MONITORING AND MAINTENANCE AT SEA

Danny Constantinis, EM&I Group, Malta, takes a detailed look at the monitoring and maintenance of floating gas assets.

The main problem for most emerging nations is providing power to develop their economies. Using well proven gas power generation technologies and floating storage and regasification units (FSRUs) is probably the simplest way to solve this problem.

FSRUs can be moored close inshore or on jetties. Many operators want to maintain their assets to trading ship standards so that they can be moved to new locations or resume their trading role.

Floating LNG (FLNG) vessels can help provide the low cost 'spot market' gas that makes FSRU projects viable.

FSRU and FLNG assets could both benefit from developments in the floating production, storage and offloading (FPSO) sector, especially where vessels are required to remain on station for periods of 25 years or more.

'Stranded gas', the spot market and floating gas

Conventionally, the gas market has involved large gas fields, long-term contracts, complex and rigid pricing structures, onshore gas plants and dedicated fleets of LNG transportation vessels.

This profile has changed with the need to access stranded gas fields, which supports the supply to spot market users, including FSRU operators.

FLNG units provide a viable solution to exploiting stranded gas especially as there are LNG trading vessels available, in the short-term at least, that can be converted to FLNG duties.

Once converted from a trading vessel, a different approach is needed to monitor and maintain FLNG and FSRU gas assets to keep them 'fit for purpose' throughout their operational life.

The integrity of hulls, tanks, pressure systems, topsides structures and hazardous area equipment (HAE) needs to be assured while on station to meet classification, regulatory and operator efficiency requirements, the latter implying significant cost, people on board (POB) and operational downtime reductions.

Much has been learnt from the FPSO industry

The FPSO Research Forum was set up 20 years ago to consider common problems and come up with solutions which improve safety and efficiency. It has achieved this by setting up joint industry projects (JIPs) to which all the interested members contribute both technically and financially.

The FPSO Research Forum and JIPs meet twice a year in different locations around the world to review progress and consider new JIPs.

This approach has been highly successful with innovations that have helped the members of the Forum weather the downturn in the industry over the last three years.

In particular, the hull inspection techniques and strategy (HITS) JIP, which represents all facets of the industry, has identified and brought a number of solutions into practical use in a short time frame.

Although FLNG and FSRU vessels are different in many respects, some of the lessons learnt from the FPSO industry and new technologies developed could be applied to the floating LNG industry once we know where the similarities and differences lie.

How different are floating gas assets?

Many FSRUs are moored on jetties in river estuaries, where strong currents and limited visibility make diving operations difficult, dangerous and often prohibited by the terminal operators. The HITS JIP has encouraged techniques, now in

common use, that have eliminated the need to use divers for hull, ship side valve and mooring chain inspections and maintenance.

Being moored on jetties can also affect cathodic protection systems and increase the need for underwater maintenance. New methods of retractable anodes are being installed on FPSOs that could help solve this problem.

FLNG assets are again different; sophisticated gas containment systems and specialised offtake equipment pose specific integrity challenges when applied to assets with long operational lives offshore.

The HITS JIP has enabled development of successful inspection methods of tanks and other confined spaces without man entry using a combination of high performance optical and laser devices. These techniques could be applied to gas assets.

The HITS JIP has also been responsible for introducing the ODIN® diverless UWILD (under water inspection in lieu of drydocking) and NoMan® remote camera technologies. These methods generate 50% direct cost savings and 70% POB savings by eliminating diving and rope access activities. Interestingly, these methods also deliver additional savings (up to 75%) in management time and there are other associated cost and operational benefits that have yet to be quantified.

There are undoubtedly other challenges for FSRUs that the industry has not yet identified and that will require solutions if these assets are to remain on site for their predicted life.

Maybe it is a good time to consider extending the scope of the lessons we have learned so far from the HITS JIP which could be used as the basis for a JIP focused on the specific needs of the FSRU and FLNG industry.

Figure 1. A typical gas terminal.

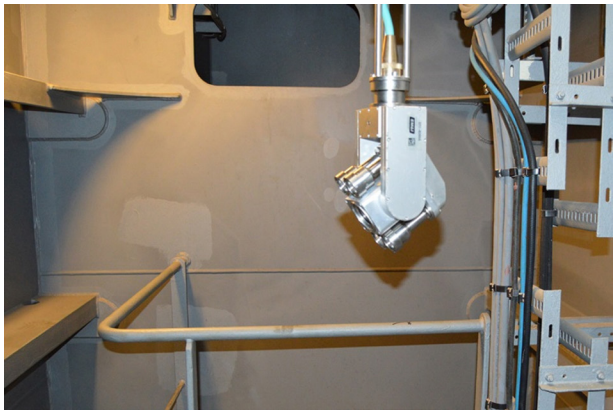

Figure 2. Remote NoMan camera inspection.

Sophisticated methods of hull and tank inspections

Sophisticated methods of inspecting and maintaining tanks, pressure vessels and Ex equipment have also been developed for FPSOs, which could also be applied to the FLNG and FSRU industry.

Many of these were originally developed for the nuclear industry (where robotic methods are advanced and well proven) and are now being adapted for the oil and gas industries.

There are many thousands of components

There are many thousands of components on the average FLNG unit and FSRU, which all need to be monitored, inspected and maintained throughout the operational life of the asset. This is usually tackled using a risk-based inspection (RBI) strategy as it would be impractical to inspect all components regularly.

However, even after applying the RBI approach, there is still a high level of inspection required and this can be reduced further by applying 'big data', statistical analysis and robotic techniques.

