	No
Housing	Mandatory in New Built Social and Multi-Occupied	Mandatory in New Build	No	No
Warehouses	Mandatory in Buildings Greater than 14,000 Sq. Metres	Mandatory in Buildings greater than 20,000 Sq. Metres	Mandatory in Buildings greater than 20,000 Sq. Metres	Mandatory in Buildings greater than 20,000 Sq. Metres

Disparities between Occupancies where sprinklers are required by UK Devolved Governments

each year their school stock is becoming more and more sustainable and resilient, and fewer pupils and teachers are having their work disrupted and teaching materials destroyed. Yet in England a review of BB100, the Government's Design Document for Fire Safety in Schools continues to rumble on as it has since 2015 despite large scale school losses occurring on a regular basis. The anticipated release date of the review is unclear, as is whether the public will have an opportunity to comment.

In 2014 the Welsh Assembly agreed that fire sprinklers should be fitted in all new built housing in Wales, this followed a hard-fought campaign by Anne Jones a Member of the Welsh Assembly and former member of the fire service. In 2018 David Stewart, a Member of the Scottish Parliament, mounted a similar campaign in Scotland and in 2021 it became a requirement for all new built social housing in Scotland to have sprinklers fitted. Like schools, it will be many years before the housing stock in both countries is fitted with sprinklers, however they are progressing towards a more sustainable and resilient housing stock.

Following the very tragic outcome of the Grenfell Tower fire, there was optimism that safety standards would improve, not just with the fitting of sprinklers and the removal of unsafe cladding but with a stronger safety culture for buildings. We have seen some changes together with a number of inquiries and working groups. England has reduced the height where sprinklers are required in new built blocks blocks of flats to 11 metres and Scotland now has a requirement for sprinklers to be fitted in all flats no matter the height. Northern Ireland has announced their intention to retrofit 31 high-rise housing blocks, but no other changes are proposed.

How is it in this United Kingdom that we can have such differing building standards, fire precautions and prevention measures? The sprinkler and watermist industry have worked together to ensure that there are single recommended standards for the fitting of sprinklers and watermist in the British Standards system across the four nations. We have also worked to ensure that there are the same standards for installation of these systems across the UK through the third-party certification schemes administered by LPC, FIRAS and IFCC and independently audited by UKAS. It is also pleasing to see an increasing uptake by sprinkler installers to be third party certificated with almost two hundred installers now registered under the three schemes.

We at BAFSA only accept installer members who are third party certificated and continue to promote the use of approved sprinkler products for installations. This has led to the recent joint initiative with EFSN to remove counterfeit sprinkler heads from online sellers and also work by BAFSA to stop the approval of self-installed sprinklers and over-stamping of sprinkler projects by certificated installers.

The British Automatic Fire Sprinkler Association has supported the sprinkler and water mist industries in the UK since 1974, in particular the need for standards, qualifications and a competent workforce. Following on from the Grenfell Tower tragedy the need for these standards and competence has never been greater in the construction industry. BAFSA along with other organisations has developed courses to ensure that the sprinkler fitters and designers are skilled and competent to the required levels for their task. It is therefore disappointing that we are not getting the same level of support from the decentralised Government of England in ensuring there is a consistent level of protection, sustainability and resilience across our buildings in the United Kingdom.

We hope that when power sharing resumes in Northern Ireland they will join in the progress achieved by Scotland and Wales in making their communities safer places to live and work together to make their buildings more sustainable and resilient by fitting automatic fire sprinklers.

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Sprinklers have a key role to play

The discussion on sustainability has been raised as an opportunity post Covid for national governments to change the approach to the built environment. Whilst there are many articles that call for the use of natural construction materials, greater insulation, and changes in energy efficiency the aspect of fire resilience is seen as a side issue. It should not be, stresses Tom Roche, Business Sprinkler Alliance. Losing the materials and the building usability in a fire will result in valuable resource taken to rebuild them. A holistic approach that addresses sustainability and fire resilience will be needed to deliver these outcomes. Active fire protection has a key role to play in this resilience.

According to the UN Environment Programme (UNEP) report[1], when adding emissions from the building construction industry on top of operational emissions, the built environment sector accounted for 38 per cent of total global energy-related CO2 emissions. Pre-pandemic building emissions from the built environment in 2019 were noted to reach their highest level. Further it has urged governments to implement deep building renovation and performance standards for newly constructed buildings into pandemic recovery packages.

Action is needed if we are to meet the aspiration of net zero carbon by 2050. The drive to preserve resources will mean a building will no longer follow the traditional linear model of 'take, make, dispose', but would be circular and built with reused materials and/or more organic (bio) materials. Buildings will also be able to be taken apart and deconstructed. Furthermore, a building will need to be flexible and adaptable to both the short term whilst being built for the long term when considering its internal use. They will also need to be smart and connected, using sensors to determine efficiency operations and user experience.

We will need to consider a building more as a system and an asset where the value is in its efficiency, flexibility, and re-usability. Protecting that reusability will therefore become key to a building's sustained value. Losing the materials and the building usability in a fire will see it taken out of the cycle – the result will be a valuable resource taken to rebuild them and increasing lifecycle costs as was noted by a study by FM Global.[2] Therefore, a holistic approach that addresses sustainability and fire resilience will be needed to deliver these outcomes. This will mean in shift in regulatory thinking too.

The current journey

For many years now the construction industry has started this journey pursuing sustainable and green construction. This has been supported by government regulations, incentives, certification schemes and the credits within them.

One of the most obvious items across Europe is the drive to use more natural products. For example, the use of timber is considered to be more sustainable for certain buildings than other traditional methods of construction. However, we also know these materials burn. High profile fire events have raised questions around the detailing and resilience of buildings where natural products are used as a structural material. There is a clear need for research in this area but also thinking in terms of what this means for long term sustainability.

Fires in newly built buildings with high-level ratings in green certification schemes have occurred. Some have been completely destroyed by fire meaning their potential saving and green credentials are gone. Valuable resources are needed to recreate them, and their function has been interrupted for several months, if not years. Some see this as a signal that fire safety regulations deliver the wrong outcome for sustainability and others that there is a blind spot in certification schemes.

This is neatly illustrated by the Carbon Neutral laboratory in Nottingham, UK which was constructed using mass timber but was destroyed shortly before it was completed in 2014. When it was rebuilt following the fire it was in line with regulations, it followed the original design and there was no increase in fire resilience – no active fire protection. The rebuild was showered with short listing for awards relating to its green credentials. Somehow the resources lost in the original fire did not matter or count. The original fire was consigned to history and had no bearing on the claims for the efficiency and carbon neutral credentials.

Active fire protection does not feature in this discussion. Instead, it is restricted to mirroring the state fire regulations in differing countries where the focus is on safety and limiting conflagration. A recent update on a study from 2015 by the Fire Protection Research Foundation summarises this very neatly by looking at the challenges that need further research.[3]

The current journey is bounded by thinking in differing silos. Sustainability and fire seldom come together in regulatory thinking. However, fire incidents are challenging this thinking, most notably here in the UK following the tragic Grenfell Tower fire. What is clear is that assuming that our current guidance and techniques will deliver the required outcomes is short-sighted.

Active fire protection and sustainability

Active protection systems like sprinklers are part of the building system and add to its overall carbon emissions. However, before dismissing active fire protection because of these emissions their benefit needs to be weighed. Studies show their benefits in minimising the impact of fire and emissions.[4]

A future view of the world wherein protecting the hard-won resources so that they can be used and reused leads to a path where minimising fire incidents will be important. Active protection systems will increasingly make sense for this reason. They will also make sense when thinking of the desire for buildings that can be flexible in use throughout their life. The whole life cost of a building and its value will be tied to both these concepts.

That said active fire protection systems will need to continue to adapt to demonstrate their improving whole life costs and sustainability credentials too. This will require adapting test regimes, increased recycling of water and perhaps new technology to improve their already high effectiveness.

In a world where sustainability is key, a disposable building will no longer be the 'right thinking'. I would contend that a sprinklered one will be.

1 2020 GLOBAL STATUS REPORT FOR BUILDINGS AND CONSTRUCTION, Global Alliance for Buildings and Construction - UNEP
2 The influence of risk factors on sustainable development – FM Global -2010
3 Fire Safety Challenges of 'Green' Buildings and Attributes – FPRF - 2020
4 Environmental Impact of Automatic Fire Sprinklers – FMGlobal - 2011

Reducing fire deaths and injuries

One of the most effective and reliable systems for protecting a home against fire is automatic fire sprinklers. Information from the US proves that they can greatly reduce fire deaths and injuries. The effectiveness of sprinklers in homes makes their widespread installation recommended and it is time these systems were used more widely throughout Europe argues Adrián Gómez, President of Tecnifuego, Spanish Association of Fire Protection Companies.

The installation of sprinklers in new homes in Spain is not yet widespread, at less than 1%. Their use and installation in other European countries indicates the possibility of a change and an increase in demand in Spain. In fact, a few months ago the Standard, UNE-EN 16925: 2020 Fixed firefighting systems – Automatic residential sprinkler systems – Design, installation and maintenance was published. This indicates a change in trend.

This standard specifies the requirements and provides recommendations for the design; installation; water supply and backflow prevention; commissioning; maintenance and testing of fixed residential automatic sprinkler systems in residential buildings, that is, buildings containing a series of units to be used for housing purposes (residences, apartment building, healthcare centres, student accommodation, small hotels, etc.).

The UNE-EN 16925 standard has been drawn up by the Technical Committee for Standardisation, CTN 23 Fire Safety, whose Secretariat is held by TECNIFUEGO, the Spanish Association of Fire Protection Companies.

The example of the USA

The situation is very different in the US where sprinklers are more widely used and their demand in new construction increases every year.

This success is due to the awareness campaigns aimed at State and local governments and authorities, the normative regulation of these systems and the use of data about their high efficiency, demonstrated by periodic statistics carried out for more than 40 years.

The most recent and complete report (period 2010-2014) managed by the National Fire Incident Reporting System (NFIRS)* of the US Fire Administration, based on the annual survey carried out by the National Fire Protection Association, NFPA, offers insightful data**. For example, only 10% of fires were in buildings with sprinklers, although half of manufacturing and two-thirds of healthcare fires were in sprinklered buildings. The death rate per 1,000 fires was 81% lower in homes with sprinklers than in homes without sprinklers. The civilian injury rate was 31% lower and the rate of firefighters injured per 1,000 fires was 79% lower in sprinklered homes. The sprinklers operated in 92% of fires where they could have been expected to do so and were then effective in controlling or extinguishing 96% of those fires.

In general, the report is evidence fire sprinklers can put out a fire while it is still small, fulfilling the function for which they are designed, which is to control the fire until the fire brigade arrives.

Another important aspect reflected in the study is that most fire fatalities occur in homes, but only 8% of residential fires were in buildings that had sprinklers.

In the report the fire death rate in buildings is calculated to be 0.8 per 1,000 fires and is reduced by 81% in homes that had sprinklers compared to those that did not.

Similarly, the civilian injury rate is 25 for every 1,000 fires in homes and the report found there are 31% fewer injuries in homes with sprinklers. The study points out that many of these injuries occurred in fires which were too small to activate the sprinkler or in the first moments of the fire, before the sprinkler worked, so it is likely serious injuries were reduced by a much higher percentage.

Meanwhile the rate of firefighter injuries was 13 per 1,000 home fires and was 79% less in homes with sprinklers.

The report concludes that homes where smoke detectors and sprinklers are installed are where the lowest rate of fire deaths occurs.

The study makes a comparison between homes with fire safety systems with different assumptions. Thus, it points out the mortality rate for every 1,000 fires was:

- 18% lower when there were battery-powered smoke detectors but no sprinklers
- 62% lower with hard-wired smoke detectors but no sprinklers
- 90% lower with sprinklers and hard-wired smoke detectors

Europe, moving forward

It is interesting to observe in the report produced by the European Fire Sprinkler Network*** (EFSN), to which TECNIFUEGO belongs, the differing legislative requirements of each country to equip buildings with fire sprinklers.

Most countries (Germany, Great Britain, Ireland, Norway, Austria, Greece, etc.) have a general requirement in their legislation for sprinklers in buildings higher than similar heights (typically 28 to 32 metres), above which it is considered impractical to attack a fire externally. In this way the fire protection measures required for public buildings are extended to private and public housing, thus offering greater security to those who reside or work in buildings higher than 28 metres.

Along these lines, each year, more countries adopt new requirements or incentives through performance-based design to install sprinklers in buildings. This will continue, particularly in nursing homes, in hospitals and in apartment blocks higher than 28 metres, where occupants are clearly at greater risk from a fire.

What is happening in Spain?

TECNIFUEGO, as an association that brings together companies and professionals in the sector, supports the EFSN campaign which asks European governments to legislate in favour of installing automatic sprinklers in buildings over 28 metres high, whatever their activity: residential, offices, hospitals, instead of only in hotels as is the case today in Spain. In addition, it participates in awareness campaigns about fires in homes, under the title: Fires kill, but protection is possible. These are intended to raise public awareness of the advantages of protection against fire through applying available technology.

In this sense, one of the contributions of TECNIFUEGO is its participation in Home Fire Sprinkler Day, organized by NFPA, where drills are shown in homes and the advantages and effectiveness of sprinkler protection are explained.

Conclusions

Finally, and to complete the vision of the benefits of the installation of automatic sprinklers at home, we are going to convey some conclusions from these campaigns:

1. There is a need to involve developers and end users in the benefits of installing fire sprinklers.
2. The escape time from a fire has been reduced to less than 4 minutes by the use of new materials in furniture and decoration.
3. A standard for residential sprinklers has been produced in Europe and can be used as the basis for future legislation.
4. Among the advantages of residential sprinklers, we must add the possibility that home insurance will be cheaper, as sprinklers offer a high degree of property protection, and a decrease in property taxes, since the community would have to invest less, both in firefighting personnel and in the urban layout for fire engine access in areas that are difficult to reach.
5. The environmental benefits are also noteworthy, by putting out a fire at an early stage, greenhouse gases are avoided, water is saved, and the water used is less contaminated with products toxic to the environment.
6. New sprinkler technologies make installation easier and cheaper, prevent leaks and are more decorative.
7. European sprinkler standards are well advanced and will make it easier to use less water to extinguish a localised fire.
8. Smoke detectors and sprinklers must both be installed.
9. The technology is so reliable it works 96% of the time, without relying on a power supply to activate.
10. We must correct the false belief that there would be a massive release of water. Only the sprinkler with a fire underneath it actuates.
11. The first steps should involve installing residential sprinklers in places with people who cannot self-evacuate when there is a fire, such as in nurseries, nursing homes and hospitals.
12. It is the simplest and most effective system for one of the most complex and dramatic risks. Highly recommended in all homes, and especially in isolated houses and apartment buildings.
13. TECNIFUEGO supports the EFSN campaign and we urge the Ministry to legislate in this regard, to require in the Technical Building Code the installation of sprinklers in buildings higher than 28 metres whatever their activity.

For more information, see our website tecnifuego.org

* U.S. Fire Administration, National Fire Data Center, National Fire Incident Reporting System Complete Reference Guide (U.S. Fire Administration, 2015), usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf.
** U.S. Experience with Sprinklers July 2017. Marty Ahrens © July 2017 National Fire Protection Association nfpa.org/research
*** EFSN eurosprinkler.org/es/ http://rociadoressalvanvidas.org/

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Dispelling Common Myths

Construction of new data centres and cold storage warehouses across the Middle East has raised questions about corrosion, which has long been the enemy of the dry and pre-action sprinkler systems that protect these spaces. Nitrogen as a supervisory gas was once considered an innovative way to reduce corrosion but has now become commonplace across the US and Europe. However, some in the region still have questions. Now Blake Tyler of Potter Electric endeavours to bust some common myths surrounding the use of nitrogen generators to combat corrosion and help further diminish the threat that corrosion presents in fire sprinkler systems everywhere.

