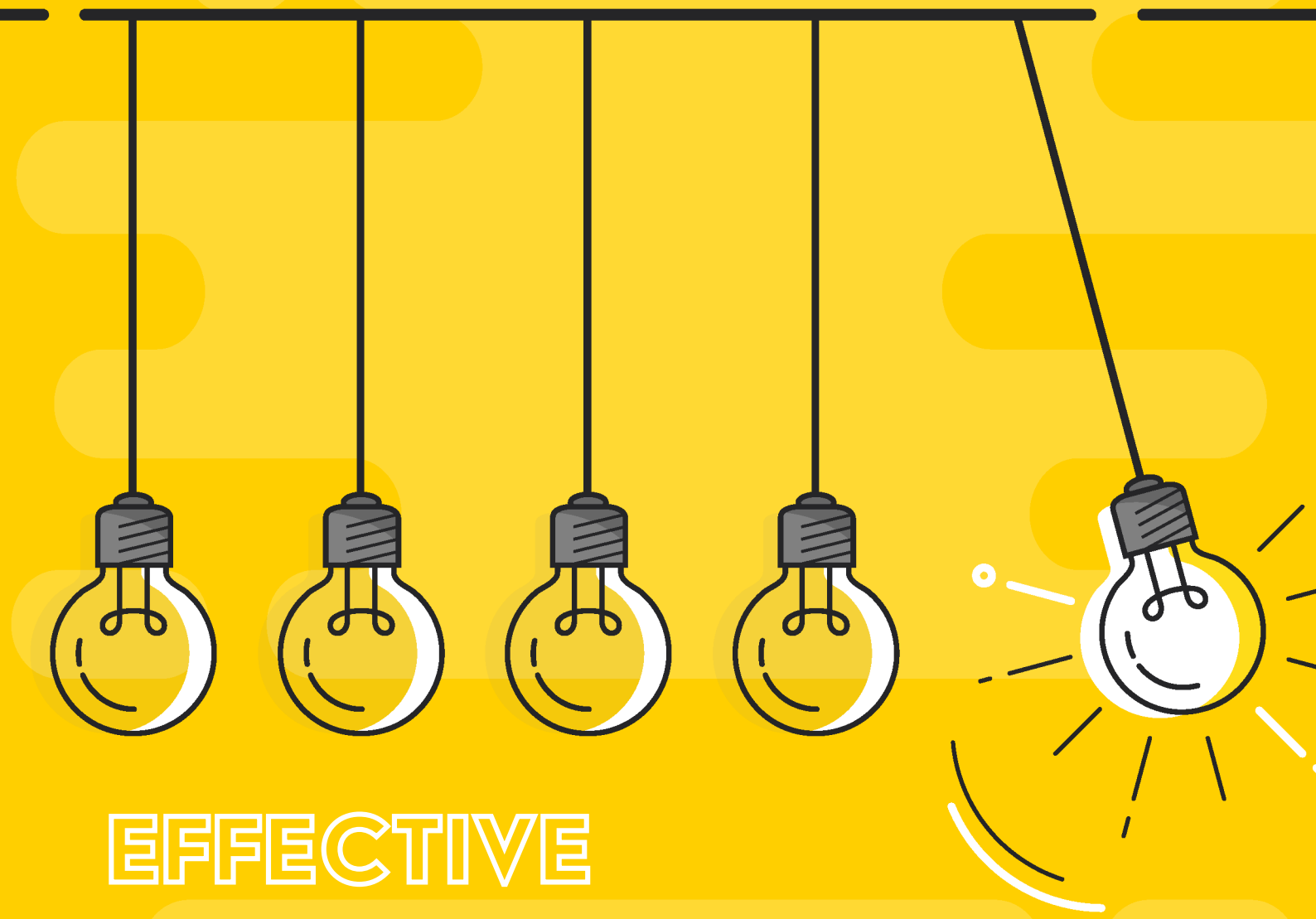

EFFECTIVE MAINTENANCE MAINTAINS MOMENTUM

Danny Constantinis, EM&I Group, Malta, outlines the importance of effective maintenance and preparation in the FSRU/FLNG industry.

