RESIST RISK WITH BLAST-RESISTANT INFRASTRUCTURE

Bryan Bulling, RedGuard, USA, addresses the importance of comprehensive safety planning in LNG plants, reducing risk, and ensuring compliance with blast-resistant infrastructure.

At an LNG export facility, several significant blast hazards have the potential to pose serious risks. Cryogenic liquid spills can lead to rapid vaporisation and explosive mixtures if they encounter a heat source. Boil-off gas (BOG) can become explosive if not managed properly. Combustible gases that ignite can cause vapour cloud explosions, resulting in powerful blasts. Failures in critical equipment such as compressors, pumps, or storage tanks can lead to sudden releases of flammable gases, causing explosions. Inadequate or

malfunctioning detection systems can delay the response to a gas leak or fire, increasing the risk of an explosion. As far as general fire hazards are concerned, leaks of LNG or associated gases can ignite, and fires have the potential to occur in LNG storage tanks.

Two major LNG producers in the US are currently engaging RedGuard for thermal protective and blast-resistant buildings in their facilities. RedGuard is involved at both ends of the LNG journey, including liquefaction and regasification plants – the company supports the production side, the transmission side with pipelines and compressors, and the large waterfront facilities where LNG is stored and loaded onto vessels.

What are 'multi-hazard' buildings?

Multi-hazard buildings are designed to address a range of potential threats based on the specific needs of the facility. They offer blast resistance by being engineered to endure the intense forces of explosions, safeguarding staff, equipment, and assets during catastrophic events while also reducing liability and enhancing peace of mind. For fire resistance, buildings are equipped to handle various thermal challenges, including protection against fire, extreme heat, flash fires, and jet fires, using fireproof materials, insulation, and intumescent coatings. Fragment protection focuses on minimising risks from flying debris or fragments produced by explosions. Additionally, toxic gas protection involves implementing containment systems, emergency response plans, personnel training, shelter-in-place strategies, and advanced HVAC systems with purge and pressurisation capabilities, along with gas detection systems and reinforced structures to guard against toxic releases.

Conversely, a 'blast-resistant building' is a structure that has been designed to withstand significant blast events. These buildings are often constructed with thick steel walls and interior features and fixtures designed to withstand the heightened psi levels associated with small-to-large blast events. They are often found in LNG export and import facilities, oil refineries, chemical processing plants, or similar operations. Blast-resistant buildings may also be constructed from concrete, modular, built on-site, permanent, temporary, or a combination of these selections.

Risk analysis cycle for LNG infrastructure

Facility siting, a requirement for oil, gas, and chemical facilities, is governed by EPA and OSHA Process Safety Management (PSM) regulations and falls under the Process Hazard Analysis section of PSM. Facility siting studies (FSS) should be performed every five years. These studies, along with quantitative risk assessments (QRAs), are crucial for identifying potential hazards and developing effective mitigation strategies. Mitigation measures might include relocating personnel, constructing permanent blast-resistant or other protective structures, retrofitting existing buildings, or using temporary blast-resistant buildings customised for specific threats. Designing for these threats involves structural analysis methods like the Single Degree of Freedom (SDOF) approach, Finite Element Analysis (FEA), and independent field testing. Additionally, non-structural considerations, such as interior components and thermal protections, are also considered.

However, many large LNG export facilities are relatively new. This means, in many cases, they have not yet completed the required five-year cycle after which an FSS or risk analysis would be due. As a result, the first hazard review cycle for these plants is just now approaching. Some operators have proactively identified and mitigated hazards from the beginning, while others have postponed this process to the future. It is important to think ahead and identify risks and hazards in order to properly prepare for hazard reviews.

Recognising the hazards, many LNG companies are now leasing temporary buildings from RedGuard to house personnel on site until hazardous areas can be rectified, as well as providing permanent capital-type buildings for long-term use.

A tailored, rather than catch-all solution

Solutions should be specifically tailored to each customer's needs. RedGuard begins with steel modular buildings designed for blast resistance, offering protection levels up to 15 psi, and then incorporates additional safeguards as required. In contrast, some companies use a 'one-size-fits-all' approach by recommending multi-hazard buildings. While this method provides broad protection, it may not always be the most suitable strategy. A risk-based approach, which thoroughly evaluates the specific threats relevant to the location, often results in a more efficient, cost-effective, and customised solution.

Deploying 'catch-all' multi-hazard buildings in all areas that require threat mitigation can create additional problems, such as:

- Increased costs due to additional specialised materials, engineering, and construction.
- Increased weight – the larger the building, the more difficult it is to handle and ship.
- Over-engineering, resulting in inefficient use of materials and resources.
- More complex and costly maintenance.
- Larger facility footprint.

Precision for the LNG industry

Using precise safety measures is RedGuard's customised approach to multi-hazard safety, addressing the unique risks and challenges of each location. Unlike a more generic approach to hazardous environments, this approach focuses on delivering targeted, effective solutions to safeguard lives and assets. It goes beyond basic multi-hazard strategies by tailoring solutions specifically to the needs of each facility.

Benefits

Modular construction

LNG plants often face controversial and delayed approvals, leading to a rush to become operational quickly. Modular construction is ideal in this scenario, enabling rapid deployment and immediate readiness. Blast-resistant modules can be used to provide temporary shelter during

plant turnarounds, which occur every 3 – 5 years, and then relocated or removed when no longer needed.

Fire and blast resistant

RedGuard's buildings are specifically designed to resist fires and blasts, the two most prevalent hazards at LNG sites. The speed of modular construction, combined with features to withstand fire and explosions, makes the buildings highly effective for these environments.

Flood and corrosion resistant

Buildings in coastal areas are elevated to a level above the 500-year storm surge and can be designed to withstand the wind load of a category 5 hurricane, or 157 mph. These details are crucial to ensure that storms do not disturb the export process. Because we are in the midst of an active hurricane season, everyone is vigilant about potential storms. Since export facilities are all located on the waterfront, the company's buildings are designed to be elevated to avoid flood risks and specially coated to resist the salt and corrosion that occurs in coastal environments.

A commitment to ethical practice

In any team project, especially in safety-critical fields like the oil and gas industry, it is crucial that all members offer unbiased recommendations. The team creating safety specifications must remain neutral and separate from the manufacturing and sales processes to avoid conflicts of interest. If the same team profits from constructing and selling the solution, they might face biases due to pressures to meet deadlines, budget constraints, or sales targets, potentially compromising the integrity of their recommendations.

To counter the risk of bias in the process of installing blast-resistant buildings in the LNG industry, Dr Ali Sari, a world-renowned blast engineer with more than 20 years of experience in the analysis of onshore and offshore structures and blast resistance engineering, is regularly called upon to guide RedGuard's best practices for fabricating buildings that can withstand explosions, especially on waterfront properties. RedGuard is also currently promoting a second opinion programme, which aims to offer an independent review.

When the buildings are tested, the setup and analysis are conducted by third parties. Third-party engineers, rather than in-house engineers, are always called upon to refine the designs and provide guidance, to eliminate the risk of bias. Some companies are entering their first cycle of hazard review and may benefit from understanding the importance of ethical practices and independent evaluations, as newer companies might not be aware of how these practices impact the quality and reliability of their buildings.

Ethics, responsibility, and safety

RedGuard believes it is important to commit to developing projects ethically, methodically, and correctly from the start, efficiently educating customers who may be new to implementing blast-resistant buildings along the way. Working closely with clients to identify their needs is the best way to maintain long-term relationships, ensuring a seamless journey from initial consultation to final delivery. LNG