The use of nitrogen in fire sprinkler systems has risen dramatically over the past decade with positive results. However, the process and products used to generate and deliver nitrogen can sometimes be cause for some apprehension. Having concerns is certainly not unusual when a new technology disrupts a long-standing traditional method. But whether you regard it as due diligence, or genuine scepticism, the myths that exist need to be addressed. These conversations are all part of the process and help to produce a better end-result.

The science behind nitrogen and its benefits in fire protection systems is simple. Nitrogen is a very stable inert gas when used in sprinkler systems. The term "inert" refers to its resistance or inability to react to what it encounters. Conditions are perfect for corrosion to occur inside the piping of a typical dry or pre-action sprinkler system.

Just like the fire triangle which requires heat, fuel and oxygen to support combustion, corrosion also needs three things : iron, oxygen, and water. Simply put, oxygen present inside the system reacts readily with the iron in the pipe, while the water helps the process occur. Once that process begins, corrosion thrives. But when the oxygen present in the air inside the piping is replaced with

an inert gas like nitrogen, the corrosion process can no longer be supported.

The concept may be simple, but the process of producing nitrogen and getting it into a sprinkler system could seem intimidating to some. The application of the technology is what often raises questions. However, time, research, and real-world experience have provided answers to many of these questions. Below are five of the most common myths and misunderstandings that occur, along with information to help put these fears to rest.

MYTH

Nitrogen use is hazardous

RESPONSE Concerns about safety are always taken seriously. But in this case, there's nothing to worry about. There are usually two aspects regarding safety and nitrogen use, and both deserve attention.

The first involves the safety of those working on or around the nitrogen generator and/or the sprinkler system using nitrogen. From a pure toxicity perspective, the answer is easy – nitrogen gas is non-toxic. Which is a good thing since the air we breathe on earth is made up of about 78% nitrogen. Like other inert, but non-toxic gasses, the risk lies in the potential for oxygen depletion if nitrogen is released in large enough quantities in a confined space. This is highly unlikely with the low volumes and pressures that nitrogen generators produce. Basic precautions such as ensuring adequate ventilation are typically recommended by manufacturers.

Often the hazards considered to be associated with nitrogen are a result of past experiences with compressed nitrogen in bottles or from liquid nitrogen. Compressed nitrogen comes with the same risk as any high-pressure cylinder. They must be secured against tipping and other physical damage to prevent a catastrophic "launching" of the cylinder itself. Liquid nitrogen is extremely cold, with a boiling point of-196°C. Because of that low temperature, nitrogen from a liquid source tends to settle into low areas, potentially increasing the asphyxiation risk. Neither of these hazards are present with the use of nitrogen generators.

The second part of this myth involves the flammability of nitrogen. Obviously, any material used in conjunction with a fire protection system must not worsen the fire it was designed to control. And that is certainly the case with nitrogen. In fact, nitrogen is used in many systems, including aircraft fuel systems, to reduce the risk of fire. The same characteristics that make it valuable for the prevention of corrosion – its ability to displace oxygen – also make it useful in preventing fires.

MYTH

Nitrogen generators are expensive, especially compared to traditional air compressors

RESPONSE Cost is always a concern, but when the benefits of nitrogen generators are weighed, their overwhelming value becomes apparent.

There's no doubt that the up-front cost of a nitrogen generator as compared to an off-the-shelf air compressor is higher. But that's not an even comparison. Now that nitrogen generator technology has existed for an extended period, and we have been able to witness first-hand the value of replacing the corrosive oxygen with an inert gas in sprinkler systems, we are able to quantify these money savings to address this myth.

Value means something different to everyone. If you ask a facility manager what brings them value in terms of their fire protection systems, they will likely respond with increased reliability and decreased maintenance issues. Both are areas where nitrogen generators are an asset. Water delivery time is an important factor in the success of a dry or pre-action sprinkler system in terms of suppressing a fire, and corrosion inside the pipe slows that water delivery, and in some instances, can completely block it. A study by NFPA in 2014 revealed that, although sprinkler systems are very reliable overall (about 96% of the time), when they activate but fail to control the fire, 18% of those cases are due to not enough water being released. Corrosion inside the pipe is certainly a factor in many of these instances.

Sprinkler system maintenance is another big concern facility managers have. Of all building systems, maintenance issues with sprinkler systems, especially impairments due to pipe replacement and other corrosion-related problems, can have some of the most catastrophic results. Whether it's losses from fires occurring during a system shut down or system failures that can cause substantial water damage, the value of nitrogen in limiting down time and structural pipe failures is significant. A recent study of nitrogen use in dry and pre-action systems shows an expected lifespan increase by a factor greater than five times. When considering those lifespan increases over a 60-year period, the cost savings from using nitrogen in lieu of compressed air is typically in the hundreds of thousands of Euros from maintenance alone.

MYTH

Maintaining nitrogen generators is difficult and costly

RESPONSE Not true, even when compared to traditional methods of supplying supervisory gas. Modern nitrogen generators, like Potter's IntelliGen series generators, are very low maintenance and the maintenance that is required is simple and intuitive. In most cases, coalescing filters clean the air before it enters the generator unit. Typical annual maintenance includes changing these filters, which is a straightforward process in most cases.

What sets a nitrogen generator apart from a standard air compressor is, of course, its ability to produce nitrogen. The most common, and lowest maintenance method of generating nitrogen is to remove it from the air using a membrane. Air from an air compressor enters the membrane after passing through the coalescing filters. As it passes through, everything except the nitrogen is stripped away. These membranes are designed to be maintenance free, can dry out if they get wet, and have an average lifespan of more than a decade with normal use. There are other methods of generating

nitrogen, namely pressure swing absorption or PSA. But this method entails more moving parts and has more required maintenance.

Besides routine maintenance like filter changes, the only other maintenance typically required is on the air compressor used by the generator. Most of the time, these air compressors are high quality and paired with the generator at the factory. Regular compressor maintenance (filters, belts, oil, etc.) can be expected, but as with the coalescing filters, is usually a part of the facility manager's regular preventive maintenance programme. The remaining elements of the nitrogen generator are electronic components that control the process, and valves. Both need very little routine maintenance.

MYTH

Nitrogen doesn't make that much difference

RESPONSE False. Nitrogen as a supervisory gas in dry and pre-action sprinkler systems has been proven time and time again to prevent corrosion.

Nitrogen generators are specified by most fire protection engineers because of the dramatic impact they have on increasing system life and decreasing maintenance. As discussed above, the piping of dry and pre-action sprinkler systems creates near perfect conditions for corrosion. Nitrogen supplied by a generator represents a simple, cost-effective, proven solution for disrupting that corrosive process.

MYTH

Nitrogen generators are only helpful on new systems

RESPONSE Not true. Although nitrogen can't reverse corrosion that has already occurred, it can slow the process that is ongoing, and help prevent additional corrosion from getting started.

The best case is one where a dry or pre-action system has used nitrogen for supervisory gas since it was first installed but retrofitting a nitrogen generator onto an existing system is always a good option.

Sprinkler systems begin corroding almost immediately, and typical air compressors just exacerbate the problem by continuously reintroducing new, moist, oxygenated air into the piping. The sooner that process can be stopped, the longer the system will last.

Take a scenario where piping is severely corroded, and pieces are being replaced on a regular basis due to leaks. Once a nitrogen generator is installed on that system, the amount of pipe needing replacement decreases exponentially, and eventually may even stop. Alternatively, without changing to nitrogen, it would be a never-ending process of pipe replacement.

Sprinkler challenges in the food industry

The food industry has many high value sites that need sprinkler protection but as Ronald Oldengarm and Johan Hoogeweg remind us, combinations of cold temperatures and hygiene requirements bring their own specific challenges.

One of the sectors currently under a magnifying glass with insurers and customers is the food processing and handling industry. Fires in these types of buildings can have a major impact on the delivery of food to consumers. In recent years there have been several fires in food factories that have led to empty shelves in supermarkets.

At the same time, a market trend in recent years has been a consolidation of production sites. Small sites are being closed and existing sites are being expanded to create 'mega' factories. Therefore, the consequences of a fire in this type of building can be significant for both the business owner and the customers. To ensure business continuity and from the perspective of insurability, the presence of a sprinkler system is increasingly required.

Dividing large production locations into small fire compartments, as often required by building regulations, is often not possible or desirable. Think of the transport systems present and the desire to create large open spaces for processing and storage of goods. A sprinkler system can be part of an equivalent fire safety strategy.

Installing a sprinkler system in a food processing plant sounds simple, however there are more points to consider than you might think. In this article, we will zoom in on some common situations that require a lot of attention when installing a sprinkler system. We will use as an example a slaughterhouse where meat is processed into finished products for sale in supermarkets. For the sake of simplicity, we will also use EN 12845 as the sprinkler rule. There are other design standards such as published by the National Fire Protection Association (NFPA) or FM Global.

Hazard classification

One of the first points to address when designing a sprinkler system is to determine the design criteria – which hazard class is applicable?

Appendix A of EN 12845 [1] indicates the hazard class for many occupancies. Table 1 shows an example of the hazard classification based on this Annex.

Ordinary hazard group 2 (OH2)	Ordinary hazard group 3 (OH3)
Abattoirs, meat factories	Dehydrated vegetable and soup factories
Bakeries	Sugar factories
Biscuit factories	
Chocolate factories	

Table 1: hazard classification (EN 12845: Table A.2 — Ordinary Hazard occupancies)

Using this annex the building falls under the description "Abattoirs, meat factories" and will be classified as an 'Ordinary hazard group 2' risk. A frequent mistake is to automatically declare this classification as suitable for the entire object. Of course, there are areas that fall within this class. However, if we make a proper analysis of the use and associated fire behaviour of the materials and processes present in the building, we often conclude that in some areas a different hazard class is required. For example, take an area where large pieces of meat are cut into small pieces. The activity itself falls within an OH2 class but the stacks of plastic crates or pallets used to store the products mean a higher hazard class should be applied, at least OH3 depending on the stack height. Local storage of packing materials like foam meat trays and foils can similarly lead to a higher hazard class. There are also areas where empty plastic crates are stored on the floor, see figure 1. These fall into a much higher hazard class.

Figure 1: storage of empty crates e.g. " Dolav"

It is possible that EN 12845[1] does not give guidance on how to protect a certain situation. For example the storage of plastic pallets over 3 metres high in areas with a ceiling height over 7.6 metres is not covered. It is then sometimes possible to achieve suitable protection by using other design standards such as NFPA 13 or the FM data sheets. The use of these design standards must be accepted by all parties involved.

Incorrectly determining the hazard class can have major consequences later. The sprinkler system will have insufficient capacity to control the fire so the usage must be adjusted to what the sprinklers can protect. This can have far-reaching consequences for the usability of the building.

Food safety

If there is one aspect that is important in this type of building it is food safety. For the users this often even takes precedence over fire safety. A sprinkler system must therefore be suitable for use in an environment where there are high demands regarding food safety. Some aspects to take into consideration are:

Glass bulb sprinklers: The use of glass bulb sprinkler heads is something about which people are very wary. Although the chance of a sprinkler bulb spontaneously breaking is very small a head can always be broken during work activities. Just the idea that glass could

Figure 2: Left glass bulb sprinkler head, right all-metal sprinkler head.

be released, which is then very difficult to retrieve and detect (very small pieces) is a nightmare scenario for many users in the food sector. The use of all-metal fusible link sprinklers is then a good solution, because metal is easier to detect, see figure 2 for an example. Metal, fusible link sprinklers are almost always used in food processing facilities.

Cleaning: From a food safety perspective, rooms and facilities must be cleaned regularly. Aggressive cleaning agents are often used for this purpose. The need for piping systems, including hanging and bracing, that are resistant to corrosive cleaning agents often in practice results in the application of stainless-steel pipes. It is important that the cleaning agents used are compatible with the materials used. For example, cleaning agents based on chlorides can lead to corrosion problems with stainless steel.

Figure 3: corrosion due to cleaning agents

System type	Cooling	Stainless steel piping	'no glass'	Cleaning with chemicals	Cleaning with Steam >100 oC activation temperature
Wet pipe	No	Possible	Possible	Possible (1)	Possible
Dry pipe	Yes	Possible	Possible	Not possible (2)	Possible
	Yes	Possible	Not possible	Possible	Possible
Anti-freeze	Yes	Possible	Possible	Pssoble (1)	Possible

Table 2: Matrix of options (1) Use stainless steel pendent sprinklers (2) No upright stainless-steel sprinklers are currently available on the market.

To ensure the long-term proper functioning of a sprinkler head it must be resistant to the cleaning agents used. Figure 3 shows an example of an indicative test of a sprinkler head where a cleaning agent caused heavy corrosion after a period of four weeks.

Steam is often used in cleaning. This should be taken into account when determining the activation temperature of the sprinkler, which should be above 100°C.

Cooling: To maintain food freshness the rooms are actively cooled. The temperatures can drop locally below 4 °C. Additional measures are then required to prevent damage from freezing in the pipe network. Possible solutions to prevent freezing of pipes include the use of:

- dry-pipe systems, with upright sprinklers
- pre-action systems, with upright sprinklers
- anti-freeze systems, with food-safe anti-freeze for small areas
- insulation and heat-tracing of pipes

The latter option is often undesirable from a hygienic point of view and is also inappropriate for a sustainable building because the pipes are permanently heated to prevent freezing.

High airflows can also impact the effectiveness of the sprinkler system.

Sprinkler system design

The above issues are easy to solve as individual challenges. It only starts to get interesting when more than one of them occur together.

In Table 2 some different options are put together in a matrix.

The above table shows it is possible to achieve a sustainable and reliable system for many combinations of challenges. The difficulty arises when a dry-pipe system is required, there is a demand for high corrosion resistance of the applied heads and there is a 'no glass' requirement. Stainless-steel sprinkler heads that have a very high resistance to corrosion are currently only available in a pendent variant. Also K-factors above 115 are not available in stainless steel.

Each situation must be carefully examined to determine the best option. The conclusion can be that replacement of parts, such as sprinkler heads, must take place more often than usual.

Last but not least

Providing adequate sprinkler protection in buildings where food is processed requires a lot of attention; there must be a good understanding of:

- the use of the building
- the room conditions such as temperature and air velocity
- the method of cleaning

This requires proper consultation with all the parties involved and choosing the right technical solutions. Sometimes it has to be admitted that not everything can be solved perfectly.

1 EN 12845 Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance: 2015

Fixed firefighting systems for road tunnels

Johnny Jessen, Business Development Manager - Underground Facilities, VID Fire-Kill reports that the company has experienced an increase in interest for the TUNPROTEC® Low Pressure Watermist Solution for tunnel protection. The reason for this is believed to be a combination of different factors such as a growing focus on safety and property damage in road tunnels and the large amount of research conducted showing the effectiveness and benefits of fixed firefighting systems in tunnels.

TUNPROTEC® Fixed Fire Fighting System for tunnel protection has been developed by VID Fire-Kill, a Danish-based leading developer and supplier of low pressure water mist firefighting systems and components. Within the last couple of years, we have noticed a growing interest for our specially designed tunnel solution. This interest, we believe, is due to a combination of things. Full-scale tunnel fire tests have proven that fixed firefighting systems can even suppress large heavy goods vehicle fires, while tunnel owners are required to provide better protection of their tunnels to protect people as well as property assets and decrease the downtime or closure of a tunnel after a vehicle fire.

The most common fixed firefighting systems for tunnels are either deluge or water mist (low or high pressure). Both technologies work in deluge operation, dividing the tunnel into 20 - 30 m fire zones with open nozzles that are activated by opening a section valve. Both technologies use many of the same firefighting methods, but with variations.

