FIRE SUPPRESSION FOR LNG FACILITIES

Justin Brown, Owens Corning, USA, explores the effectiveness of fire safety systems for LNG facilities, with emphasis on passive pool fire suppression.

As the world continues its shift to fuels with lower carbon intensity, demand for LNG continues to grow. Europe is expected to become more reliant on LNG, while in Asia, LNG will be needed to fuel vast infrastructure projects.[1] These are among the reasons Bloomberg expects LNG demand to grow by 33% by the end of this decade, as seen in Figure 1. In order to supply this LNG, more facilities are already under construction.[1]

With increased LNG facility construction, there is also an increased need for efficient, effective, and reliable safety systems, particularly for fire suppression. LNG impoundment basins are designed and strategically located to route spills away from process equipment, and to reduce fire hazards and pool vaporisation. Prior to ignition, heat can be transferred to the LNG from the walls and bottom of the impoundment basin, as well as from the environment, due to wind and sun. If ignited, an LNG fire can cascade into a self-propagating reaction, radiating extreme heat to the nearby facility and process piping. After ignition, radiation feedback from the flame to the pool surface drives vaporisation rates higher.

Active and passive fire suppression systems

Table 1 outlines several methodologies for protecting against a cascading fire event, using active and/or passive systems. Active systems are triggered by a person or activation mechanism. An active fire mitigation system carries the inherent risk that it could fail to activate due to a lack of detection or system malfunction. A passive fire mitigation system deploys with no activation required. It is installed prior to operation and, is in essence, always available. Passive fire mitigation that is properly maintained will function without external intervention, which means that passive systems receive preference in regulatory reviews.

Operations can use a combination of both active and passive systems, and it is worth revisiting these various methodologies and systems to better understand their advantages and disadvantages, as well as how systems can be best employed to maximise their performance, and minimise risk.

Separating critical equipment from the impoundment basin is simple and sensible, but the facility's footprint may limit the distance equipment can be moved. If equipment cannot be separated as desired, the next option in helping to prevent cascading fire events is to limit the radiant heat from the basin in the event of a pool fire. This can be accomplished through passive or active systems. One passive option is to make the basin deeper and narrower, limiting its surface area and any subsequent pool fire. However, construction factors can limit the ability to dig a basin deep enough to accomplish this goal.

Another suppression system that works to reduce radiant heat during a fire event is the FOAMGLAS® PFS™ Pool Fire Suppressant System Generation 2, engineered by Owens Corning. This patented system uses blocks of low-density cellular glass – which is both buoyant and non-flammable – alongside a reflective stainless steel finish. In the event of an LNG spill, the non-flammable cellular glass floats to the top, creating a barrier between the liquid and solar radiation, or other heat sources. If ignition does occur, the cellular glass system limits the flame height. This system is an effective option on its own, or it can be used in conjunction with active systems for multiple modes of reliable protection. This system may also reduce the need for other fire protection systems within the facility. By reducing the size of the fire and the heat flux to adjacent equipment and structures, it could also reduce the need for alternative systems, such as a fire water system or Hi-Ex foam.

Fireproofing all of the critical equipment is also an approach to preventing cascading fire events. Cellular glass insulation is often used for this method as it is non-combustible, and provides a number of other insulating advantages for LNG systems, such as being impermeable to water in both liquid and vapour forms. Fireproofing all equipment can be time consuming and costly; however, because basin placement and fireproofing do not require any activation by personnel, these are considered passive fire safety measures.

Fire water systems, such as sprinklers, can also be used to protect critical equipment. As with any active system, a fire water system must be triggered by people or activation mechanisms, and the system must be properly maintained to ensure it works when needed. Weather conditions also have the potential to reduce the effectiveness of a fire water system.

Many operations also use chemical foam to suppress radiant heat. This is an active system, and when properly deployed, it can be effective. However, like any active system, it must be triggered in an emergency. The system must also be

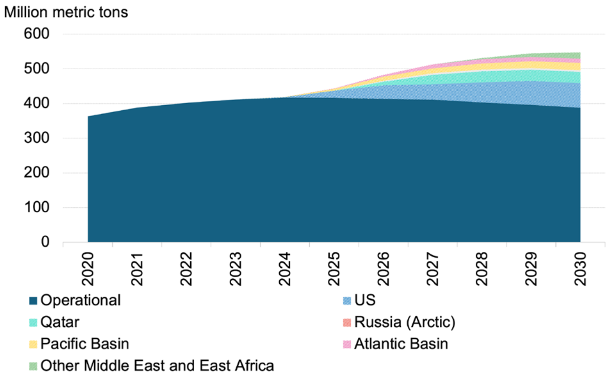

Figure 1. Global LNG outlook to 2030.[1]

Table 1. Approaches to impoundment basin fire protection: preventing cascading fire events

Methodology	System	Mode
Separate critical equipment from fire	Move impoundment basin away from tanks/ piping	Passive solution
Reduce thermal radiation from basins	Increase basin depth to reduce surface area	Passive solution
Reduce thermal radiation from basins	Pool fire suppression system	Passive solution
Fireproof critical equipment	Passive fire protection insulation/coatings	Passive solution
Provide active cooling to critical equipment	Fire water systems	Active solution
Reduce thermal radiation from basins	Hi-Ex foam systems	Active solution

