An extra lease OF LIFE

The life extension of existing floating production units (FPSOs) is increasingly important, as hydrocarbon supply shortages are evident and the construction of new and converted assets will take time.

Most FPSOs are converted very large crude carriers (VLCCs), so the hull and many of the marine systems are as old as the vessel itself.

According to the American Bureau of Shipping (ABS) – which is one of the main classification societies for FPSOs – 25% are over 40 years old, and 70% are over 20 years old, so there may well be an increasing demand for life extensions of oil and gas-producing assets over the next few decades while alternative and renewable energy sources come online.[1]

It may take some years before renewable energy makes a big difference to the need for hydrocarbons, and during this transition the hydrocarbon-producing assets will of course need to be maintained.

Floating offshore wind (FOW) is one of the renewable sectors that will make a significant impact and will undoubtedly progress, despite the challenges of adequate port and manufacturing facilities, supply chain development and an established regulatory framework.

Danny Constantinis, EM&I Group, Malta, addresses the importance of keeping existing oil and gas assets going during the transition to renewables.

Figure 1. *NoMan cargo oil tank.*

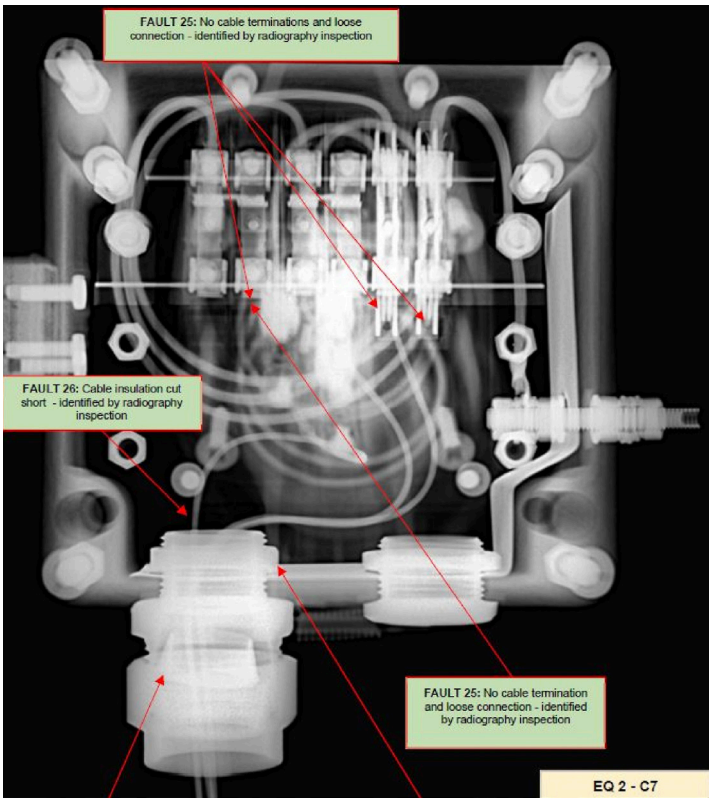

Figure 2. *ExPert.*

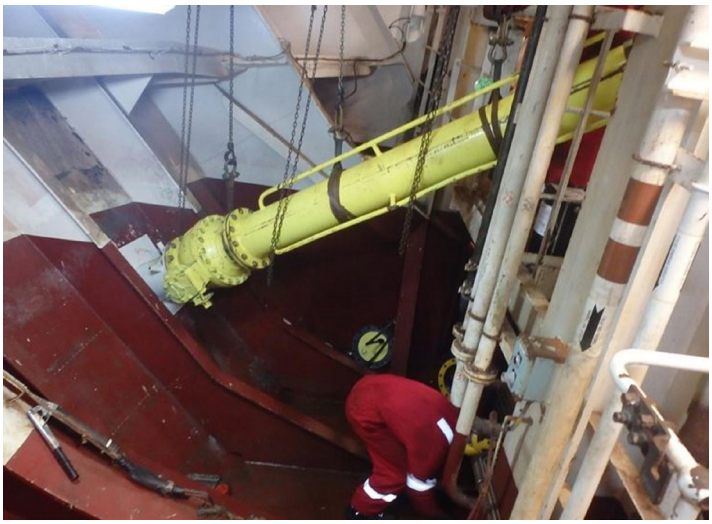

Figure 3. *HullGuard impressed current cathodic protection installation.*

Nevertheless, FOW and most renewables need to deal with the question of energy storage, and until this is resolved there will be a need for back-up energy and therefore the need for hydrocarbon supplies for some time to come, bringing the question of life extensions to the fore.

