More brains are better than one

Danny Constantinis, EM&I Group, Malta, explains how a group effort to identify asset integrity challenges in the LNG sector can help achieve a safer, greener future.

Gas is fast being considered an acceptable alternative to other fossil fuels, such as coal or oil, as it is cleaner and less harmful to the environment and is a largely acceptable intermediary source of energy until greener sources of energy can be developed, such as wind, hydro, or others.

Until relatively recently, LNG was carried in specialised carriers and the product was delivered to shore-based storage and regasification facilities, mainly in places such as Japan and Korea. The regularity of supply was dictated by the demand ashore. As time progressed, companies recognised the advantages of placing the regasification plant on the carriers and to moor them, long-term, to purpose-built jetties. Land suitable for permanent LNG storage tanks was becoming scarce and the onerous regulatory regimes made it more difficult to get approval to develop such facilities. The regas vessel either acted as peak shaving facilities, where they plugged into the grid pipeline and provided gas as and when the demand arose, or baseload facilities, which were a primary source of gas to a power station or large industrial plant.

These FRSUs benefit from lower capital and operating costs, the ability to operate profitably for smaller capacity requirements, faster project schedules, and commercial flexibility as the units can be relocated after their contract termination. They are often leased, and this lease is usually a long-term agreement (e.g. 10 to 12 years), which includes the facility plus operation and maintenance.

The FSRU concept developed into an opportunity to be less reliant on the pipeline gas from others and to be semi-independent in terms of gas supply and more in control of pricing.

The model has therefore seen a significant growth, to the point where there are now over 40 facilities operating globally.

A further development was to gather stranded gas using floating LNG (FLNG) where it was not economic to run pipelines to shore.

The gas is compressed and stored on the vessel until it can be transferred to trading LNG vessels and shipped to onshore terminals or indeed FSRU units.

There are many variations on the FLNG scene including gas-to-power units which take the gas from subsea fields and use it as fuel for electrical power generators installed on the floating asset. This concept is a highly flexible solution for

example for near-shore power generation where there is little infrastructure or land availability onshore, or even for large industrial plant wishing to change from onshore coal or oil burning power suppliers to greener gas.

Taken a step further, there are jetty-free solutions being developed where the gas is offloaded to floating terminals.

The integrity challenges faced by assets permanently moored offshore, or permanently moored alongside a jetty, are well established. More and more the emphasis on safety and efficiency is at the forefront of many operators' minds, to eliminate fatalities or serious injury and prevent stoppages to production or send-out.

The Hull Inspection Techniques and Strategy (HITS) joint industry project (JIP), which was set up by the Global FPSO Research Forum in 2012, set out to avoid the need to use divers and personnel working in hazardous areas, including at height and/or in confined spaces.

This has led to the development of asset integrity technologies such as the ODIN© diverless under water inspection in lieu of drydocking (UWILD), and the NoMan® remote camera and synchronous laser systems.

These methodologies, initially adopted and proven by the oil and gas sector, can also be adapted and used successfully in the LNG sector for floating production, storage, and regasification facilities.

To help focus on identifying asset integrity challenges and solutions a JIP was formed called the FloGas JIP, which was started in 2019 and led by the EM&I Group.

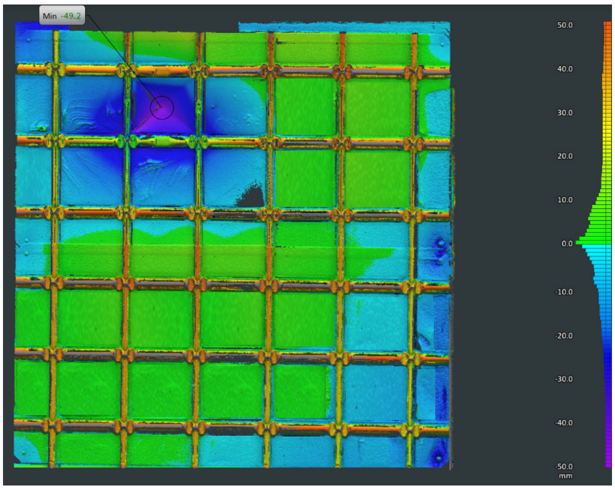

Figure 1. NoMan® laser scan of an LNG tank membrane.

Figure 2. An FSRU asset.

As with the oil and gas industry, the invitees to FloGas consisted of operators, classification societies, and service providers. The first two meetings were used to establish the group and to identify which asset integrity challenges needed to be addressed when dealing with cryogenic containment systems.