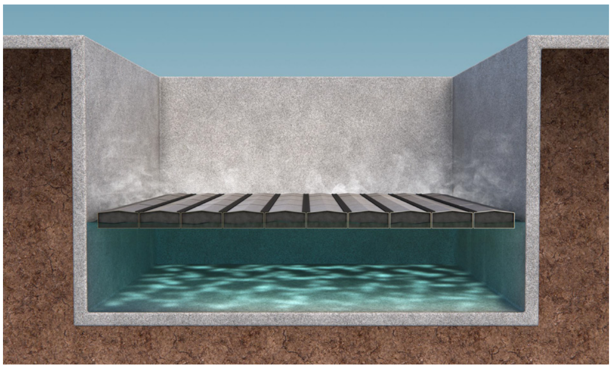

Figure 2. How the FOAMGLAS® PFS™ System Gen 2 works.

maintained regularly, and its effectiveness depends on it deploying without error or delay in the moment of need. Since most import and export LNG facilities are located near water, wind is also an issue. High wind conditions are enormous detractors for foam, blowing it off course and reducing its ability to be effectively applied.

Figure 3. Flame height comparison: basin with and without FOAMGLAS® PFS^{TM} Pool Fire Supressant System Generation 2.[2]

Pool fire suppression system in practice

The system comprises of a series of individual blocks of cellular glass, coated with a silicone adhesive and cladded in stainless steel. Once in place, the blocks are linked together using a series of stainless steel bridges, allowing the individual elements to work as a single unit. The system can be customised to the basin size and is easy to install. Once installed, maintenance needs are minimal, and the system is designed to provide long-term resistance to weathering.

This is a passive system that remains in place to assist in providing immediate and automatic control of LNG pool fires, without deployment delays. Due to its buonancy, the system rises immediately to the surface of the LNG to provide an insulating cap that reduces vaporisation and, in the event of ignition, limits thermal radiation and flame height, as shown in Figure 2.

Cellular glass has several unique properties that make it a suitable material for a pool fire suppression system. It is composed of millions of sealed glass cells that are impermeable to vapour and liquid – including hydrocarbons. It has a high compressive strength, and is designed to stand up against outside elements and most corrosive chemicals. In a spill event, cellular glass not only reduces risks of flame spread but also vaporisation, which often leads to fire.

These systems have been installed in operations around the world to enhance safety and help facilities meet regulatory requirements. For example, when an LNG facility in Florida, US, doubled its LNG capacity within a limited-space site, this system was installed to help mitigate safety concerns.

Testing performance

The FOAMGLAS® PFS^{TM} system has demonstrated effective performance in controlling vapour and thermal flux in tests that mimic real-world LNG operational settings. One study, conducted by Owens Corning, compared vapour, thermal radiative output, and fire size in a basin with no pool fire suppression system to one using this system.

In each of the respective tests, the impoundment basin, which measured 2 m x 2 m x 1.2 m, was filled with approximately 1.5 m^3 of LNG. After vapour concentrations were recorded, the pool was ignited, and radiant heat measurements were then taken.

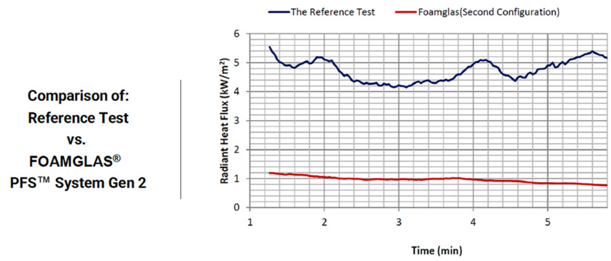

Figure 4. Comparison of reference test and FOAMGLAS® PFS^{TM} System Gen 2.[2]

The experiment, illustrated in Figure 3, demonstrated that the system was effective in reducing radiant thermal flux and also controlled the fire immediately after ignition. By reducing the exposed surface area of the pool, the system was able to hold the fire to a steady state.

Figure 4 shows that in the impoundment basin equipped with the system, radiant heat flux was reduced by approximately 80% compared to the reference test.

Owens Corning is beginning new research of this system in 1Q25 and expects to release results upon concluding these tests. This testing will provide valuable insights into large-scale pool fire suppression.

With this system, it becomes a material that can be trusted even in LNG spill situations. This passive fire protection system complements active systems and offers operations more flexibility in their working configurations and greater confidence that their fire safety measures will deploy as expected when performance is critical. By reducing vaporisation and flame height, this system can help protect personnel, infrastructure, and the environment in the rare event of a spill.

References

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2. 'Vapour & Fire Control Testing of FOAMGLAS® PFSTM System Gen 2', Owens Corning, (2014), https://www.foamglas.com/-/media/project/foamglas/public/corporate/foamglascom/files/test-reports/industry/test-report-vapor-and-fire-control-on-lng-and-lpg-with-pfs-gen-1-en.pdf.

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