The floating storage and regasification unit/floating LNG (FSRU/FLNG) industry is growing rapidly, and it is showing no signs of slowing down. As with all things in boom times, the focus is firmly on output. However, while boom times are always output-focused, we need to prepare in advance if we are to ensure continuity and profitability when the industry reaches steady state, or even finds itself in a downturn.

In any frontier industry, the speed of growth must not be allowed to create risk that could itself threaten the viability of the industry, nor can we allow uncontrolled costs to increase as the industry becomes more commoditised.

The best way to secure the future of our industry is to operate safely with high levels of asset integrity, and with a programme of continuous improvement.

Safety, asset integrity and operational excellence are supported by efficient maintenance and, following the recent collapse in oil price, the offshore industry is determined to keep costs down permanently rather than navigate the 'boom and bust' patterns that we have observed over the years. This will lead to more stable prices, and therefore a more stable industry willing to invest in new projects and the innovations needed to achieve the safety, integrity and profitability that all stakeholders need.

Effective maintenance programmes are a key part of the strategy and it is widely agreed that better use of data and robotics will help reduce unnecessary work and human risk.

Where do we start?

The floating production storage and offloading unit (FPSO) industry is a good place to look for examples of how to innovate and share knowledge successfully. Operators and oil majors quickly realised a problem shared is a problem halved, as is the cost. There are a number of FPSO joint industry projects (JIPs) and one relevant example is the HITS (Hull Inspection Techniques & Strategy) JIP which is part of a not-for-profit organisation called the FPSO Forum. HITS membership is made up of oil majors, service providers, classification societies and regulators. During the more than 20 years the FPSO Forum has been established, it has encouraged the development of many new technologies, which have significantly improved safety and reduced operational costs.

Figure 1. In service isolation valve inspection.

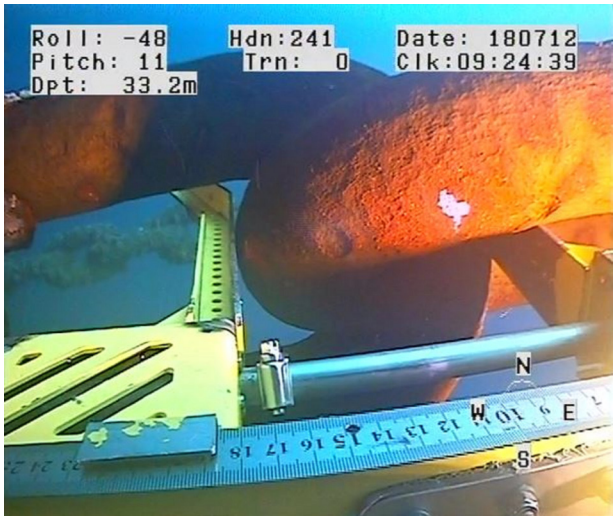

Figure 2. Caliper measurement of mooring chain.

Perhaps more importantly, the combined expertise of its broad membership and the spirit of cooperation between members has helped identify potential issues and solutions before they caused a problem.

For example, the HITS JIP identified the following common concerns for FPSO stakeholders:

- Avoiding the use of divers for safety, POB and cost reasons.
- Avoiding putting people in hazardous areas (confined spaces, working at height, working underwater, etc.).
- Minimising the need to clean cargo oil tanks.

Another important lesson learned was the benefits of looking for solutions in other industries and adapting them for use in our own.

So, from which industries have we 'borrowed' technology?

Avoiding the use of divers

The gas transmission industry provided a means of placing nuclear industry miniature cameras into sea chests and isolation valves so that they can be inspected without affecting operations (Figure 1).

This works by hot tapping into the pipe inboard of the valve and welding a special port onto the pipe which then enables a camera (or other tools) to be inserted into the pipe near the valve.

The valve can be cleaned and inspected while in operation, which is a major improvement on either diver-based systems with blanking plates and valve removal, or the use of borescopes inserted via a filter, which clearly can only inspect a valve in the closed position and even then only if the valve is not passing.

Hull inspections were improved using deck launched remotely operated underwater vehicles (ROVs) adapted to carry out cavitation cleaning of sea chest inlet grids, impressed current cathodic protection (ICCP) anodes and points of structural interest, such as bilge keel end connections.

Cathodic potential measurement tools and non-destructive testing (NDT) tools used to carry out ultrasonic gauging were modified to be attached to the 'inspection and maintenance class' ROVs.