Statistics and robotics

Statistics are like radar or a microscope that enable us to see things that we would not normally see. They are beginning to play a big part in helping us to optimise the industry.

Robotics are also making big inroads into asset integrity, as we try to reduce the risk of using divers and personnel working in hazardous areas such as underwater, at height or in confined spaces. We are fast approaching the time when only a small team of offshore operators using sophisticated robotic equipment will be able to work in real time with an onshore team of experts to inspect and monitor all the essential equipment and guide the maintenance team and programme.

Non-intrusive Ex inspections can have a big impact

Other developments include the ability to carry out detailed non-intrusive inspections of Ex electrical equipment without shutting the systems down, thus saving significant costs and operational downtime.

With many of the larger floating assets having approximately 20 000 items of HAE equipment, it is vital to know what to inspect and when. Current methods are largely prescriptive, and it is difficult to meet the inspection requirement because of the large volume of components.

Inspection efficiency is improving with prioritised workscopes, suitable databases, hand held 'palmtop' data loggers and radio frequency identification (RFID) tags, which help record, update and store the data.

However, a major opportunity to improve safety and reduce costs comes from non-intrusive inspections (NII) of Ex equipment.

Because some of the failure mechanisms are linked to incorrect assembly rather than time related degradation, there is a need to strip down certain components for detailed inspections.

Much of the inspection cost relates to having to isolate systems for highly trained technicians to strip down, inspect and remediate sealed components.

The FPSO industry has developed non-intrusive methods to 'see' inside sealed components such as connectors, junction boxes and switches without having to isolate systems and strip down equipment, thus only shutting down for remedial maintenance where necessary.

Figure 3. Inspection engineer carrying out unmanned tank inspection.

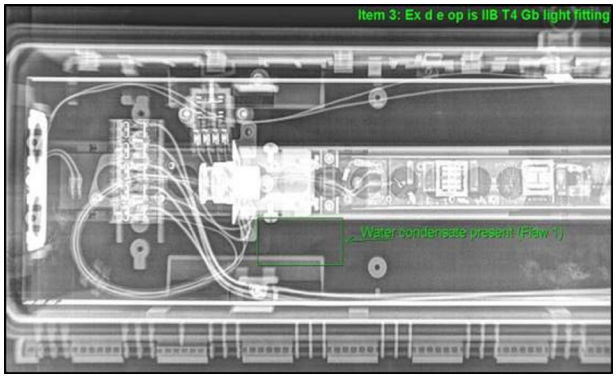

Figure 4. Non-intrusive inspection of Ex item.

Figure 5. Camera insertion through ODIN access port.

Class societies and regulators

The class societies are open to innovations which reduce safety risk and have been supportive members of the FPSO Research Forum JIPs.

Properly structured proposals which reduce risk to people and property are well received and indeed the classification societies themselves are investing heavily in new strategies and technology.

Continuous hull inspection cycles, diverless UWILDs, unmanned tank and confined space inspections, robotics and digitisation are part of the routine language in the conversations with class and regulators. They equally recognise the safety and environmental benefits that these new technologies bring while operators enjoy the ability to meet class and regulatory requirements while remaining on station, on hire and in operation while the work is carried out.

Staying on station and in production

One example of this 'win-win' strategy is ODIN, a proven system for both valve inspections and repairs.

Class approved ODIN access ports can be installed adjacent to critical valves, so that a remote camera and manipulator can be inserted into the pipe to inspect the valve whilst it is in operation.

In the event of a valve needing to be repaired or replaced, inflatable bladders are inserted through the ODIN access ports to isolate the valve concerned so that it can be removed and repaired or replaced.

On a recent project on a drillship offshore Angola, 21 valves were inspected and three valves repaired using this technology, to the complete satisfaction of both the client and the class society involved noting that the work was carried out safely while the vessel was on hire, on station and in operation throughout the project.

This type of inspection/maintenance port can be fitted while the vessel is in operation, but it would be more economic to install them during the newbuild or conversion stages if possible, rather than when the vessel is offshore.

Similar benefits have been achieved in tank and confined space inspections using high performance optical/laser systems.

One such system, NoMan®, enabled a man time reduction of 90% when inspecting cargo oil tanks on a North Sea FPSO. These systems use remotely operated cameras to carry out general visual inspections (GVIs) and close visual inspections (CVIs) to classification society standards and laser devices to provide 3D images of the tanks to confirm that there is no distortion.

Synchronous lasers have already been shown to have the ability to remotely measure structural component thickness and other anomalies on FPSOs and this may have a similar application for gas containment tanks and their associated marine structures.

There is scope for the FLNG and FSRU community to set up a research forum

There is scope for the FLNG and FSRU community to set up a research forum similar to the FPSO Research Forum, or consider an alliance with the FPSO Research Forum, which has been operating very successfully for over 20 years.

New JIPs could be set up to solve the specific problems of FLNG and FSRU vessels, and knowledge pooled to make the business safer and more efficient.

Does floating gas have a future?

The future for FLNG vessels and their ability to deal with stranded gas fields, and FSRU vessels to deliver gas quickly and safely to isolated areas in emerging nations with little infrastructure, is compelling. A 1000 MW gas-fired power station using well proven technology can be built in just 18 months. Linked to an FSRU supplied with gas supplied by FLNG units equates to producing power quickly and safely.

While the world economy grows and emerging nations develop, there is a need for a low cost, rapidly available and environmentally acceptable energy source.

Floating gas must be one of the best contenders to deliver this solution globally. LNG