Deluge/sprinkler firefighting

Deluge systems operate with distribution of large droplet sizes (> 1mm) with low kinetic energy when discharged by the nozzle. Deluge systems suppress the fire by discharging large amounts of water over specified areas and thereby wetting and cooling the fuel surface.

Deluge/sprinkler systems typically use open sprinkler heads/nozzles, applying typically:

Nozzles: Min. 1.1 bar
Pumps: 6 bar

Deluge/Sprinkler offers:

- Robustness,
- High water consumption/flow rate,
- Less maintenance than high pressure water mist,
- Lower component costs (using typically coated steel pipes (PN16)),
- Can share water-main with the hydrants

Water mist firefighting

Water mist employs several firefighting methods that make it equal or better than deluge/sprinkler solutions, but with significantly less water consumption. Water mist uses a combination of wetting the surface and distributing smaller droplets which quickly can absorb more energy/heat from the fire than the larger droplets distributed by deluge systems.

Water mist (High Pressure)

Operates with a relatively high pressure and uses open sprinkler heads/nozzles, applying typically:

Nozzles: 35-80 bar
Pumps: 64-140 bar

High pressure water mist technology distributes water in very

small droplets and the high pressure applied (35+ bar) results in a high droplet energy/heat absorption and evaporation rate.

High pressure water mist offers:

- Smaller pipe dimensions than a deluge system,
- Less spatial requirements than a deluge system,
- Significantly lower water consumption than a deluge system,
- Require larger pumps and power than deluge and low pressure water mist
- More complexity and less robust than a deluge system and low pressure water mist,
- Require more maintenance service/sequences than a deluge system and low pressure water mist,
- A less cost-effective system than deluge & low pressure water mist.

Water mist (low pressure)
Operates with a relatively low pressure and uses open sprinkler heads/nozzles, applying typically:

Nozzles: 10 bar
Pumps: 15 bar

Low pressure water mist technology can be described as a technology that utilises or bridges the best from the deluge and high pressure water mist technologies. Low pressure water mist offers:

- Smaller pipe dimensions and spatial requirements similar to high pressure,
- Simplicity and robustness like deluge,
- Low maintenance requirements like deluge,
- Low water consumption like high pressure,
- Can share water-main with hydrants like deluge,
- Cost efficient = can utilise standard PN 16 components and press-fit like deluge,

Japan was the first country to install a fixed firefighting system in a tunnel more than 50 years ago. Japan, together with Australia and USA, prefer deluge systems. In European tunnels, (except for Sweden) water mist is the preferred technology.

Singapore is another country that typically applies deluge systems in their road tunnels. For the major upgrade of South-East Asia's longest urban road tunnels, the Kallang-Paya Lebar tunnel and Central Expressway tunnel, Land Transport Authorities (LTA) in Singapore wanted to install a fixed firefighting

system in the tunnels, as Singapore authorities prohibited long vehicles from entering the road tunnels as part of the fire safety measures to minimize the risk of heavy goods vehicle fires. The tunnels were opened without fixed firefighting systems being installed. When studying the installation of a deluge system it became clear that there was a very practical problem in that the drainage capacity in the existing tunnels was unable to support the installation of a deluge system.

In 2018, Land Transport Authorities (LTA) initiated a tender for refurbishing the tunnels, including the installation of a fixed firefighting system, indicating water mist as the preferred technology in the tender due to the lower water consumption.

In spring 2018 VID Fire-Kill's TUNPROTEC® Low Pressure Water mist Solution was selected as the preferred solution for the two tunnels in Singapore.

- Our low pressure water mist solution was selected due to several advantages over a deluge solution and high pressure water mist
- Our system offered significantly less consumption of water than conventional deluge systems
- Our system allowed for a significantly smaller water reservoir and drainage system
- Our system required significantly less space for pipes and valves
- Our system reduced installation time by 35% due to the modular prefab nozzle pipes and press-fit installation, less complex valve trims and installation.

Another criterion from LTA was that the low pressure water mist solution should offer the same capabilities as a deluge system in relation to fighting a heavy goods vehicle fire, i.e. reducing the heat release rate at high ventilation velocities.

In 2018, TUNPROTEC® underwent an extensive series of full-scale tunnel fire testing in San Pedro de Anes test centre in Spain with potential fire scenarios of up to 250 MW. The tests showed that the heat release rate reduction was equal to a deluge system. Further, all tenability requirements in accordance with NFPA 502 were fulfilled and the system was approved by LTA.

(KPE) & (CE) tunnel protection highlights:

- The project includes more than 1,200 deluge valves
- 100 km of pre-fabricated nozzle pipes.
- Tunnel width: varies between 15.3 and 19 m
- Tunnel Height: 5.9 m
- Installation Year: 2018-21

We are confident that the firefighting industry will see an increasing demand for more sustainable active tunnel firefighting solutions in the future.

A solution is needed now

There is no doubt that the trend towards the use of synthetic fluorine free foams (SFFF) in fixed fire protection systems is gathering pace. The conversation is no longer if, or even when, it is simply that the market needs a solution now. Unfortunately, these solutions are not coming to market quickly enough to meet legislative and environmental demand and any hope of "drop in replacements" is beyond reality for now. A particular area of concern explains Simon Barratt, Foam Product Manager, Viking, is the availability of suitable SFFF products for use in conventional sprinkler systems.

So what is the problem?

Fire protection sprinklers and sprinkler nozzles are a simple but effective form of active fire protection used in many different applications globally. They are deployed in closed head systems with a fusible element or as sprinkler nozzles in open deluge systems with the fusible element removed. For many years, we have been enhancing these systems with foam to tackle more challenging fire scenarios such as those posed by Class B ignitable liquids. Typical applications are refineries, aircraft hangars, manufacturing and logistics centres with ignitable liquids and other commodities, where water alone is less/ineffective.

Conventional fire sprinklers were not designed with foam use in mind. They are designed to efficiently distribute water in the desired manner depending on the object or risk they are protecting. They are also small, discreet and, due to the high volume used throughout the world, have a sensitive, almost commodity-based price point. Despite this, used with the correct combination of system components and foam concentrate, they can perform very well as foam-enhanced sprinkler systems.

Foam qualities and discharge devices

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

The second important factor is the Drainage rate. This is a measurement of how quickly the expanded foam returns to a solution. Effective performance is a balance of the two, as the expansion is needed to form a blanket over the ignitable liquid and starve the fire of oxygen whilst the drainage is important to provide a continual cooling effect on the fire and surrounding structures.

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

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

Why is a sprinkler different?

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

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

Both these organisations recognise that conventional non-aspirated sprinklers are different in foam performance to other discharge devices and therefore,

Foam Water Sprinkler Discharge Devices

Foam water sprinklers are Approved with the concentrate specified in this listing and at the application rates specified in the table below. The use of foam water sprinklers with other concentrates or at other application rates may result in foam of significantly different fire extinguishing capabilities and burn back (reignition) resistance.

Product	Type of Equipment	Concentrate % in Water	Configuration	Approved Fuel Hazards	Min Solution Application Rate		Max Subsequent Water Application Rate		Min Installation Height		Max Installation Height		Connection	Orientation	K-Factor
					gpm/ft²	(mm/min)	gpm/ft²	(mm/min)	ft	(m)	ft	(m)			
VK100, VK108, VK300, VK301	Automatic Foam Water Sprinkler	3x3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Hydrocarbon	0.2	(8)	0.3	(12.22)	5	(1.5)	20	(6.1)	1/2" NPT	Upright	5.6
VK100, VK108, VK300, VK301	Automatic Foam Water Sprinkler	3x3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	IPA	0.2	(8)	N/A		5	(1.5)	20	(6.1)	1/2" NPT	Upright	5.6
VK100, VK108, VK300, VK301	Automatic Foam Water Sprinkler	3x3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Acetone	0.3	(12)	N/A		5	(1.5)	20	(6.1)	1/2" NPT	Upright	5.6

FM Approval Guide – Fixed Extinguishing Systems

the traditional foam quality approach is not applicable. Instead, each sprinkler type is tested under prescribed conditions with variables such as foam concentrate type, K-Factor, application density, fuel type and installation height. The example sprinkler and foam concentrate approval in the Table gives clear design and usage parameters from the fire testing.

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

A difference with the European Standard

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

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

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

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

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

New advances in SFFF

It should be recognised that we are in a phase when demand for Approved/Listed foam systems is moving faster than manufacturers can bring solutions to market. This situation is not due to complacency or lack of effort, it is because replacing fluorinated foam systems with non-fluorinated is challenging, time consuming and expensive. At the time of writing, there is a slow increase in the number of high-quality foams meeting some of the requirement of FM5130 and UL162 entering the market. Choices for foam concentrates with non-aspirated foam concentrates remain very small however.

An exciting new foam to enter the market is Fomtec's Enviro ARK product, which is developed in conjunction with a selection of Viking sprinklers and hardware. The Enviro ARK foam concentrate becomes the very first SFFF foam concentrate to achieve FM Approval for use on hydrocarbon and polar solvent ignitable liquids. This achievement is the culmination of many years of work with a strict focus on non-aspirated sprinkler performance. For certain applications, particularly warehouse storage, it is important to have a high performing foam working with non-aspirated sprinklers as there can be thousands of these small, cost effective foam discharge devices installed.

Although aspirated sprinklers are available, these tend to be expensive by comparison and some also miss high-level approvals such as FM and UL. They are also larger in size which may be an issue for installation compared to a conventional sprinkler and for sure would increase system material costs.

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

For additional information, please contact the author, Simon Barratt at barratts@viking-emea.com

Simon is the Foam Product Manager for Viking with 20+ years in the fire sprinkler and foam market.

How old is this sprinkler head?

How can you tell how old a sprinkler head is? This seems very simple but sometimes it is quite hard to find out. In this article, Johan Hoogeweg, Fire Safety Consultant, takes a closer look at how to determine the production year of a sprinkler head.

Figure 1: date on the deflector 1979, Wormald model D

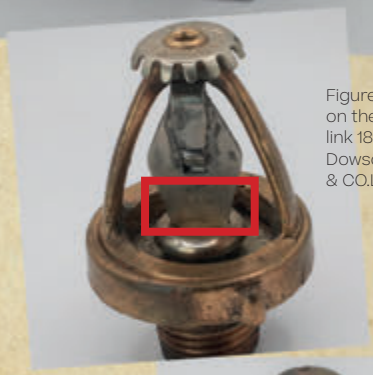


Figure 2: date on the thermal link 1899, Dowson Taylor & CO.LTD.

Figure 3: date on the frame 1909, Rockwood model B 'double hat'

Figure 4: Date on the thermal link '65', behind the 'hook' 1965, Automatic

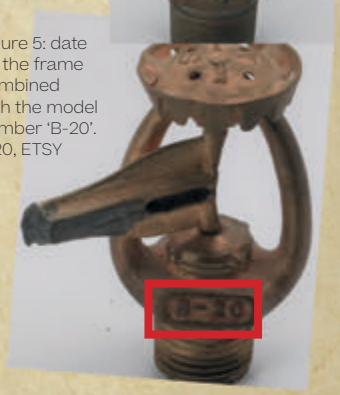


Figure 5: date on the frame combined with the model number 'B-20'. 1920, ETSY

One of the most important parts of a sprinkler system is the sprinkler head itself. Without a properly functioning sprinkler head, the system will certainly not detect and control or extinguish a fire. All sprinkler standards include requirements and/or advice on how to carry out maintenance in order to keep the installation in a state where it will function when needed. For example annex K of EN 12845 states that after 25 years 'A number of sprinklers should be removed and tested to ensure that they are fully functional.'

Test frequency

Depending on the applicable maintenance standard, different moments apply when sprinkler heads must be tested. Table 1 shows the test intervals for two commonly used maintenance standards.

Standard	Sprinkler type / situation	Frequency
EN 12845[1]	All sprinklers	25 years
NFPA 25[2]	Sprinklers	50 years and every 10 years thereafter
	Sprinklers	75 years and every 5 years thereafter
	Dry-sprinklers	15 years and every 10 years thereafter
	Extra-high temperature or greater solder type sprinklers	5 years
	Fast response sprinklers	20 years and every 5 years thereafter
	Sprinklers in harsh environments	5 years

Table 1: Inspection frequency for sprinkler heads
NFPA 25 also states that sprinkler heads manufactured prior to 1920 should be replaced.

How can you find a date?

How can you tell what the production year of a sprinkler head is? How would you find out the age? Drawings and documents often do not give this information, are incomplete or there have been many changes in the building resulting in many differences in the system Sometimes you can find the heads in the spare sprinkler cabinet in the sprinkler pump room or near the alarm valves.

Adding a production date on the head is actually quite common since the first sprinkler heads appeared on the market. Adding a date is also mentioned as a requirement in modern product standards like FM class 2000[3]. 'the following shall be displayed on a non-operating part of the sprinkler: Year of manufacture...'

Each manufacturer places it in a different location. Common locations where a date on the head can be found are:

- on the deflector, figure 1
- on the thermal link, figure 2
- on the frame, figure 3

The way a date is written may vary, as an example the following ways occur: 1990, 90 or a combination of a model number with a year like M90. 04 can be 1904 or 2004, but in general based on the design of the head, it is easy to see the correct period.

With this knowledge, you can take the ladder and go up to the ceiling. Can you easily see the date? Well, sometimes it is very clear, sometimes you need a magnifying glass and in other cases it is so obvious that you overlook it. Dirt, dust or a little paint on the frame can easily hide the date. Some manufacturers are really good at minimal markings or hiding them.

The following pictures show some places where you can find the date on a sprinkler head.

Sprinklers without a date?

Sometimes there is no date on a sprinkler head, particularly on sprinklers from before 1900. From literature it is often possible to determine the period in which the sprinkler head was produced. A good reference book is 'Automatic Sprinkler protection', published in 1919[4]. The exact production date is not mentioned but in 1906 they made the model E and older models were no longer produced. So it is safe to say this head was produced before 1906.

Figure 6: Date on the thermal link in small letters '98'. 1998 Reliable

Figure 7: Date on the frame in thin letters '19 53' Angus Fire Armor Ltd.

Figure 8: Witter head

WITTER

Witter & Son, Bolton, England.

1. Pendent valve sprinkler. Valve held in place by lever hooked to frame at each end and with adjusting screw passing through the center. Fusible joint consisted of two flat angular parts pivoted at top and soldered together at lower end. Spring under valve disc.

WITTER

WITTER. E

E-1906. Upright or pendent valve sprinkler. Valve disc held in place by strut. Spring under valve disc.
Not used in America so far as known.
Used extensively in England and other countries.

Figure 9: reference in literature

References

1 EN 12845 Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance: 2015
2 NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems: 2020
3 FM Class Number 2000 Approval Standard for Automatic Sprinklers for Fire Protection: 2018
4 Automatic Sprinkler protection, Gorham Dana: 1919

All pictures are taken from the private collection of the author

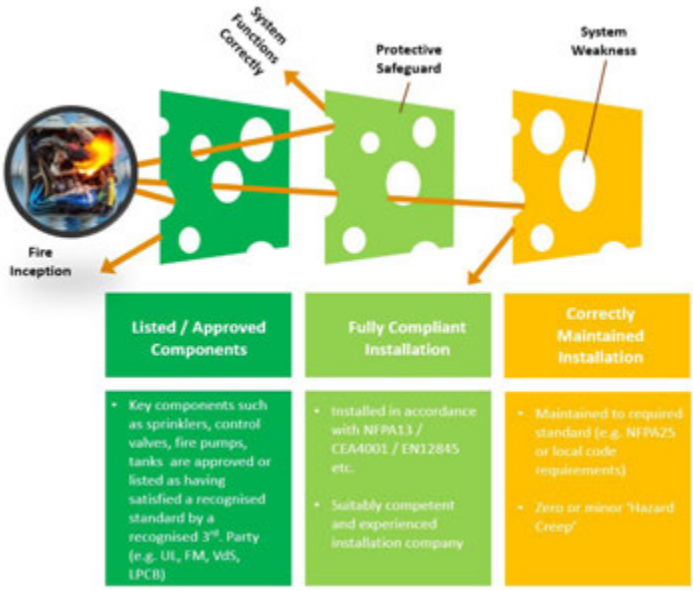
Statistics reveal, reports Guy Watson of Reliable Automatic Sprinkler Co., that when properly installed and maintained, automatic fire sprinkler systems are a highly reliable and effective way of controlling and limiting the spread of fire in a building, and providing essential life safety, property and business protection functions.