A lack of expertise and skills

This leads back to the question of the practicalities of life extensions for ageing assets, both for executing the modifications and for continuing to operate the assets with a diminishing resource of people and service providers, noting that many will have transitioned to the renewables sector.

Fortunately, much of the technology required for ageing hydrocarbon producers will be similar to that required for FOW assets.

This is because the industry drivers of using robotics and data to ensure improvements in safety, cost and efficiency will apply not only to newly constructed assets but also to older operating assets and the upcoming FOW units.

Conventional life extension strategies may have to change to take on board these new requirements, and this creates challenges in adapting modern integrity techniques to extending the life of older designs.

For example, a life extension study might well look at the fatigue or corrosion remaining life and develop plans to replace or protect structures and pressure systems for a further period; 'soft issues' such as maintaining, upgrading or replacing control systems may be much more difficult however.

As an industry, there is wide experience of doing this kind of work, but when the scope includes such challenges as ensuring that the life-extended asset operates with minimal people on board (POB) – using robots to inspect and maintain the asset – then a different approach is required.

Designing life extensions with robotics in mind

In some ways, life extension projects offer an opportunity to bring in new technology that improves safety and efficiency, and indeed some of the practical life extension execution work can benefit from robotics and improved use of data.

EM&I has led a joint industry project (JIP) on behalf of the Global FPSO Research Forum for the last 8 years called Hull Inspection Techniques and Strategy (HITS), which has stimulated some innovations and technologies that can be used on all floating assets, including those planning a life extension.

Recently, some of this technology was adapted to carry out underwater hull repairs (normally requiring the FPSO to drydock), to be implemented on station and without either production interference or use of divers.

Better for the environment

Many similar technologies can be designed into life extension projects that make the asset safer and more efficient. They do not require divers or put people at risk in hazardous areas, such as working at height or in confined spaces.

Some of the robotic and digital technologies that have been stimulated by the HITS JIP include the ODIN® diverless underwater inspection and maintenance systems and the NoMan® rapid robotic surveys of confined spaces. The next stage of HITS will study robotic and risk-based methods to minimise the need to clean tanks prior to inspection.

Other technologies that reduce safety risks and costs include ANALYSE™ data analysis methods that halve the need

to put POB for pressure system surveys; ExPert™, which is a non-intrusive and remote method for Ex equipment inspections; and HullGuard®, which is a diverless hull corrosion protection system.

Remote inspections and autonomous vessels

Resident robots and autonomous vessels will play an increasing role in improving efficiency and safety, so that relevant experts and class society surveyors will not need to visit the offshore assets concerned. This also saves on POB and helicopter trips, which in turn reduces costs and carbon emissions. It may also help with the inevitable diminishing number of skilled personnel available who are familiar with such assets, as the target of net zero by 2050 draws closer.

Robots and innovative methods can make hull repairs and renewals much safer and simpler. In addition, ODIN access ports can be used to drill through the hull adjacent to the repair area from within the hull, enabling wire guides to be passed to the outside of the hull, taken to the surface by a remotely operated vehicle (ROV), which is effectively a robot, and connected to a cofferdam that is winched into position over the area to be repaired.

The ROV can observe the whole process from outside the hull and advise the technicians operating the winches inside the hull when the cofferdam is in position. The hull repair can then take place, and on completion the cofferdam is released and returned to the surface.

Extensive repair projects have already been carried out successfully for a supermajor and leading FPSO operators.

This type of technology allows assets to remain on station, on hire and in production while the repairs are carried out, so it is an important development for the life extension of ageing assets.

Isolation valves are often as old as the vessel itself and repairs are often complex and time-consuming, so early detection of leaks or problems with seals is vital for efficient operation. The ODIN technology allows the operator to literally see the valve opening and sealing in real-time and while in operation.

Early warning of problems can then be resolved again using robotic systems to clean or replace the valves.

Confined spaces

Storage tanks and other confined spaces, including pressure vessels, can also be inspected without manned entry using the NoMan remote camera and laser scanning technologies. The camera system is now ATEX (Ex) rated, so does not require tanks to be prepared for human entry, gas freed and vented before it is inserted through deck openings for both general visual inspection (GVI) and close visual inspection (CVI).

The camera has its own lighting, can pan, tilt and zoom, and is mounted on articulated carbon fibre manipulators that can be used at any level and articulated in the tanks to view the structure from different angles.