Calipers and photogrammetry equipment were used to ensure mooring chain integrity so that, in effect, all of the tasks that a diver would carry out to complete an underwater inspection in lieu of drydocking (UWILD) were now able to be carried out by alternative means (Figure 2).

This approach has also been taken up by the drilling industry, particularly for those assets that rely on dynamic positioning where the operation of thrusters makes diving methods unsafe unless the asset stops drilling and comes off station, clearly an expensive outcome for both the drilling company and the field owner.

Operators now have a better method of inspecting hulls and isolation valves, but, clearly, unless technology was able to innovate a means of carrying out repairs without divers, the benefits of such operations would have been short lived.

Once more, the gas industry provided a means of 'plugging' pipes so that faulty valves could be replaced without having to use divers to place blanks over the sea inlets and overboard discharges.

This 'plugging' method involves inserting two inflatable 'balloons' through a port on the outboard side of the valve to be

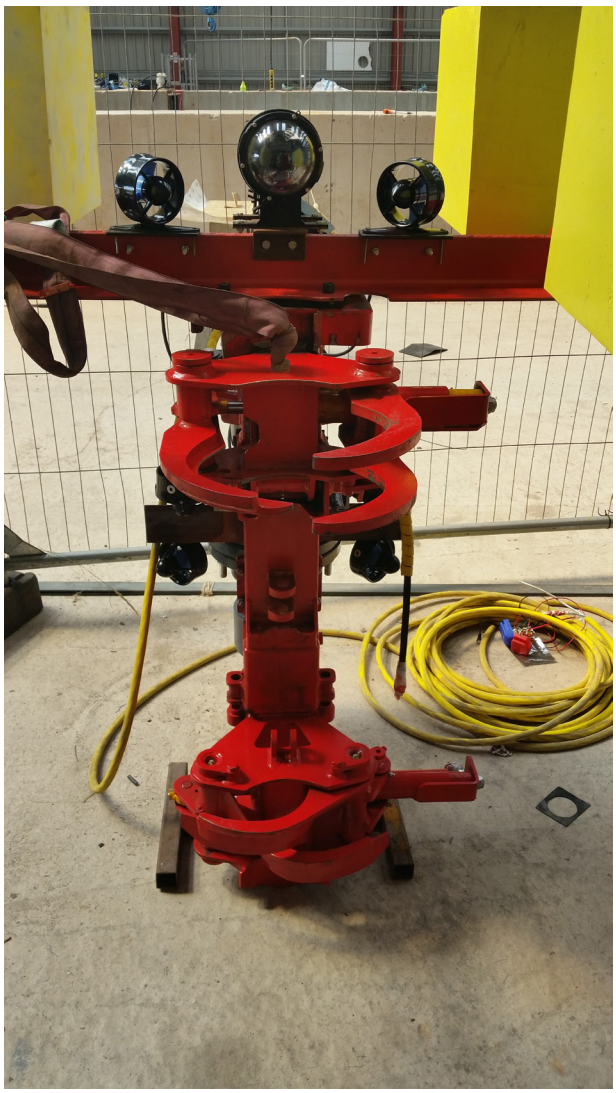

Figure 3. Mooring chain crawler.

Figure 4. Remote camera inspection of confined spaces.

replaced. Once inflated, the balloons create a double block whose pressure can be monitored constantly while the faulty valve (or pipework) is removed and repaired/replaced.

More than 20 valves have so far been replaced, and on going projects are extending the use of the technology to other applications, including caissons.

Trials are planned to use this technology to inspect and replace process pressure system valves.

With regards to deeper waters and mooring chains reaching depths in excess of 2000 m, it is the forestry industry who 'lent' our industry the idea of chain crawlers for the inspection and potential repair of deep-water moorings (Figure 3).

These are being site trialled in 2019 and offer the opportunity to deploy a range of inspection and maintenance tools.

Unmanned inspection of confined spaces

Turning our attention to robotic inspection of confined spaces, the nuclear industry was an obvious sector from which to seek advice.

The nuclear industry has confined spaces that are not designed for human entry (for obvious reasons), and they have therefore developed methods of robotic inspections using high performance cameras, which have now been adapted to be inserted through Butterworth hatches or purpose fitted ports in the deck (Figure 4).