FloGas has recently held its third meeting and has already started to form working groups to develop safe and economical methods for the enhanced integrity of FLNG assets such as FSRU and FLNG vessels. These groups will be concentrating their efforts on dealing with the top three challenges identified in FloGas 3, namely:

- Remote inspection of LNG storage tanks without man entry.
- Hull inspection and integrity management (FSRU) alongside, in shallow, turbid, or potentially fast flowing water.
- Grow the competency and numbers of inspectors of LNG systems.

The initial focus has been on item one, to avoid man entry into the LNG containment and other confined spaces.

A working group was set up to explore new asset integrity methods using advanced technology such as robotic cameras and laser systems.

These new technologies were adaptations of proven methods but because the structures to be inspected and monitored are so different to the oil sector structures, an extensive technology development programme was instigated.

It will also involve the challenging of current methodologies and the reimagining of the regulatory framework in order to make the operation of FLNG assets as safe and efficient as possible. The group will be looking at issues such as the frequency and execution of tank inspections and whether putting people into these areas can be avoided in the first place.

Prior to entering the dockyards, LNG trading vessels are warmed up, gas freed, and opened up for a visual inspection. The classification society surveyor will focus on areas such as the pump and pump tower, the tank bottom sides to look for deformations or bonding issues, and to establish leakage rates.

For the FLNG units, where the systems remain live either by virtue of production or by send out, the time taken to take one tank out of service and bring it to a temperature for inspectors to safely enter can be onerous. Likewise, bringing the tank back into service can be risky, especially if the thermal gradient exceeds the design parameters of the containment system. Can this thermal cycling be avoided or minimised? It is an area the FloGas JIP will explore.

Study on LNG tank structure mapping

As a result of the success of the HITS JIP, EM&I commissioned a study to see how the laser technology can be used to map the tank structure and to identify any anomalies in the membrane containment system.

The purpose of the first phase was to trial laser scanning on the various types of membrane containment using optical and laser systems such as the NoMan technology.

Typical anomalies principally included sloshing damage and leaks through the membrane.

Trials were carried out in China and Europe on representative full scale test pieces and a number of challenges became apparent.

One challenge was the highly reflective nature of the membranes which had the effect of blinding the laser scanner so that certain parts of the lining were not sending the laser signals back to the transmitter. This was overcome by scanning from multiple locations and selecting suitable targeting procedures so that areas that had been reflective in one position were now able to send back data for processing.

The NoMan technology has now been successfully trialled on full scale containment system test pieces in China and the UK and the FloGas Working Group is now looking at the requirements to enable the system to work in LNG containment without person entry.

Now that the basic physics has been proven, the next phase is to consider how these inspection robots can be introduced into the LNG storage space through the limited access available at the pump tower bend or potentially through the vapour dome.

While still at the proof-of-concept stage, engineers working on this challenge feel confident that solutions are available and work is underway to try out these systems on live assets towards the end of 2022. When compared with traditional methods the system is expected to be safer, faster, and greener.

Initially, the system is expected to be operated by a two-person team, followed by the development of remote inspection systems where the owner and classification society representatives will attend from onshore, possibly continents away. This may appear to be a long-term vision but in fact the concept of remote surveys is well established and tests and trials have been carried out to demonstrate the effectiveness of the method in 2020.

Deployment methods for a resident robot system have already been designed for unmanned installations whereby a camera and laser system is located in a launch pod above each LNG tank and inserted into the tank remotely through an ODIN type access port.

These ports have already been proven on numerous applications in different sectors of the industry so would need little adaptation to the LNG requirement.

It is hoped that, because of the output from the FloGas working groups, the industry will recognise the need for new designs so that tank entry by people becomes a thing of the past. However, EM&I's interest in the future does not end here. As the world seeks a decarbonised alternative to fossil fuels, several other floating energy options are being seriously considered.

Floating mini nuclear power plants are already being designed and could be an effective solution to providing energy to bridge the gap between fossil fuels and renewable energy.

Developing and developed countries would find such methods attractive especially where there is a shortfall in existing infrastructure. The benefits of such power generation systems are that they are very compact and efficient, being capable of producing electrical energy without the potential weather uncertainties but can also produce hydrogen and ammonia, either as a primary product or as a byproduct.

The hydrogen is created using electrolysis to convert water into hydrogen. Hydrogen is not an easy product to store and transport in bulk (liquefaction temperature of approximately -250°C, which is close to absolute zero), so it needs to be carried in another product, such as ammonia.

Storage and carriage of ammonia is an already well-developed technology and could possibly replace or lead to modified versions of facilities such as FSRUs in the future.

Green hydrogen is also being developed by using unwanted energy from wind or solar power generation facilities and this can add to the energy mix as well as overcome the challenges of storing renewable energy.

The technology developed by the LNG industry in producing, transporting, and storing energy will prove invaluable in the future needs for greener global energy. **LNG**