Maintaining sprinkler system reliability

The most recently published studies have reported that where sprinklers could have been expected to have operated, the reliability was found to be greater than 99% (Melin 2018, Parsons 2018.) This high level of reliability is a product of several factors, including:

1. Use of system components that are Listed / Approved to a recognised standard by a 3rd party certification body (e.g., UL199 for sprinklers)
2. System components installed in accordance with manufacturer's instructions
3. System designed and installed in accordance with a recognised standard

Sprinkler systems are not 'out of the box' solutions, i.e., they are not bought as a complete article in the same way that a car is manufactured for a customer. End-users rely on the expertise of a suitably competent installation company to follow a generic sprinkler standard (e.g., EN12845 or NFPA13) and to satisfy a performance specification that is agreed by the Authority Having Jurisdiction (AHJ). Understandably, AHJs who approve and verify design concepts invest a considerable amount of time and energy ensuring that the above three factors are rigorously complied with during a new installation project.



For new systems everything should be compliant on day one, after which it is typical that planned maintenance will be undertaken for the next 12 months by the installation company. Planned maintenance is an essential link in the chain, the 'fourth factor' that must be in place to ensure that reliability continues to be above 99% over the lifetime of a system. But where is the information to be found that details the 'Who / What / When / Why?' regarding ongoing system maintenance? The answer is not as straightforward as it may first seem because all the information does not exist in a single document. Although there are published standards that provide a good level of guidance, this is just one layer of information. Other layers of information may include national annexes, insurer's requirements, and manufacturer's technical bulletins.

Standards for Maintenance

In Europe, EN12845 is the widely adopted installation standard. Chapter 20 of this standard provides guidance on what the planned maintenance regime should look like following commissioning.

However, the following should be considered when evaluating planned maintenance requirements:

- Chapter 20 is not intended to be a detailed, extensive guide on how to maintain the individual components that make up a particular sprinkler system
- When read in isolation, Chapter 20 can be misinterpreted by both contractors and AHJs
- The experience of many AHJs is that although EN12845 is widely adopted as an installation standard, Chapter 20 is not widely enforced throughout Europe

National Annexes

To help provide a 'Road Map' on how the system should be maintained, and to address the points above, various countries have included more detailed information on how sprinkler systems are expected to be tested & maintained in national annexes (e.g., TB203 in the LPC rules appended to the UK version of EN12845).

Insurers' Requirements

Insurance brokers such as Aon and Willis Towers Watson, and insurance companies such as Zurich, Aviva and Generali publish their own details on the levels of planned maintenance expected to be in place over the lifetime of a system. These detailed publications supplement maintenance standards or national annexes.

	EN12845	NFPA25
Who?	**20.1** - 'The user shall appoint an individual and a substitute, who after they have been given the necessary Instructions, shall ensure that the system remains in working condition' Annex P.5.2 (c) '...sprinkler system maintenance contract with a qualified company' Annex M – 'It is usual in European Countries, for companies given the responsibility to design, install and maintain sprinkler systems in accordance with this current European Standard, to be certified in this field by an independent certification body.'	**4.1.1** – Responsibility for properly maintaining the system lies with 'The property owner or designated representative' **4.1.1.2** – Requirement for 'Qualified personnel to perform inspection, testing and maintenance **4.1.1.3** – Circumstances in which responsibility can be delegated **4.1.1.4** – '...the designated representative shall comply with the requirements identified for the property owner or the designated representative throughout this standard.'
What?	**20.2.1** - 'The installer shall provide the user with a documented inspection and checking procedure for the system. The programme shall include instructions on the action to be taken in respect of faults, operating the system, with particular mention of the procedure for emergency starting of pumps, and details of the weekly routine of 20.2.2.' **20.3.1.1** - 'In addition to the schedule given in this clause any procedures recommended by component suppliers shall be carried out.' Annex F.8 – Additional precautions for maintenance Annex K – 25 Year Inspection	Table 5.1.1.2 – Summary of Sprinkler System Inspection, Testing & Maintenance Sprinklers, Pipe Supports, Water Motor Alarms: **5.2** – Inspection Frequencies **5.3** – Testing Frequencies **5.4** – Maintenance Frequencies Fire Pumps: **8.2** – Inspection Frequencies **8.3** – Testing Frequencies **8.4** – Maintenance Frequencies Water Storage Tanks: **9.2** – Inspection Frequencies **9.3** – Testing Frequencies **9.4** – Maintenance Frequencies Common Components & Valves: **13.2** – Inspection Frequencies **13.3** – Testing Frequencies **13.4** – Maintenance Frequencies Internal Piping Condition and Obstruction Investigation: **14.0**
When?	**20.2.2** – Weekly Routine **20.2.3** – Monthly Routine **20.3.2** – Quarterly (3 Monthly) Routine **20.3.3** – Half-Yearly Routine **20.3.4** – Yearly Routine **20.3.5** – 3 Yearly Routine **20.3.6** – 10 Yearly Routine	

Summary - Who? What? When? Why?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Additionally, risks insured by FM Global may receive detailed information on sprinkler system maintenance and testing.

Manufacturers' Technical Bulletins

Manufacturers of sprinkler system components (i.e., sprinklers, alarm signalling devices, control valves, pumps, tanks) produce regularly updated, detailed instructions on how specific components are to be maintained and tested. The frequency between maintenance operations will typically be aligned with the requirements of NFPA25, (National Fire Protection Association standard for the 'Inspection, Testing and Maintenance of Water-Based Fire Protection Systems') - although if a local code, national annex, or insurer requires more regular frequencies, these requirements should be incorporated in addition to any requirements mentioned in a manufacturer's technical bulletins.

NFPA25 is a globally recognised standard that specifically focuses on how sprinkler systems should be maintained. It is a valuable resource for installers and end-users throughout the world, who should be familiar with its contents for the following reasons:

- It is currently the most detailed standard available for sprinkler system maintenance
- It is currently the most up-to-date standard for sprinkler system maintenance
- USA-based manufacturers of sprinkler system components design their equipment to comply with the requirements of this standard (and where local codes and standards differ, it may be the unwritten intention that these are applied in addition to the requirements of NFPA25.)

NFPA25 Key Facts

- Technical Committee appointed 1990
- First edition published 1992
- Current edition 2020
- Can be viewed for free at www.nfpa.org/25

The National Fire Protection Association refers to its standards as 'Living documents, continuously adding new ways to keep people safe in an ever-evolving world.' Innovation in fire safety technology is constant, and the 2020 edition of NFPA 25 introduces new technologies including automated testing technology, such as a flow switch capable of simulating water flow.

Why?

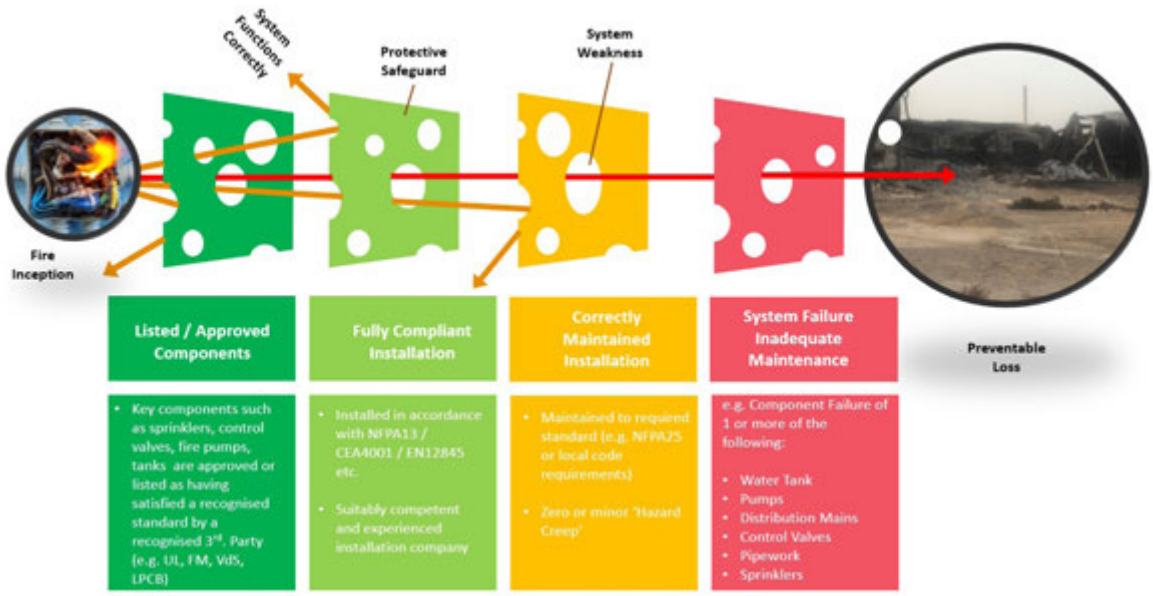
Automatic fire sprinkler systems are a fairly standard building-code requirement, but they are far from being a 'fit & forget' product. In general, sprinkler systems in Europe are installed to high standards and the vast majority comply with some globally recognised installation standard. However, it is regularly reported by insurance inspectors that ageing systems are not being maintained to a globally recognised standard.

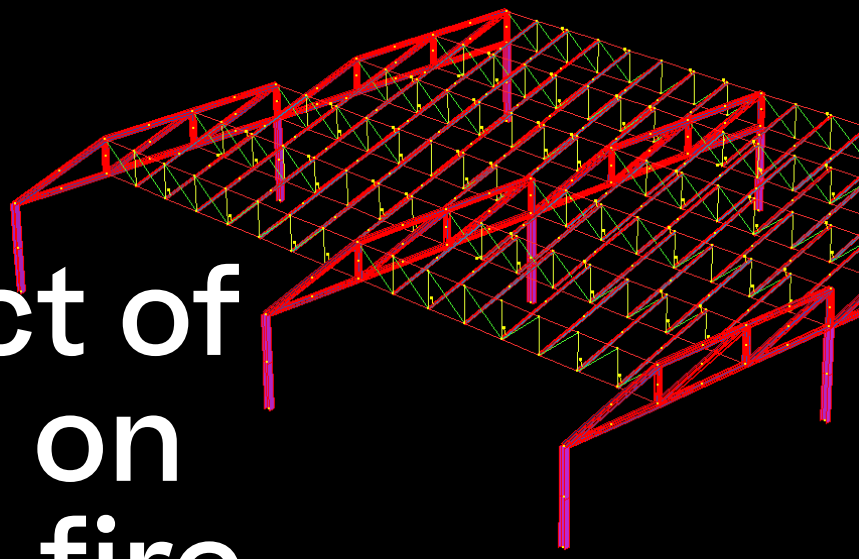
Automatic sprinkler systems are a significant investment, the benefits of which are not always immediately obvious. For example, even if a sprinkler system spends its entire life only in stand-by mode, it can pay for itself through savings on insurance premiums (often huge underwriting decisions are based on the high reliability of fully serviceable systems.) Additionally, the anticipated performance of the system in a fire scenario may be used for life safety purposes throughout the lifetime of a building, such as permitting an increase the allowable distances to fire exits.

Conclusion

The ability of a sprinkler system to function as originally intended is dependent on a suitable planned maintenance regime. As the system ages, the budget for planned maintenance will need to be increased to allow for the required 3-, 10- & 25-year inspections. However, the budget for planned maintenance will always be less than the costs associated with reactive maintenance, (i.e., such as when components fail due to inadequate servicing.)

If component failure due to insufficient maintenance coincided with a fire event – the costs associated with property loss and business interruption, not to mention the possibility that lives could be lost, could be catastrophic. This makes investing in a high standard of planned maintenance excellent value. It therefore follows that maintenance standards such as EN12845 Chapter 20 and NFPA25 should always be considered as a starting point for establishing the scope of a planned maintenance regime, not the finish line.





The impact of sprinklers on structural fire resistance

Structural fire resistance is always included in code requirements, its purposes being to ensure that the load-bearing capacity of the structural members and compartmentation of the building are maintained for a minimum time during a fire. Its evaluation with an analytical approach allows structural fire engineers to verify regulatory compliance in lieu of using methods in the Eurocodes, which often end in rejection or the necessity to apply expensive passive protection. Daniele Andriotto, Giovanni Cosma and Luciano Nigro of Jensen Hughes examine the evaluation procedure.

The evaluation of the resistance of a building according to the so-called natural fire curve allows fire specialists to determine the actual behaviour of structures during a realistic fire scenario, rather than by referring to the conventional temperature / time fire development curves.

A full analytical procedure for structural fire design would address the behaviour of the structural system at elevated temperatures, the potential heat exposure and the beneficial effects of active and passive fire protection systems, together with the uncertainties associated with these three features and the importance of the structure. This fire safety engineering (FSE) approach applied to the fire resistance of structures can nowadays be considered a specialized discipline and branch of engineering.

The general starting conditions common for any structural calculation are defined within the European standard series EN 1990 – also called Eurocodes – where to obtain an accurate calculation of fire resistance an in-depth study of the mechanical behaviour of the structural elements must be conducted, to analyse the possible interactions between elements when stressed in different ways and to evaluate the thermal conductivity of the structure.

Within the prescriptive approach, the thermal effect of the fire on structures is determined using a nominal time-temperature curve defined within EN 1991-1-2, also referred as the ISO834 curve.

After having determined the thermal effects of the fire using this temperature-time curve, the fire engineer must evaluate the response of the structure, choosing an appropriate method to solve the heat transfer equations and determine the structural temperature-time curve.

The second step according to this prescriptive approach is the assessment of the structural behaviour and the evaluation of any possible mitigation measure. Even the selection of passive structural fire protection can be made using a prescriptive approach, where the time is defined by national regulations. On the other hand, when following a performance-based approach, it is the fire engineer's task to quantify the risk associated with the building and to demonstrate that acceptable thresholds are met. This study highlights the structural performance of a building subjected to a fire with a focus on how active fire safety systems can influence the result.

Performance based design

When structural fire resistance is calculated using the natural fire curve, the fire resistance performance must be determined through thermal and structural modelling of the entire structure or significant sub-groups of structures to address all the indirect, imposed or hindered stresses that are generated by deformations or expansions.

When the safety factors included within the nominal fire curves procedure are no longer considered, it is essential to analyse the indirect stresses, caused by the

thermal expansion of the structures affected by the temperature gradient, which usually prevent the verification of the structure with the "single element" method.

When advancing a performance-based design approach, particular attention must be given to the documentation to be produced. Above all, the fire resistance design must be clearly documented while illustrating the philosophy and the assumptions adopted to develop the calculations so that the regulator can fully understand the adopted strategy and evaluate it accordingly.

The documentation must therefore include at least the following main steps:

- Review of the architectural design of the building under examination
- Definition of fire safety objectives
- Identification of fire risks and possible consequences
- Identification of possible fire safety strategies
- Identification of the acceptance criteria and calculation methods used for the analysis
- Identification of the fire scenarios adopted for the analysis.

