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PASSIVE FIRE PROTECTION NETWORK

PASSIVE FIRE PROTECTION – WHY IS IT CHOSEN IN HIGH RISK ENVIRONMENTS?

Discussion Paper

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PREFACE

Fires in road tunnels present challenges for those designing and operating these important items of critical infrastructure. The confinement of the tunnel and the potential for multiple sources of combustible materials produce severe fire loads on structure, and difficulties for those evacuating or needing access to carry out firefighting and rescue activities.

Any method used to mitigate the effects of a fire must work when it's needed and must not cause a problem at all other times. And it may never be needed - but we always need to have confidence and evidence that when called upon it works as expected.

Relatively speaking, a passive mitigation system is preferred to an active mitigation system that provides the same protection function because there is less to go wrong – less chance that the system might be damaged or that it might malfunction when it's needed.

Our traditional thinking is that water helps us to mitigate the effects of fires – it reduces heat levels, it protects the structure, and it puts the fire out. In many instances water does these things, but sometimes fires are too hot, too aggressive and too large for water-based systems to be fully effective. Fire protection based on fixed water-based systems, such as sprinklers, deluge, monitors or water mist, involves active systems that are based on assemblies of mechanical and electrical components – and they need to fully function when they are called upon in a fire. The complexity, reliability and vulnerability of active systems is an important consideration when deciding if the risks to fires are being adequately managed.

Passive fire protection will not extinguish a fire, large or small, but it will protect structures and equipment from failing, it will provide shielding - helping people to shelter or to escape - and it will limit damage. And as the name suggests, PASSIVE fire protection doesn't need activation or complex systems for it to function. And that brings huge potential benefits.

When hydrocarbons are being produced or processed on offshore oil and gas facilities, the fires that could occur as a result of an accident can be severe. And research, now reflected in the fire testing methods for tunnel products, shows that there are many similarities between fires on oil and gas facilities and fires that occur in road tunnels.

In this paper, John Dunk of PFPNet, Bart Hendrix of RWS and Micha de Jong of Efectis look at the benefits that passive fire protection brings to the offshore oil and gas industry in protecting people, business and the environment from the immediate and long term effects of fires. There are lessons to be learned from this experience for those considering how to provide fire protection for road tunnels.

Simon Thurlbeck, PFPNet, October 2020

PASSIVE FIRE PROTECTION – WHY IS IT CHOSEN IN HIGH RISK ENVIRONMENTS?

When addressing the requirements for fire protection in industrial, commercial and infrastructure environments two types of fire protection are commonly discussed, passive fire protection and active fire protection. The two types can be described as:

- Passive Fire Protection - a spray applied coating or a board or panel system, which is used to create a thermal barrier between the fire and the item being protected, most commonly structural steel or items of plant.
- Active Fire Protection - there are different types but the most common is application of water in the area of the fire, the water being delivered through pipework to nozzles exiting in a spray to provide cooling, reducing the impact of the fire and potentially extinguishing it. Others can deploy an extinguishing gas directly into an enclosed area.

So how is a particular system chosen for high risk environments and why are those choices important?

This article addresses these issues when looking at what might be considered one of the most high-risk environments, the offshore oil and gas exploration and production environment. It is hoped that the benefits described for passive fire protection may also be understood in the context of other critical environments such as fire protection in road tunnels where many of the issues relating to reliability, maintenance and incident impact are equally critical.

Over many decades oil and gas has been produced in offshore locations around the world, often in some of the harshest environmental conditions. Frequently located hundreds of kilometres away from the nearest land, these installations rise above the sea surface supported by fixed or floating structures. Sitting in a relatively small footprint, the operating part of an offshore installation - the 'topsides' - is a complex and dangerous environment.

In that small area, often with dimensions less than the size of a football pitch, can be found; a drilling rig, what is effectively a small refinery or gas plant for processing, compressor stations for export of product, a powerplant to generate electricity and a small 'hotel' or living quarters for the crew that operate the installation, and a helicopter landing platform to facilitate getting crew to and from the installation.