These cameras can carry out general visual and close visual inspections from various positions in the tanks to get the necessary coverage. Moreover, they carry their own high powered lighting systems and use 'intelligent' carbon fibre poles to manoeuvre the camera and carry power and data to the control panel. As a comparison, the robotic method uses 90% fewer man hours and puts no one at risk, while the cost benefits are over 50%.

Clearly, there are some instances where ultrasonic gauging is required. In these instances, synchronous laser systems from the civil engineering sector have been modified to carry out remote ultrasonic gauging. These have been successfully trialled onshore and are now being trialled on site offshore in early 2019.

Where tanks are water filled, for example during drilling operations, miniature ROVs are successfully used to carry out close visual inspections and ultrasonic gaugings. Robotic cameras and lasers have already been used to inspect pressure vessels without human entry, thus reducing preparation costs and avoiding safety risks of human entry.

Overall, the conventional methods using people working at height in tanks or in confined spaces are changing quickly, and technicians and engineers are being retrained to use the new methods.

Protecting the hull

Conventional hull protection systems use either sacrificial anodes or ICCP systems. Both of these carry the risk of requiring diving operations to inspect, maintain or replace them over long periods on site. A new diverless approach is being installed on a North Sea FPSO that use the same concept as submarine periscopes to deploy retractable anodes that need neither divers nor ROVs to install, operate or maintain.

Using data more effectively

Solutions are not confined to robots and other types of hardware. The fundamentals of using data better to reduce unnecessary inspection and maintenance work is advancing across the industry. Historic data is being analysed to glean additional information on fitness for service and future trends. One method has already been used to reduce inspection scopes for pressure systems.

Instead of an inspector going out to collect thousands of thickness data points in accordance with a risked based inspection (RBI) scope (90% of which do not detect an anomaly), the new approach has the technicians collecting information directly into a device which tells them when they have enough data to confirm fitness for service to an agreed level of confidence, in line with American Petroleum Institute (API) codes for example.

What of the future?

Of course, the rapidly evolving capabilities of unmanned aerial vehicles (UAVs) have not gone untested, and HITS has provided detailed guidance on where these devices deliver value. Even the medical industry has contributed a means of using low energy X-Ray units to inspect Ex hazardous area electrical equipment without shutting down systems and opening up electrical components. This technology is likely to be commercially available in mid-2019.

Do we need our own JIP?

Should the FRSU/FLNG industry have its own JIP? If the opinions of industry insiders are anything to go by, the answer must surely be yes.

Initial talks with operators, classification societies and regulators have indicated an appetite to get together and have preliminary discussions on how such a JIP might work and which topics and issues would be of common interest.

It is clear that many of the innovations developed for FPSOs and drilling units can be applied or modified for FLNG and FSRU assets. However, there are many new and unique challenges that will affect the FLNG/FSRU industry, and these are areas that such a JIP might wish to explore. For example, are there challenges in inspecting the LNG containment tanks remotely?

A further consideration is the interactions between FSRUs and their jetties and offloading systems. Jetties are generally not designed for vessels to remain on station for many years. Does the long-term integrity, protection and maintenance of these specialised jetties need further study? Do we have enough data on the combined performance of jetties and FSRUs to develop RBI strategies and plans?

Many FSRU terminals are located where water conditions are particularly nutrient-rich and acidic, a recipe conducive to increased rates of corrosion, high solids content and rapid marine growth. Will ICCP systems which are designed to protect the vessels hull compete with the jetty corrosion protection systems?

Are jetties designed for extreme weather conditions while an FSRU is attached or will the FSRUs need to detach and move to safer waters?

Will piping, valves, machinery and structures be affected by rapid marine growth?

Are there common standards for the combined jetty FSRU systems and who has responsibility for overall integrity and standards?

All of these areas could be topics of great interest to operators, regulators, classification societies and indeed users of the gas.

Conclusion

Managing integrity and protecting our industry by efficient maintenance needs our combined experience and knowledge. There is a real opportunity to learn from one another and from other industries, and it is surely better to work together, sharing costs and reducing the time to develop effective solutions. So, is it now time for the FSRU/FLNG industry to have its own JIP? **LNG**