Particular and careful attention must be given to the identification of the fire scenarios, which will determine the temperature gradient acting on the structure and therefore its behaviour during a fire.

The fire scenarios must outline the expected Heat Release Rate (HRR) curve, and should take into account the fuel load, its spatial configuration in the analysed building, and all the other phenomena that can change the outcome of the fire, e.g. the presence of an active fire suppression system, the availability of ventilation within the enclosure and the type of fuel involved in the fire.

The effects of ventilation in a fire have been thoroughly studied and different calculation methods have been derived from field experiments allowing fire engineers to distinguish between the fuel-controlled fire and the ventilation-controlled fire, in which the rate of burning is determined by the maximum rate at which air can flow into the compartment.

Unlike in ventilation-controlled fires, where the amount of oxygen can be directly and precisely calculated to understand its effects on the development of the HRR, the effect of fire suppression systems cannot easily be evaluated as little work has been performed on the effects of automatic sprinklers on fire severity and smoke movement. Nonetheless, it is worldwide accepted that automatic sprinklers provide a very efficient means of controlling fires within a building, often limiting the fire at the initial stage of growth and restricting the heat generation to a single compartment. However, the effects of an isolated sprinkler spray with the interaction of the fire gases and the fuel elements is an extremely complex physical, thermal and chemical problem which involves different variables that need to be taken into account when evaluating the development of the HRR curve.

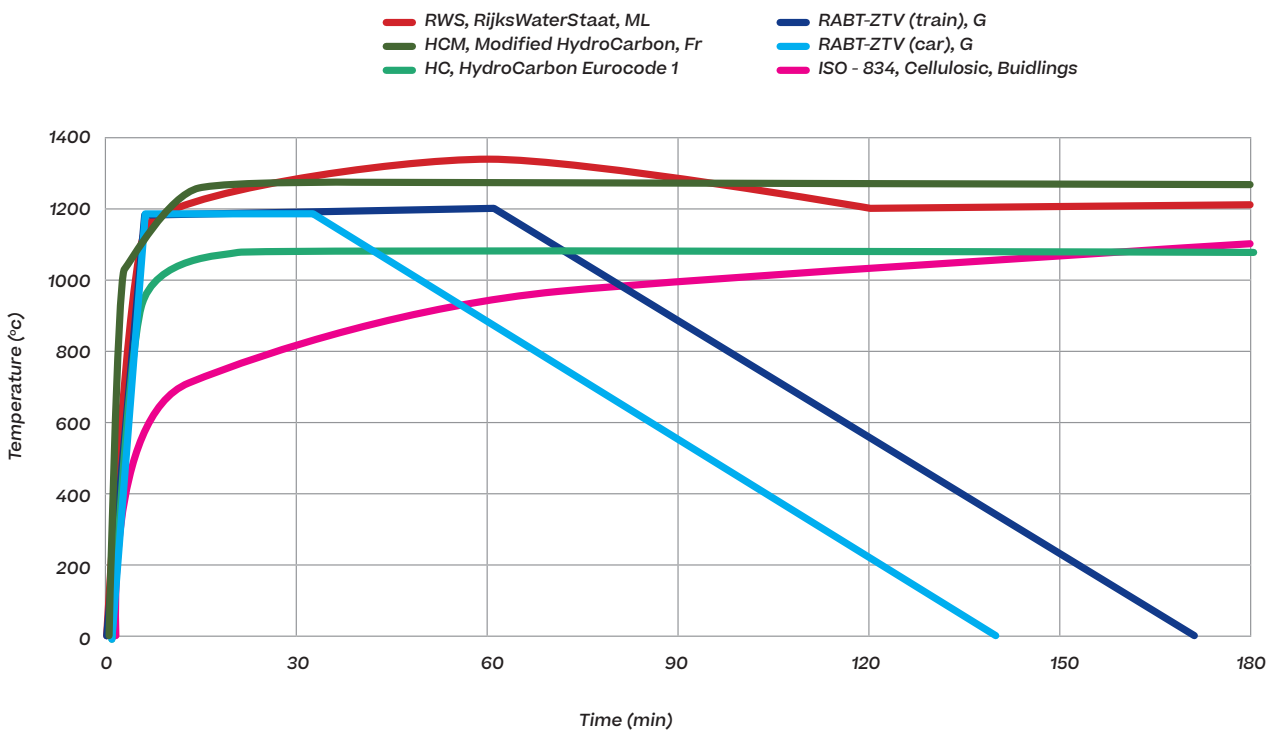
The role of active systems around the world

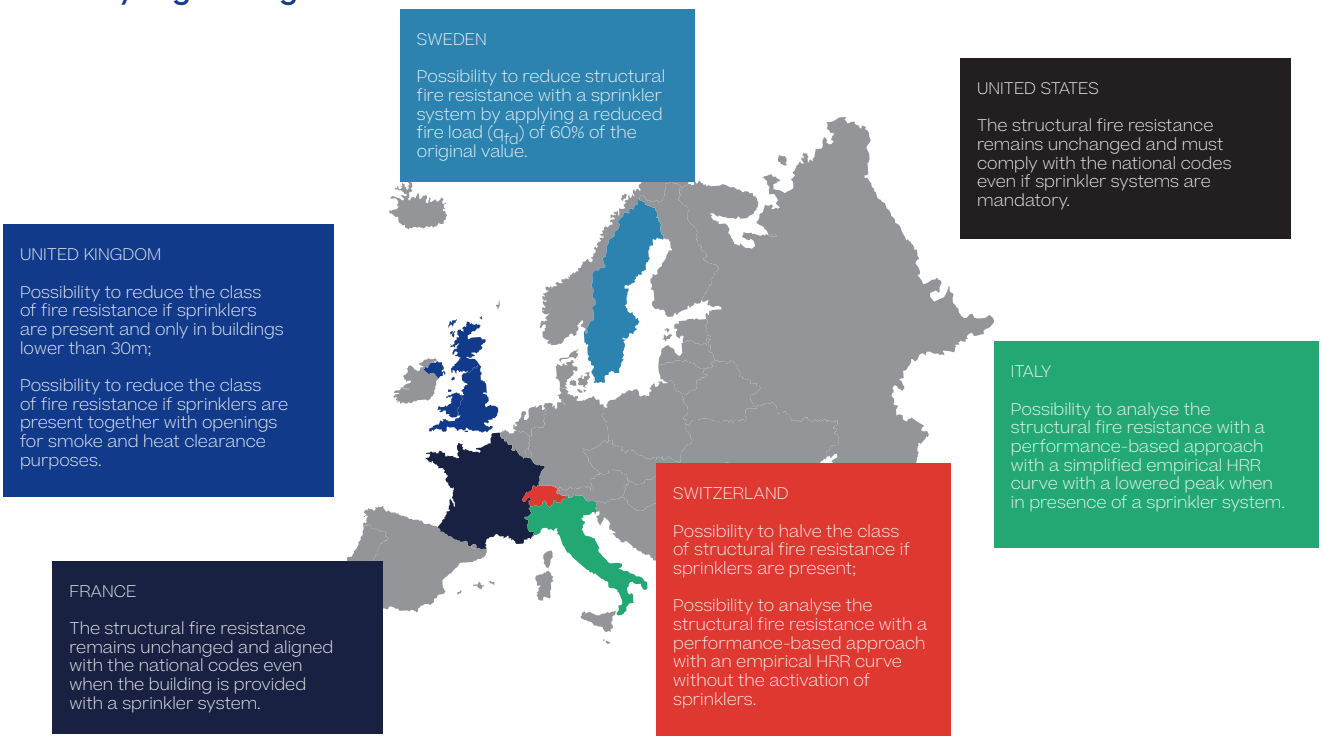
As the relationship between the active fire protection systems and structural fire resistance cannot be directly calculated, it is therefore necessary to apply some prescriptive assumptions, which differ from country to country.

In the scope of this study, it was felt important to compare and interpret the approach that each regulator has adopted to create a general overview that fire engineers can use. The identification and calculation of an accurate HRR curve is one of the main parameters that characterise the thermal input to be applied to a structure.

The Italian national fire code, D.M18-10-19, allows the fire engineer to limit the HRR curve in the presence of an automatic fire control and extinguishing system. According to the code, the HRR can be maintained with a constant profile from time "tx" of activation of the active sprinkler system, thus limiting the energy released into the enclosure for the entire duration of the fire until the final decay phase occurs.

The possibility to "limit" the HRR curve to a lower value involves significant benefits for the thermal input to be





applied to the structures as well as the overall amount of smoke produced by the fire, therefore impacting the correct sizing of additional active protection systems. At the same time, it should be noted that this approach is profoundly different from that adopted by other European countries. One clear example is shown within the Eurocodes.

Within the Eurocode 1 part 1-2, the additional specific information paragraph specifies that a full analytical procedure for structural fire design would take into account the behaviour of the structural system at elevated temperatures, the potential heat exposure and the beneficial effects of active and passive fire protection systems, together with all the uncertainties associated this process. Hence, the procedure also includes an analysis of the uncertainties and the possible consequential effects on structures (e.g. potential structural failure).

A correct analysis also requires the designer to consider the case in which one or more of the passive and / or active protection measures may fail, such as an inactive sprinkler system or a fire door stuck in the open position. This worst-case scenario is totally neglected by the Italian Code. This study compares the approaches of other countries and highlights the importance of the "uncertainties" when totally neglected.

According to the building code ruling in Switzerland (AICAA 2015), sprinkler systems can be taken into consideration for the determination of the fire resistance of the load-bearing structures, such as the walls and slabs, as well as increasing the maximum size of the allowed fire compartment. At the same time, the mere presence of a fire control system allows the fire engineer to halve the class of the fire resistance of the designed structure. Additionally, within the Swiss legislation, the designer can address the structural fire design through a performance-based approach. In this instance, the designer is required to define and agree with the relevant authorities the fire scenarios that will be used in the evaluation of the structural response in case of fire. The study must also consider the unavailability of one of the active protection systems, if applicable, and therefore evaluate all the possible consequences.

Two fire codes used in the United Kingdom (BS9991 and BS9999) allow the designer to reduce structural fire resistance in buildings lower than 30 m if a sprinkler system is installed to EN12845.

In residential buildings, BS9991 gives the opportunity to assess the resistance of structural elements based on the number of openings towards the exterior within the analysed compartment. This method takes into account the heat generated by the fire and exhausted towards the outside of the building.

The Swedish fire prevention code (BFS 2018:4) allows the fire engineer to reduce the fire load to 60% of its original value when the building is fitted with a sprinkler system. However, unavailability of the system is not considered.

In France, the presence of an active fire protection system does not permit any relaxation in the fire resistance of structural members, which must comply with the requirements and methods imposed by the national code (ERP R-123 and EN 13501-2). Similarly, in the USA (IBC: 2018), the presence of a fire protection system does not allow any downgrade in the fire resistance of structural elements.

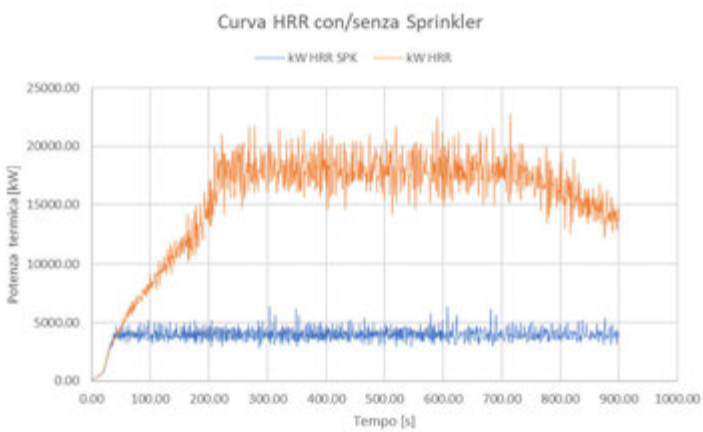


Figure 1 - HRR curve with and without sprinkler activation

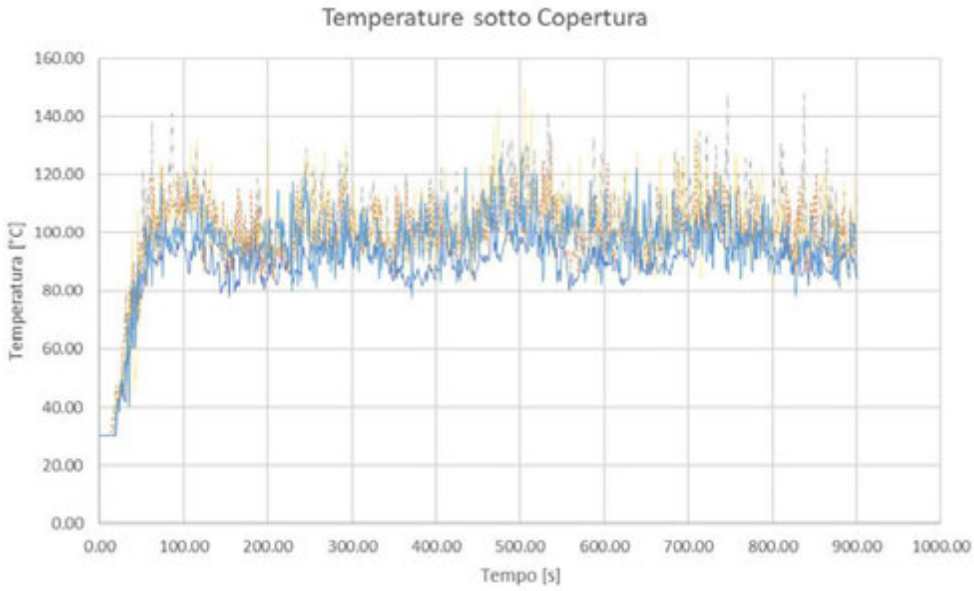


Figure 2 – Resulting ceiling temperature with activation of a sprinkler system

The effects of active fire protection on fire resistance design

Reducing the HRR curve to a calculated value at the time of sprinkler activation can have a significant impact on the outcome of the structural fire resistance calculations.

As an example, we can consider a fire compartment characterised by a steel structure with a reticular steel roof and columns built in a regular, symmetrical configuration and equipped with automatic active protection such as a wet sprinkler system. The results associated with a computational fluid dynamic simulation that limits HRR on the activation of the sprinkler system or, vice versa, which allows its full development are profoundly different. Refer to Figure 1.

From the fire modelling analysis, developed with FDS, it is possible to clearly understand the difference among the resulting temperatures registered at ceiling level.

The CFD modelling results are profoundly different. In the first case, the structures can maintain their stability for the entire duration of the fire thanks to the sprinkler intervention. On the other hand, if the sprinkler system does not activate, the structural stability would be guaranteed just for a limited time, after which it may lead to a total or partial structural collapse.