Oil and gas is extracted from reservoirs below the seabed, often at high pressures and temperatures, and goes through some level of processing (which could be significant) prior to export to the land, either by pipelines or shuttle vessel. When handling highly flammable hydrocarbons in such a complex environment it is hard to think of a situation where more care is necessary in selection of fire protection and how critical that fire protection is in order to save lives, protect assets and protect the environment in the event of an incident. So why is it that passive fire protection is one of the primary protection methods used on these facilities?

ITS ALL ABOUT MITIGATING RISK AS RELIABLY AS POSSIBLE

The total elimination of risk is not possible. There is always the potential for an accident, and the industry therefore implements risk mitigation strategies that identify and manage any risks, including fire risks, to a level that is as low as possible. The objective is to put in place a robust safety management process that includes systems to prevent accidents from occurring, and to mitigate their effects if they do.

For fires, the consideration is of fires impacting structure or items of process plant and weakening the materials from which they are constructed. This can result in structural collapse or escalation of the fire to a larger fire, and could lead to loss of life, loss of the asset and damage to the environment.

In understanding why passive fire protection, as opposed to active fire protection, has many benefits as a solution to prevent this we need to understand what makes passive fire protection a more reliable and dependable option.

PASSIVE VS ACTIVE FIRE PROTECTION

Firstly, passive fire protection is exactly that, passive. It needs no external activation or intervention to work but remains passively on the plant or structure to which it has been applied until such time as it is exposed to fire.

In the case of fire protection coatings applied to metallic plant and structural items, such as cementitious or epoxy intumescent coatings, the heat of the fire produces a chemical reaction in the material turning it from an inert coating into a fire protection coating. This controls the transfer of heat from the fire through to the steel on which it is installed. Depending on the required level and duration of protection required, the coatings will be applied at thicknesses which have been tested and approved to meet that requirement.

In the case of fireproofing boards, panels or jackets, they form a thermal insulation layer on the structure or plant item. The thickness is designed depending on the applicable thermal insulation requirements for the structure or equipment. By means of testing and certification, thermal properties of these boards are known and can be used for determination of the required thickness.

By contrast active fire protection systems are more complex and do require external activation. This is usually done by sensors which detect a fire and trigger a response, via a fire detection control system, to a firewater or suppression system. An active firewater system will usually have pumps that must be started, and which deliver water by a pipe network to the area where the fire has been detected. Alternatively, actuation of the firewater system can be by manual means – having a human pressing a button.

Active fire protection systems are complex mechanical and electronic systems, and for them to function when needed it is clear that the reliability of the system is critical. Reliability studies and component testing can be used to help demonstrate that a system is reliable, and very often it will be necessary to test the complete system in place to prove reliability on a regular basis. In many cases a complete system test is not only undesirable but can cause disruption to operations and a significant clean-up task. And of course, there needs to be an adequate supply of water.

So in terms of demonstrating that effective measures have been put in place to mitigate the impact of fire, the reliability and dependability of passive fire protection is easier to demonstrate than for active systems requiring electrical and mechanical activation and then operation, and a continuous, uninterrupted, supply of water or other suppressant to be effective.

MAINTENANCE

This is another differentiator for passive fire protection as typically, the harsher the environment, the higher the requirements placed on passive fire protection manufacturers to qualify their products as suitable for use.

For example, the potential for degradation of coatings and passive fire protection systems in severe environments, such as offshore, is well understood. National and international standards are in place that specify test regimes to replicate the environmental exposure to which fire protection coatings must be exposed in order to assess their ability to maintain lifetime performance levels. In the case of fire protection coatings this includes an assessment of fire performance before and after exposure with limits set on allowable degradation in order to qualify a material as acceptable for use.

Why is this important? The answer is simple: The oil and gas industry has recognised that any maintenance activity offshore comes at an enormous cost, often tens or hundreds of times the cost of doing the same task in an onshore construction environment. Access is often difficult and complex to arrange, and disruption to the day-to-day operation of the asset is regarded as highly undesirable. Having a fire protection system that has been developed and tested to show it can withstand its environment and duty without requiring maintenance, and still function when needed, removes these concerns.