The laser scanners are deployed on stabilised robotic systems that access the confined spaces generally through existing access holes in the tank or pressure vessel.

NoMan is a class-approved system capable of detecting and measuring corrosion, distortion, pitting and coating damage, and can also take thickness measurements, meaning that the system provides vital information without the need for manned entry.

The question of cost and risk is always a feature of using new technology, but these systems are thoroughly tested and accepted as a means of improving safety to as low as reasonably practicable (ALARP) a level. Thus, these are viable alternatives for avoiding the risk to human life and indeed reducing the number of personnel exposed to risk.

The need for regular inspection

The thousands of electrical (Ex) components in hazardous areas on FPSOs need regular inspection, which normally involves isolating the electrical systems before dismantling the items for inspection and then reassembling them. This is a slow and expensive business, with the risk of introducing errors during dismantling and reassembly.

Figure 4. *Hull side shell repairs.*

Figure 5. *ODIN valve inspection.*

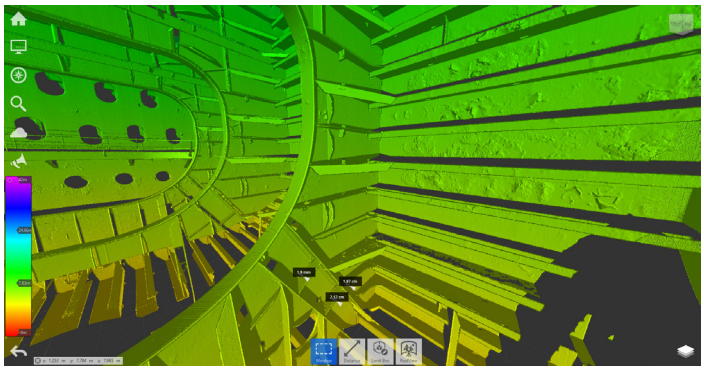

Figure 6. *Aseng laser.*

Alternative methods have been developed using both operational data to inform electronic management systems that optimise the integrity process and remote/robotic tools that are safer, faster and more economic. The ExPert system uses portable scanners and remotely operated cameras that can 'see though' the items concerned and allow the operators to identify any anomalies. Visual inspections can be carried out without having to work at heights and the system does not require electrical systems to be isolated during inspection. The digital data is rapidly fed into the system, allowing quick intervention where necessary.

Pressure systems

Pressure systems need special attention, so normally require numerous ultrasonic thickness measurements (UTMs) to be taken on a regular basis to meet class requirements. However, the 'hit rate' for finding anomalies is less than 5%, so again industry has worked to find a better way to tackle this problem.

Using extensive historic data and in partnership with leading universities a statistical approach has been developed called 'ANALYSE', which safely reduces UTM workscopes by up to 50% yet delivers better insights into the condition of the pressure system.

Installing anodes without using divers

Many ageing FPSOs need their anodes replacing to protect the hull from corrosion. This was a challenge without using divers, so the ODIN access ports were adapted to allow retractable HullGuard anodes to be inserted through the hull and connected to an impressed current cathodic protection (ICCP) system. This has been successful because the anodes can also be retracted for inspection, cleaning and/or replacement at any time from within the hull.

Mooring chains

Mooring chains also need to be cleaned and inspected during periodic surveys to ensure that the chains are in good condition and the links have not suffered excessive wear or damage. This is currently being done using ROVs equipped with cavitation cleaners and callipers, but new technology is being tested that is designed to inspect and maintain the full length of mooring chains autonomously.

Conclusion

Keeping existing oil and gas assets going during the transition to renewables is essential.

It will be challenging, as the expertise and experience required will be in short supply, so new technologies are being developed that minimise the risk to people by using robots to efficiently carry out the dangerous work and obtaining of data.

Fortunately, many of the emerging technologies described will also be applicable to FOW and other renewable energy sources, making the transition itself efficient.

Oil and gas will still be required for the numerous by-products and lubrication, but in much smaller quantities. There will, therefore, be a need to keep some assets going beyond 2050 and net zero, but this will probably become a 'specialist' market and only economic sources will be considered.

Reference

1. American Bureau of Shipping webinar, 'Driving Safety and Reducing Risk: FPU Life Extension' (11 March 2021), https://absinfo.eagle.org/acton/fs/blocks/showLandingPage/a/16130/p/p-025c/t/page/fm/0