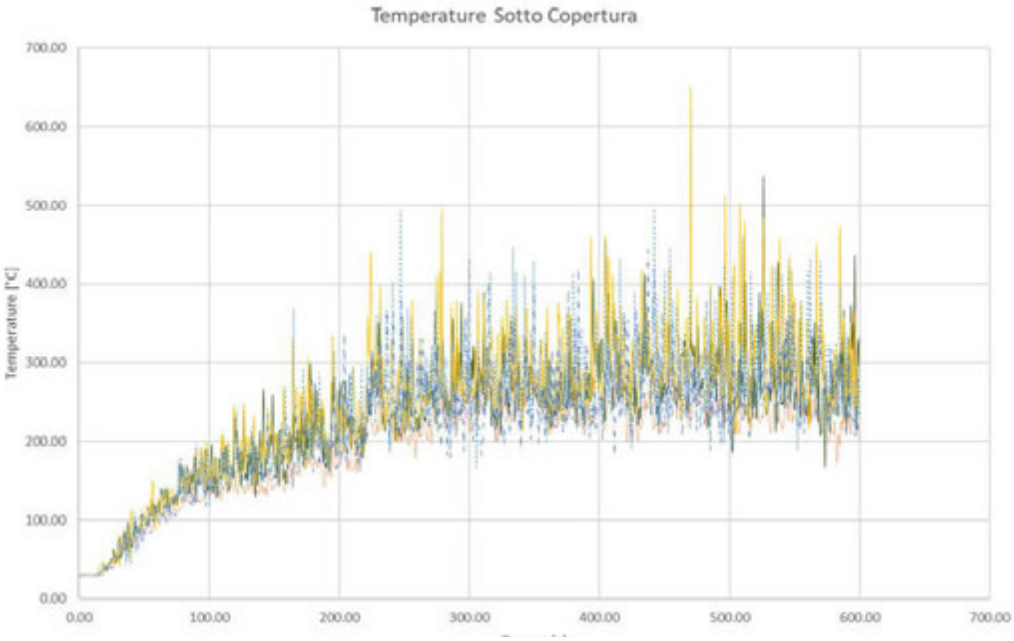


Figure 3 – Resulting ceiling temperatures without activation of a sprinkler system

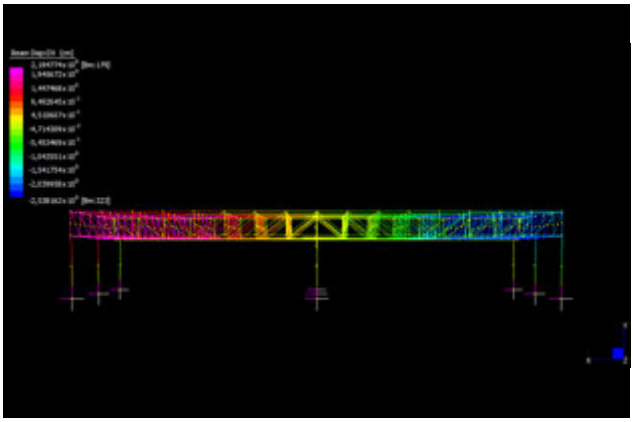


Figure 4: Deformed geometry with the activation of a sprinkler system

As an example, we consider a building with a metallic structure formed by frames consisting of columns with a double T section and a shed roof with primary reticular beams, which support a secondary row of reticular beams with C and L profiles, single or coupled according to their stressing state. This kind of structural solution is commonly adopted in many industrial facilities.

The following images show the main results of the thermo-structural analysis conducted by applying the natural curves defined with fluid dynamic modelling in conditions of activation and absence of the automatic sprinkler system.

The results, clearly evident in the images shown here, are quite severe for the case where the sprinkler system is not activated and, on the other hand, the conclusion on the fire structural stability is very comforting in case the sprinkler system is activated.

The results obtained from the first scenario highlights that the structural deformation is rather limited and contained and approximately in the range of 2 centimetres. In the second case, where the same structure is affected by a fire without the activation of a sprinkler system, the deformation on the structural elements is more evident, increasing by 130% compared to the previous result. This is not always acceptable for metal structures, especially those built in the industrial field, where the profile optimisations and other economic savings usually lead to low-resistant structures.

Conclusions

In the field of structural fire engineering, it is possible to deviate from regulatory requirements and undertake a "tailor-made" performance approach. As described in the previous paragraphs, some national, European and overseas regulations allow for a certain degree of relaxation in structural fire resistance when buildings are equipped with sprinkler systems.

However, when dealing with a fire safety engineered approach to structures the analysis must be carefully defined on a case-by-case basis. In the performance-based approach, the evaluation of the actual structural behaviour, when subjected to high temperature arising from a fire, must be preceded by a careful fire scenario analysis. Fire engineers should consider the fire dynamics especially when evaluating the effects generated by any active fire protection system.

It is therefore important to know the boundary conditions and all the variables that are assumed during the development of the performance-based analysis. It is essential to identify the project fire scenarios, in which the most realistic possible fires are evaluated. After identifying a suitable scenario, or cluster of scenarios, it will be possible to evaluate the consequent structural stresses without neglecting other fundamental aspects such as occupants' and rescue teams' safety.

As previously described, a scenario presenting a lower heat release rate results in lower thermal stresses on the analysed structures compared to the same scenario, with unchanged boundary conditions, with a fully developed fire. This approach may result in different and discordant times for the stability and fire resistance of the structure.

Therefore, it is difficult to base the entire assessment of the behaviour of the analysed structures on a single fire scenario that does not consider variations in the assumptions considered in the study. NFPA 101, for example, requires project evaluation to be performed against 8 predetermined scenarios but with active or passive fire protection measures put out of order one at a time.

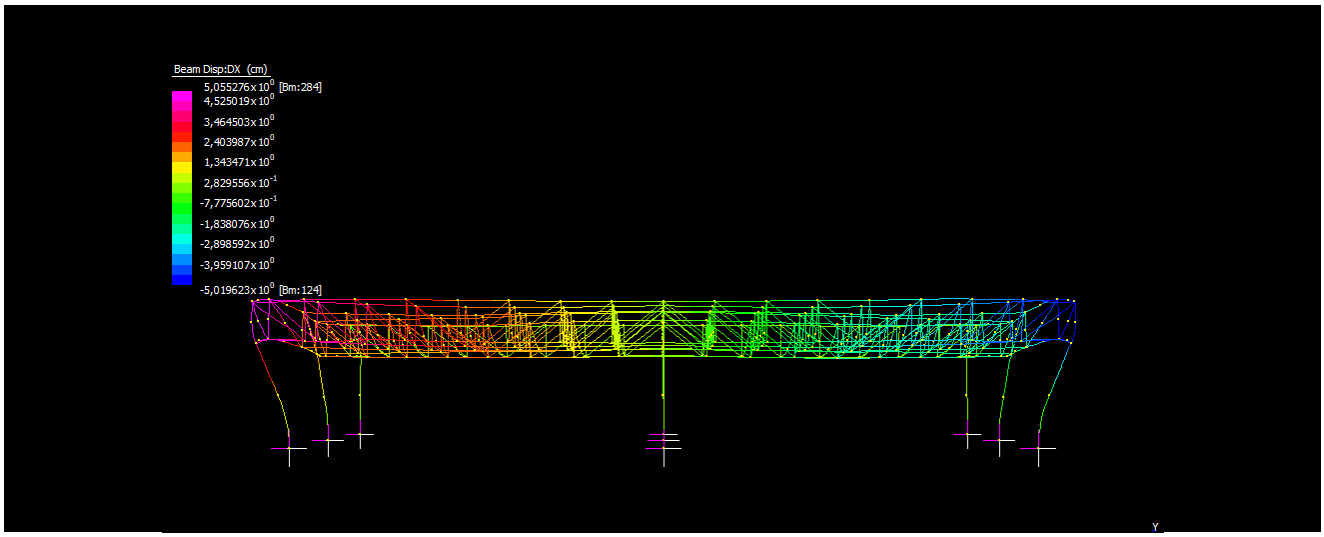


Figure 5: Deformed structural geometry without the activation of the sprinkler system

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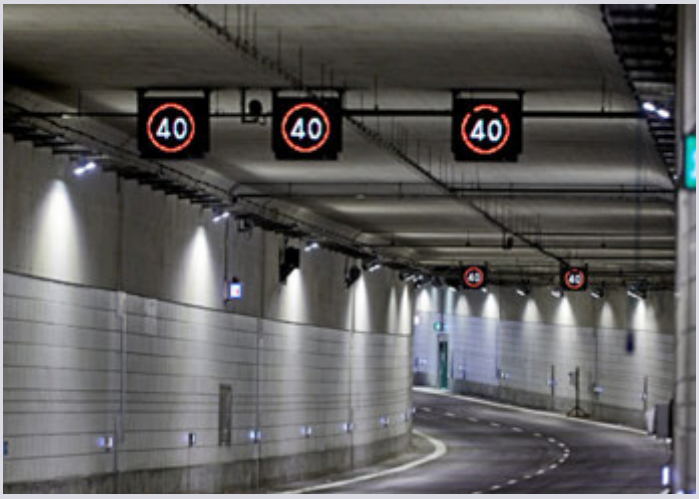

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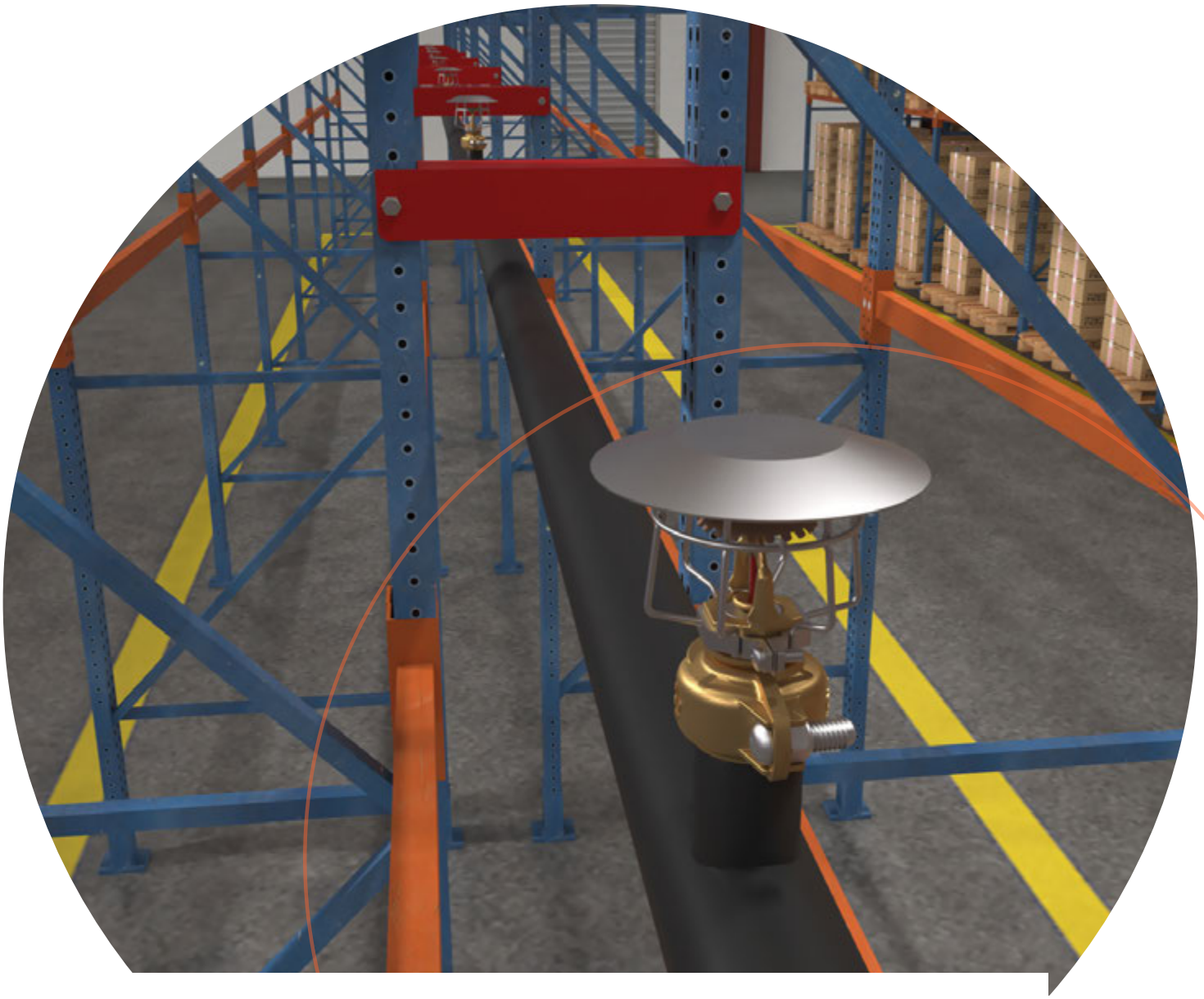


Manufacturers can mitigate labour risks

Construction has proven to be – and still very much is – a great form of employment for millions of people around the world. However a shortage of trained and experienced labour is putting pressure on the sprinkler industry, writes Graeme Leonard, Director of Sales – Fire Protection, Victaulic, and he believes manufacturers have a role to play through offering training and introducing better products that are less labour-intensive to install.

Construction is the bedrock upon which most economies are built. Take into account growing populations, continually developing industries and technologies, and increased demands on what the built environment can provide, it's not hard to see why there is a constant stream of work for those in the building industry.

However, in the last couple of years, a worrying trend has started to creep into the industry. Spread across most of Europe, a shortage of experienced and trained labour has become evident. What appears to be a myriad of factors all coming together, like an ageing population of skilled workers and not enough young people interested in a construction job, we regularly hear from the industry and see on some of our own projects, that contractors are suffering from a scarcity of skilled labourers.

Especially in the fire protection sector, where the systems being created, assembled and installed protect not only a vast array of products but the lives of human beings as well, finding solutions to remedy a lack of skilled labour is evidently incredibly important. There are certainly a number of ways of doing this: increasing the accessibility to training or setting a minimum standard backed by accreditation both spring to mind as potential avenues to take. But another way to look at the challenge is to approach it from the view of the products the industry is asking workers to use, and the role the manufacturer can play in training.

Additional challenges

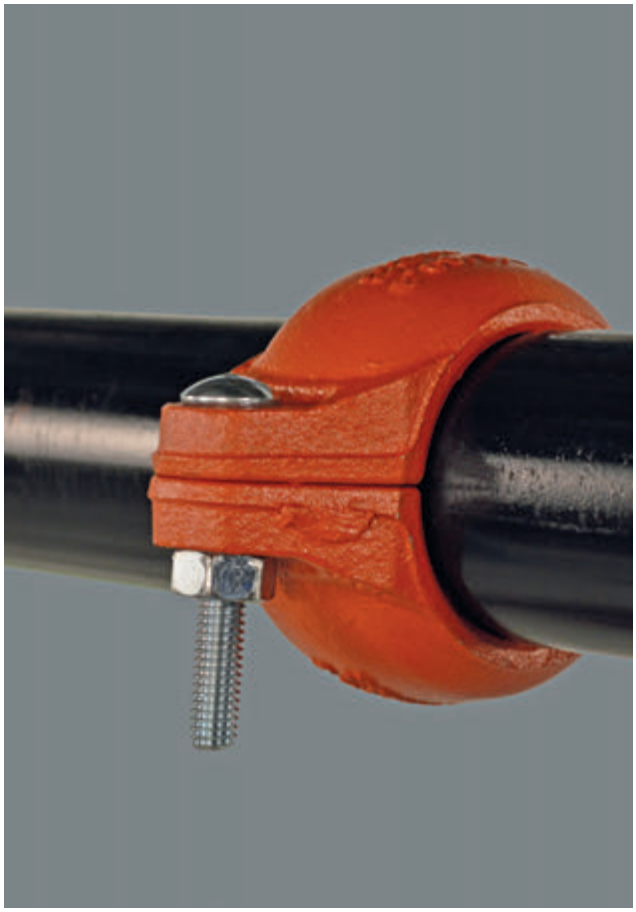
The main challenge faced by the industry for tendering jobs has always been predicting the actual time spent onsite and the cost involved with it. With the availability of an experienced team being scarce and having potentially to put a less skilled crew on the job, even more pressure is put on budgeting for this. Is a less experienced crew going to be able to deliver the project on time, or should additional crew members be factored in? Is the crew going to deliver a reliable system or will there be a risk of having a recall to make corrections due to lack of installation experience? These are just some of the questions that surface due to the scarcity of experienced labour and keep contractors awake.