DAMAGE AND RESILIENCE

Engineers and specifiers consider mechanical damage when assessing the suitability of passive fire protection. In both the onshore and offshore oil and gas exploration and production environments, explosion before fire is a real risk, and this is one source of such damage.

When hydrocarbon gases are accidentally released, the likelihood of an explosion is very real. Engineers look at the impact of explosion on the structure or plant item being protected and on the passive fire protection material itself. Explosions can cause severe deformation of the steel structure or plant item and if the passive fire protection material is not able to withstand these deflections it may become cracked, disbonded and simply unable to provide the required level of protection should a fire then follow the explosion. Passive fire protection systems are therefore evaluated against large scale explosions under controlled conditions to assess their ability to remain intact and provide the required fire protection to the structures and plant items on which they are installed.

Fire detection systems and active fire-fighting systems are complex, multi-component assemblies of sensors, electrical and control systems, power supplies, pumps, piping and cabling systems which are widely distributed throughout the regions where fire and explosions occur. This makes them vulnerable to damage from explosions unless they are carefully designed, located and protected themselves. With passive fire protection systems, the use in vulnerable areas is very much simplified by using a product that is not a complex arrangement of different components, but a straightforward product that is relatively low cost, has been tested, has no sensitive components, and can be widely deployed without careful detailed design.

As well as accidents, mechanical impact damage can be caused to passive fire protection by day-to-day activities and can be seen, for example, where localised impact has either cracked or removed an area of coating. However, localised damage is unlikely to have a significant effect on the overall fire integrity because only small areas of damage means that the majority of the structure or plant item remains protected and a localised 'hotspot' has negligible impact on overall fire resistance. And localised damage is relatively easy to identify and repair. Localised damage to complex active fire detection and fire-fighting systems carries the risk that the local damage to one part of the system prevents the whole system from functioning

When engineers consider what are acceptable risks on a facility, undertaking detailed risk and safety studies such as scenario analyses, HAZOPs, or quantified risk assessments, requires an understanding of the probability of failure on demand (PFD) of the safety systems that are being used. Here the main difference between passive and active fire protection systems is, that the PFD for passive systems is intrinsically lower than that of an active system because the active system contains many components that all have the potential to fail.

A well specified, manufactured and installed passive fire protection system has a lot less to go wrong with it.

IN SUMMARY

When addressing how to provide fire protection many factors must be taken into consideration, but it is clear that reliability and dependability of the fire protection are high on the list in order to minimise damage and disruption should a fire occur.

It is also clear that there are many similarities across situations which could be considered as “high hazard”. A good example of this can be seen when comparing oil and gas facilities and road tunnels. In either of these uses not only must control of escalation and safe evacuation of people be considered but also the longer term impacts a result of disruption to production or use. These can be, directly or indirectly, many times the cost of fire damage itself. Having an oil and gas facility or road tunnel our of use for many months or years has significant consequences for a business and society.

Active fire protection systems can be applied successfully across many facilities. They have the ability to reduce the damaging effects of a fire, and can for certain types of fire, extinguish them. Their cooling can help to reduce levels of heat when people are escaping. To do this successfully they need to work, when needed, with no unexpected failures in the various key components across the system.

By contrast:

- Passive fire protection requires no external activation and is not subject to interruption – it is there when needed.
- A passive solution lends itself to being able to demonstrate that measures have been put in place to mitigate fire impact, limiting concerns over dependability and reliability
- Passive fire protection materials are extensively tested to meet the requirements of the environment in which they are installed – this ensures longevity and the ability to provide fire protection over the lifetime of the asset being protected
- Little or no maintenance is required for passive materials with the possible exception of mechanical damage which can easily be detected and repaired where necessary
- Passive fire protection technology is proven, with many decades of use and millions of square metres of structure and safety critical equipment protected.
- There are many examples where fires have been successfully mitigated by passive fire protection systems, and such is their performance that they have resisted fires that have burned for many hours longer than the passive fire protection was design for.

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