It's important to also factor in the impact COVID-19 has had on efficiency on the job site. Making sure building areas are COVID secure has become a necessity for HSE Managers across the board but has, in turn, limited the volume of personnel permitted on a job site at one given time. This has undoubtedly led to a slowdown in efficiency, and when coupled with a generally less experienced workforce, can lead to projects leaking into multiple days after the proposed completion date.

It's easy to understand that challenging times, combined with a shortage of experienced labour, definitely doesn't play in favour of the contractor and leaves him behind with increased uncertainty about labour costs and having to take additional risks that might impact his bottom line.

Letting products mitigate the risk

Identifying a growing trend, in particular one which is on the whole negative like the loss of experience in the industry, is easy to do, but it's much harder to remedy. We believe that specific product design by the manufacturer can play a big role in providing a cure. Listening to their clients to pinpoint the issues they have onsite and helping to overcome these with new innovations, adapted to the needs of the market, is just a start. Producing products that are designed to speed up the installation while



making it easier and more reliable is certainly one thing that can help to mitigate the risk of having less skilled labour and provide the contractor more certainty about the time spent onsite.

A key innovation we have developed to help overcome installation challenges and avoid potential incorrect installations is our patented Installation-Ready™ technology, meaning that these products come to the site ready to be installed and don't require disassembly prior to installation. The products spread right across our full range, from couplings and fittings to even some of our sprinklers.

The idea behind Installation-ReadyTM products is really quite easy to follow: how can we make the installation process more efficient while reducing risk of incorrect installation? The design of our installation-ready products allows an installer to join pipes by simply pushing the couplings or fittings onto the grooved end of a pipe, fitting, valve or accessory, connecting it to, for instance, a second grooved-end pipe and then tightening the nuts using standard hand tools or an impact wrench. Also added confidence and reliability are built into these products – when the bolt pads touch metal-to-metal, a proper, leak free installation is guaranteed without having to meet a specific torque requirement. While still requiring precision and attention to detail, like tightening the nuts evenly by alternating sides and making sure the bolt pads touch, the process removes the need for more skill-intensive techniques and helps to speed up the installation process.

We're now looking to further simplify the tightening process by developing a product with only one bolt: the Style 109 FireLockTM Installation-ReadyTM Rigid Coupling.

With the Style 109 coupling, installers will enjoy the benefit of a one-bolt design that brings increased efficiencies, safety and value to their fire protection system. This coupling also allows for visual inspection of a single bolt pad connection, adding confidence in a leak-free installation, and can be easily handled and installed overhead, while the one-bolt design eliminates the risk of faulty installation due to not tightening the bolts evenly.

Incorrect sprinkler installation also entails big risks for contractors because it always involves having to revisit the site and renting scissor lifts again, thus adding additional costs to the project. We try to address this as well with our Installation-Ready sprinklers. This grooved sprinkler with coupling already attached is designed so it can be installed with more speed and certainty of a proper installation than a threaded sprinkler, while also avoiding the risk of repetitive strain of installers. This in turn helps contractors to better control their labour and optimise the number of workers on the ground.

Setting a benchmark

Ultimately, we're trying to provide an ideal scenario for contractors: products which reduce time on the job site and save them money by mitigating the problems posed by the shortage of skilled labour. And while we're very happy for our products to be a solution, I still believe there is more support the industry can provide contractors in the form of training standards, and here Victaulic is happy to play its part too alongside other industry stakeholders.

Undoubtedly, real value can be derived from manufacturers taking on a mandatory role in training. The manufacturers are the specialists in their own products and have the ability to disseminate product-relevant knowledge to workers on site. That is why we are driving the industry towards training programmes, this both on the job site as well as in one of our training facilities. During these programmes, we cover a broad range of topics like how to groove pipe, measuring the groove depth, how to install and service our alarm valves and how to properly install couplings, sprinklers and valves etc.

If we're talking about ideal scenarios for contractors, I believe the industry should strive to have at least one member of an installation team hold training certification from the manufacturer for the products they're handling. That way the contractor can rest assured knowing that a specialist with the relevant skills and knowledge is always available on site to help and support other members of the installation team and to assist whenever required.

Making a more attractive industry

Bidding for a project will always entail some level of insecurity and there is definitely much to say about the shortage of experienced labour in the industry and the ramifications this has on projects and contractors. As a manufacturer looking to support our clients and the industry, we help to mitigate risk and to build up a force of knowledgeable people in the field. We are keeping our finger on the market pulse to deliver high quality products that increase efficiency and reduce the chance of incorrect installation while making sure that their users receive the necessary training about them.

But unfortunately, there is not one solution fix-all for the shortage of experienced labour in our industry. A long term solution will need to be put in place to make the industry more attractive to new people that are willing to invest their time and to allow them to build up the necessary skills and knowledge to deliver outstanding, high quality projects.

Protocol for internal inspections

In the Netherlands, a request has been made by the business community to inspect the internal condition of the pipe network of sprinkler systems. In order to prevent inspection bodies from all dealing with this in a different way, it has been agreed to draw up an inspection protocol. By making use of this protocol, Sven Sterkendries of Normec explains, all end users are assured that inspection bodies can assess the internal condition of the pipeline network in a harmonised manner.

The purpose of this inspection protocol is to enable an assessment of the performance of the installation in relation to the internal condition of the pipe network and the functionality of the sprinklers. By working in a structured manner according to a predetermined plan, the inspection can be carried out efficiently and effectively. An internal inspection of a sprinkler installation consists of an inspection of the pipework and an inspection of the sprinklers.

Preparation

Before the inspection can be carried out, all documents (drawings) must be available. A cherry-picker may need to be reserved and certain work areas may need to be cordoned off for safety.

It is important that the planning is properly described prior to the inspection. Make sure the division of labour is clear to all parties involved so that all work can be done efficiently and according to plan.

Broadly speaking, the inspection consists of two parts: the inspection of the pipe network and the inspection of the sprinklers. The scope and location of the inspections must be clearly determined in advance and recorded on the drawing. During the inspections, as much visual material (photos and videos) as possible must be collected.

An inspection report must be drawn up and must include the general details of the building, a description of how the inspections were carried out and a conclusion of the inspection. The inspection report must undergo a peer review before it can be sent to the client.

It is a perquisite that the inspection plan is sent to all parties before the start of work so that everyone is informed and adjustments can be made if necessary.

Conducting the inspection

The pipework must be flushed before the start of the inspection and to do this, the section concerned must be temporarily decommissioned. The user must carefully observe the decommissioning regulations for this. Consider, for example, informing the fire brigade and insurance companies, applying alternative fire safety measures, etc.

Before conducting the internal inspection of the pipework, the pipe network shall be flushed and all main and manifold lines must be flushed through the flushing valves. When flushing, a filter with a maximum mesh size of 1 mm must be fitted. Flushing continues until there is no more contamination in the filter.

During the inspection of the pipework, the subjects below must be recorded in the inspection plan.

Pipework inspection	
Scope of the inspection	At least 20 m sprinkler pipes and 7 m distribution or main pipes per 5 alarm valves. Alternatively, a different size may be determined in consultation with the inspection body
Location of the inspection	The assessment positions should be evenly distributed among the sprinkler sections. Risks such as sagging in the pipework, environmental influences and leaks must be considered
Assessment method	The pipework can be assessed by endoscopic examination or at anywhere the system is opened (for example, where sprinklers are replaced or when servicing an alarm valve)
Assessment criteria	The free internal cross-sectional area of the pipework must be at least 90% of the nominal cross-sectional area

Table 1 – Pipework inspection

The pipe sections to be inspected must be indicated on a drawing and the observations must be recorded in photos and / or videos.

When inspecting the sprinklers, the subjects below must be recorded in the inspection plan.

The sprinklers to be inspected must be indicated on a drawing and the observations must be recorded in photographs and / or videos. The sprinklers removed must be stored in such a way that they retain the properties they had when installed. Sprinkler drying or contamination can affect the results of the assessment.

Sprinkler inspection	
Accreditation	The sprinklers must be assessed by a laboratory that is accredited for testing sprinklers in accordance with NEN-EN 12259 or the inspection protocol.
Scope of the inspection	The number of sprinklers to be assessed depends on the number of sprinklers installed per type.
Selection of sprinklers for assessment	Sprinkler selection should be evenly distributed throughout the installation.
Assessment criteria	The activation temperature, the K-factor and the minimum pressure at which the sprinkler opens must be assessed.

Table 2 – Sprinkler inspection

The inspector

Requirements are also imposed on those who conduct the inspection. The inspector must be qualified for sprinkler systems and competent to:

- estimate the risks of corrosion and blockage in an installation
- select pipe sections where corrosion or blockages can occur
- select sprinklers where poor results are expected (changes in ambient temperature, chemical influences, etc)
- interpret camera images of the internal condition of the pipes
- assess the effect of the corrosion or blockage found on the efficiency of the installation

Frequency of internal inspections

The frequency of the internal inspection depends on the standard that is applied. On the basis of NEN-EN 12845, as described in Appendix K, the pipes and sprinklers must be inspected after 25 years. Annex K is described in the Dutch standard (NEN-EN 12845) as “normative” and must therefore be applied. In the European standard (EN 12845), Annex K is “informative”.

When other standards are used (such as NFPA 25 or FM 2-81), this is handled in a different way and with a different frequency.

SIN is 20 years old

January 1, 2021 marked the 20th anniversary since the Sprinkler Identification Number (SIN) became a mandatory feature on all sprinklers installed to the requirements of National Fire Protection Association (NFPA) NFPA 13, Standard for the Installation of Sprinkler Systems and now Paul Sincaglia, Managing Director, International Fire Suppression Alliance explores its uses and applications.

While the use and application of the SIN is an everyday practice across Canada, the United States, and other nations that adopted either the International Building Code and/or NFPA 13 as part of their building regulations, much of the world remains largely unaware of the benefits and history of this simple system.

What is a SIN?

A SIN is a four to six character alpha-numeric code that includes one or two English letters followed by three or four numbers which is physically applied to the sprinkler head. Typical examples could include: L414 or BD1423.

The SIN characters (letters) identify the sprinkler manufacturer. Manufacturers obtain and register one or two letter codes with the International Fire Suppression Alliance (www.IFSA.global) who serve as the industry clearing house for this programme. The following three or four numbers are then provided by each manufacturer in a manner that best suits their needs. Some manufacturers use the numbers to represent specific sprinkler characteristics within their product lines, others use them strictly as a cataloguing number.

But regardless of how each manufacturer chooses to manage their Sprinkler Identification Number programme, the goal of this highly flexible system is the same: to ensure proper application of each sprinkler head for the life of the sprinkler system. When adopted, use of the SIN permits fire sprinkler system engineers and designers to select sprinkler heads based on their respective capabilities and limitations and to indicate their location on their drawings. The sprinkler pipe fitters, project managers, building inspectors and fire officials are then able to visually identify and confirm that

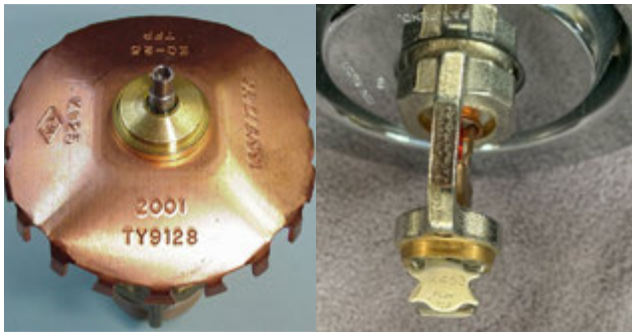


Figure 1: Location of some typical SIN on sprinkler heads (courtesy of the JCI and IFSA)

the proper sprinkler head is installed in each location. And in the future, should the sprinkler system need modification or repair, the same SIN marking makes it possible for sprinkler professionals and fire officials to reconfirm a sprinkler's design capabilities or to identify an appropriate replacement.

What prompted development of the SIN?

The fire sprinkler industry is not usually thought of as being innovative or "on the cutting edge". And to be fair, the great majority of the sprinklers installed today do not look all that different from some of the patented designs from the late 1800s. In fact, through the first half of the 20th century the majority of sprinkler head evolution was limited to improvements in manufacturing, reliability, and quality. But by the 1950's, with ongoing loss prevention research and an expanding record of successful fire control, the fire sprinkler industry reached a pivotal conclusion; fire sprinkler head discharge directed toward the source of the fire is simply more effective. Thereby giving rise to the ½" K-5.6 (K80) Standard Spray Upright (SSU) and Pendent (SSP) sprinklers that became a basis of design that is still widely in use today.

But by the 1970's significant shifts in industrial practices, particularly warehouse storage, and an increasing focus on sprinklers as a residential life safety tool revealed that the standard spray sprinkler head was not well suited to some of the challenges and corresponding performance objectives. In response, the sprinkler industry began creating a range of specialised products that incorporated combinations of faster response, greater water flow, larger droplet sizes, and specialised water spray patterns better suited to controlling the fire hazards out in the field.

Yet, while these new products were demonstrating the successful application of fire sprinkler technology to meet the challenges of an evolving world, all these new products were creating a new set of problems for practitioners out in the field. The SSU and SSP sprinklers of the past had been largely interchangeable with similar sprinkler products provided they had the same orientation and temperature ratings. But these new sprinkler innovations required installers and maintenance personnel to have an ability to readily identify and confirm that the right sprinkler was selected and installed properly.

NFPA 13, Standard for the Installation of Sprinkler Systems sought to address the expanding variety of sprinklers by requiring manufacturers to provide a means of visual identification that included the installation of pintles to the deflectors, adding markings on the sprinkler frames, and mandating sprinklers with larger orifice sizes employ larger thread connections. (See Figures 2 and 3)

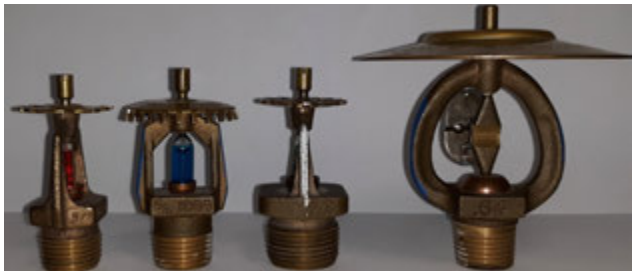


Figure 3: Fire sprinklers with pintles and orifice size frame markings manufactured before 2001 (Courtesy of The Viking Corporation)

But this method of marking and identification proved to be largely unworkable as many of the new sprinkler heads incorporated more than just one feature outside of what had once been considered "standard".

There had to be a better way

During the drafting cycle for what became the 1999 Edition of NFPA 13, the Sprinkler Committee conceived of a coded numbering system intended to identify specific sprinkler performance criteria across the fire sprinkler industry. But it quickly became clear that creation of a highly structured coding system would just not be workable. There were already significant variations across the sprinkler industry where differences between manufacturers and their speciality products made it all but impossible to codify. And that was before trying to create sufficient room within the system to account for future innovations, obsolescence, and any current or future differences in the product approval standards.

As a result, the goal of a SIN was limited to the creation of a system to provide a means to identify key differences of sprinkler performance such as a change in orifice size, response classification, distribution characteristics, and maximum working pressure, etc. All would require a separate alpha-numeric designation. However, each manufacturer remained free to develop and employ a system that worked best for them. For example, Model AB120 could be one manufacturer's standard response K-5.6 (K-80 metric) upright spray sprinkler, while Model BC120 could be another manufacturer's K-14 (K-200 metric) pendent ESFR.

Nominal Orifice Size (in.)	(mm)	K Factor[1]	Percent of Nominal ½ in. Discharge	Thread Type	Pintle	Nominal Orifice Size Marked On Frame
¼	6.4	1.3–1.5	25	½ in. NPT	Yes	Yes
5/16	8.0	1.8–2.0	33.3	½ in. NPT	Yes	Yes
⅜	9.5	2.6–2.9	50	½ in. NPT	Yes	Yes
7/16	11.0	4.0–4.4	75	½ in. NPT	Yes	Yes
½	12.7	5.3–5.8	100	½ in. NPT	No	No
17/32	13.5	7.4–8.2	140	¾ in. NPT or	No	No
				½ in. NPT	Yes	Yes
⅝	15.9	11.0–11.5	200	½ in. NPT or	Yes	Yes
				¾ in. NPT	Yes	Yes
¾	19.0	13.5–14.5	250	¾ in. NPT	Yes	Yes

Figure 2: Table 2-2-2, NFPA 13 (1996 Edition)

Omitted Character	Reasons
CE	European Community product approval marking
D	
EC	ISO acronym for Extended Coverage sprinklers
EH	Could be confused with Extra Hazard occupancy classification
FM	Acronym for Factory Mutual
FR	ISO acronym for Fast Response
HS	Could be confused with Horizontal Sidewall sprinkler
I	Could be confused with the number "1"
IF	
II	Could be confused with numbers
IR	ISO acronym for Special (Intermediate) Response sprinklers
K	"K" followed by numbers could be confused with the sprinkler K-factor
LH	Could be confused with Light Hazard occupancy classification
O	Could be confused with the number "0"
OH	Could be confused with Ordinary Hazard occupancy classification
OO	ISO Acronym for on/off sprinklers or could be confused with numbers
P	Could be confused with Pendent orientation
QR	Acronym for Quick Response
SK	
SP	ISO acronym for Spray Pendent sprinkler
SR	Acronym for Standard Response
SU	ISO acronym for Spray Upright sprinkler
SW	Could be confused with the Sidewall orientation
U	Could be confused with the Upright orientation
UL	Acronym for Underwriters Laboratories
W	ISO acronym for Sidewall sprinkler
WH	ISO acronym for Sidewall Horizontal sprinkler
WP	ISO acronym for Sidewall Pendent sprinkler
WU	ISO acronym for Sidewall Upright sprinkler
2nd Character "I" or "O"	As the number of digits in a SIN can range from 4 to 6 the second digit could be either a letter or a number. In order to later determine, with ease, if the second digit is a "1" versus an "I" or a "0" versus an "O", character designations will no longer be issued with the second character of "I" or "O" (effective August 2007).

Table 1: List of Prohibited SIN Characters

Similarly, individual manufacturers are not required to have separate SIN numbers for every product variation. Multiple finish, temperature rating, and threaded connection type options can all share the same SIN, provided the sprinkler head performance remains the same.

NOTE: Differences in sprinkler installation and product approval standards required designers, installers, and end users select and install sprinklers in accordance with the applicable standards. Any sprinkler having a particular SIN may be suitable for use under one standard but may or may not be certified or otherwise permitted to be used under others.

The SIN today

As mentioned previously, sprinkler manufacturers obtain and register the one or two letter codes with the International Fire Suppression Alliance. But there are some limitations. First, there are some character combinations that are simply prohibited because their use could potentially become confused with established industry acronyms and abbreviations. (See Table 1)

Second, once a SIN character combination has been registered and applied to a sprinkler product, that character combination becomes the permanent property of the registering manufacturer. Third, manufacturers are limited to registering a maximum of two letter character designations. And while that remains current policy, the IFSA monitors changes and consolidation in the industry causing some character combinations to become dormant while others have accumulated with corporate acquisitions. Those changes are updated on the IFSA website in order to permit sprinkler professionals to not only identify the originally registered manufacturers, but also their successors.

As of this writing, there have been 119 SIN Character letter combinations registered. Of these 56 are in active use with either UL or FM. And new character registrations have generally averaged about 6 every calendar year. A full list of current SIN Character registrations can be found at the following website: www.firesprinkler.global/sin-database.

The SIN future

The fire sprinkler industry will continue to grow, particularly as nations around the world add and expand the number of sprinkler protection requirements within their building codes. And there will certainly be further innovation in sprinkler technology to address new and unique applications. Therefore, there is still a need for a harmonised system that will permit designers, installers, maintainers, and regulators to readily identify sprinklers to ensure everyone's mutual safety.

The IFSA and its governing members are proponents of the current Sprinkler Identification Number system. In fact, UL LLC requires all sprinklers certified to their standards to employ a SIN. FM Approvals recognises and encourages use of the programme but does not currently require it. As a result, a significant number of global sprinkler manufacturers, including all the larger manufacturers in Europe, are already active users of SIN for at least some of their products.

Ideally, the IFSA would like to see CEN, ISO, and other sprinkler product certification bodies adopt the use of the SIN into their product, design, and installation standards. Doing so would harmonise a global industry and help to ensure that the correct sprinklers are selected, installed, and maintained in a manner that continues the unrivalled success of water-based fire protection as a means to protect against fires.

High-performance, cost-effective solution

Extensive testing led to the selection of a specially developed sprinkler system for Stockholm's Northern Link road tunnels. Based on a unique sprinkler, the system offers robust fire performance and greatly reduced costs, reports Henrik Johansson

When the Swedish Transport Authority (STA) started to compare technologies and systems around 2010 for protecting the Northern Link and Stockholm Bypass tunnels, they could not find any existing system and technology that matched their criteria – performance, redundancy, resistance to the environment, robustness, maintenance and lifetime cost.

STA involved the well-reputed fire engineering firm Brandskyddslaget and the RISE Fire Research laboratory to help them investigate technologies that protect the same type of hazards in other applications. Early in the project,

Brandskyddslaget sprinkler engineers understood that the main risks are similar to those in high rack storage. The project team also looked at how the installation cost may be reduced without interfering with the system performance. Brandskyddslaget then turned to Johnson Controls as the world leader in both storage protection and horizontal sidewall sprinkler technology. It was also determined that the cost of a fixed fire-fighting system (FFFS) is mainly driven by the amount of pipe. The horizontal sidewall type of nozzle technology was found to reduce the pipe demand by up to 70%, which resulted in significant cost savings.

Ro-Ro ships and warehouses

The research by RISE/ Brandskyddslaget showed that 10 mm/min was the optimal water density for road tunnels. This conclusion was mainly based on laboratory testing for RO-RO ships (SP Report 2009:29) and the few official FFFS road tunnel test reports available. The risk on a RO-RO ship is more or less identical to the risk in road tunnels. The difference is the air velocity and shape of the room.

The ideal nozzle type and water density was now identified; however, the solution did not exist. Johnson Controls was assigned to develop a large K-Factor horizontal sidewall nozzle. This product line is known as Tyco Model TN and is offered in two sizes, K240 and K360. TN is a technology with its origin in the sprinkler fire protection of high rack storage. In the late 80's, the increased performance of sprinklers creating bigger droplets began to be recognised by the fire protection industry as an effective way to protect warehouses. Inventions like the Early Suppression Fast Response (ESFR) sprinklers and similar designs that created big droplets changed the market substantially. These technologies made it possible to protect rack storage with a ceiling-only sprinkler system design. Today this technology is used for

protecting warehouses with up to 16.8 metre ceiling heights and storage heights up to 15.2 metres that store a variety of commodities.

Effectiveness of bigger droplets

The fuel, goods transported in trucks and the storage in a warehouse, is the same. However, high rack storage fires are more challenging and difficult to control or extinguish than tunnel fires. The difference is in the storage configuration. High rack storage configurations generate longer distances to the fire, more obstructions are present, and there is more air (oxygen) to feed the fire.

One similarity between storage configurations and tunnels designs is air velocity. The updraft velocity of high rack storage fires can reach 20 metres per second, while tunnels may have wind speeds up to 10 metres per second. Therefore, the mass and momentum of bigger droplets are needed to drive them through the updraft and the obstructions that are created. The Tyco Model TN nozzle will form the same type of big, stable droplets which penetrate into the core of any tunnel fire. In comparison, small droplets are more volatile and will be moved away by the air movement. Full scale fire tests with water mist systems show that three zones are consistently activated.

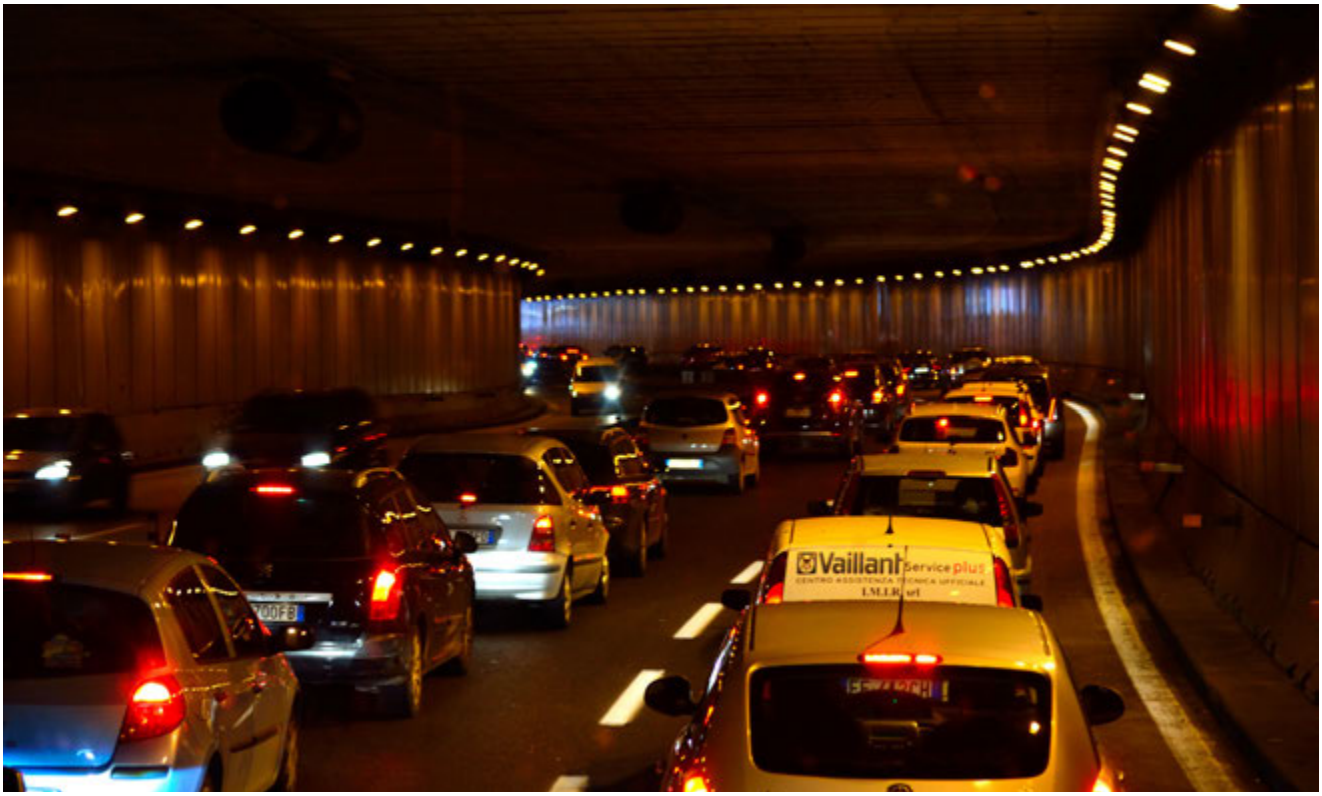
The Tyco TN nozzle activates only one zone when the same conditions are tested. In addition, drifting is a problem for smaller droplets while bigger droplets are more stable with high air velocities. Another problem related to small droplets is the lack of penetration into materials, which adds to the difficulties of effective fire protection. It has been proven that water mist does not deplete or have a better effect on the oxygen than larger droplets in the tunnel application. In a tunnel air blows right through the fire, feeding it with oxygen. It is impossible to block the oxygen in these relatively high wind speeds. Pre-wetting of the fuel, penetration, and cooling the fire are the main functions for successful firefighting in road tunnels, as in high rack storage.

Proven performance

Tyco Model TN nozzles have proven performance in ten full scale tests by RISE and STA. The test mock-up was identical in all tests with a total potential fire load of 100 megawatts (MW). The differences between the tests are nozzle orifices, flows and delay times. The flow varied from 1400 litres per minute to 2225 litres per minute and the delay time until the water was distributed onto the fire ranged from 4 to 18 minutes. In the tests only one zone of 30 metres with six nozzles was activated. All tests were considered successful and only 10-25% of the fuel was consumed. This means that the fire will be controlled within one zone. The design can be based on one zone with the length limited to the longest vehicles.

Compared to other FFFS for road tunnel protection, Tyco Model TN products show higher impact in lowering the heat release rate (HRR) and even suppressing the fire. The Tyco Models TN-17 and TN-25 nozzles perform much better than products that have been tested in the past with 10 mm/min water density. Both nozzles perform with water densities below 7 mm/min and still meet the STA performance criteria.

The standard design today is for deluge zones of 20 -25 metres.



Although the Tyco Model TN capability of controlling the fire with single zone activation is verified by testing, the Tyco Model TN is designed to activate two zones at the same time. The two-zone design is needed for situations when a vehicle is positioned between two zones. A 15-metre-wide tunnel designed with 25-metre-long zones will require ten Tyco Model TN nozzles per zone positioned back-to-back on one pipe in the centre of the tunnel. The Tyco Model TN-17 nozzle requires 0.95 bar nozzle pressure which provides a flow of 301 litres per minute. Two-zone activation requires 20 nozzles to flow; therefore, the total system design requires a flow of 4678 litres per minute.

Special Considerations Convective Heat

For life safety and the evacuation of people, convective heat is often discussed in tunnel fire protection. Smaller droplets may cool the air better than bigger droplets but are less effective in cooling the structures. Bigger droplets also cool down the air very well and have a much better impact on the HRR, and as a result less convective heat is produced. In summary, the Tyco Model TN technology is more effective in suppressing the fire and reducing the generation of convective heat. Improved cooling capabilities on structures as well as maintaining a tenable environment are additional features of the Tyco Model TN products.

Visibility

In firefighting visibility is critical. The fire brigade can fight the fire from over 25 metres away with a clear view. A fire protection system shall not cause a life safety risk in case of an accidental activation of the system. Tyco Model TN products provide visibility equal to a rain shower because of the large droplets, while most other systems will create a thick fog. With most tunnel fire protection solutions, an activation will totally block the view of the drivers. With zero visibility, the risk of accidents increases substantially.

The Complete Tunnel Fire Protection Solution

The Tyco Model TN technology is a complete solution including TN nozzles, deluge valves and options like CorroFlow™ pipe and Johnson Controls Zettler laser optical linear heat detection. The Tyco hydraulic deluge valves are widely used in the fire industry based on proven performance. They are considered fail-safe and are tested for surviving the lifetime of a tunnel. The Tyco hydraulic deluge valve controls the pressure individually per zone. Regardless of the demand from the hydraulically most remote zone, the system can be designed for the demand from a single zone. This reduces the total water demand. CorroFlow™ is a lightweight thermoplastic coated steel pipe with better corrosion protection than high-grade stainless-steel pipe. A fixed firefighting system is dependent on accurate detection. The Johnson Controls Zettler MZX Laser Plus provides fast and precise detection in the tunnel environment. The first system of the Tyco Model TN concept was installed 2017 in the Northern Link tunnel in Stockholm. It has proven its performance by controlling several fires involving cars and trucks.

The award-winning* Tyco Model TN solution generates the highest performance, most cost effective, flexible and life safety-focused system for road tunnel protection on the market today.

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* European Association of Research and Technology Organizations (EARTO) Innovation award: https://www.earto.eu/rto-innovation/rise-end-of-the-tunnel-for-firefighting-system/

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