Meeting the Challenges of Subsea Pipeline Repairs

Marian Copilet

Advances in reservoir understanding and breakthroughs in technology, including developments in directional drilling, lead to original estimates of recoverable reserves of oil and gas in many old fields to be revised upwards. Recently developed satellite fields required access to old pipelines even after the original field had been shut down. In all these cases, mature oil and gas field facilities and offshore infrastructures were required to continue to function safely well beyond their original design life.

In the case of subsea pipelines, regular inspection and maintenance programmes can monitor and mitigate but not totally eliminate the effects of corrosion, fatigue and other failure mechanisms. Subsea pipelines are also at risk of damage from dropped objects, dragged anchors or fishing nets, or changes to subsea floor conditions caused by currents or earthquakes.

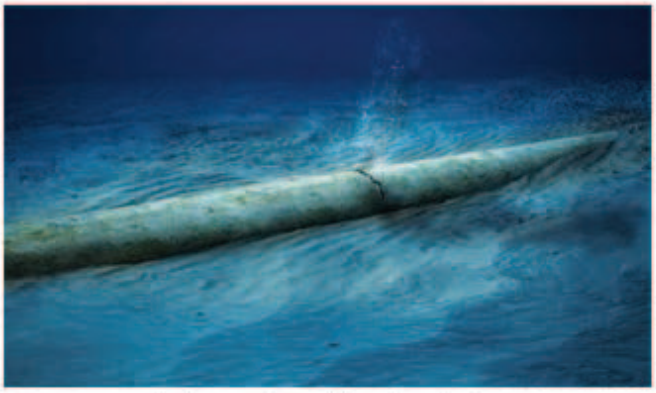
The capability to carry out repairs and interventions to subsea pipelines is critical to their continued safe and profitable operation. In shallow waters, variously defined as down to either 200m (600ft), repairs can be carried out by skilled divers using specialised tooling. In deep waters the repairs are carried out using tools adapted for operation using Remote Operated Vehicles (ROVs).

Subsea repair clamp installed by ROV

In order to determine the optimum repair solution, an extensive inspection programme needs to be carried out, including internal inspection using in-line inspection vehicles, sometimes referred to as intelligent pigs, followed by confirmation of the location and extent of the damage using external inspection.

MINOR PIPELINE REPAIRS

Defects such as pinhole leaks, defects in girth welds, localised metal loss or impact damage that do not exceed 1 x Pipeline Diameter, are classified as minor pipeline repairs. Where the repair is intended to be permanent, a split-sleeve clamp with sealing and mechanical grips capability may be installed on the pipeline.



Leak caused by crack in subsea pipeline

Where the pipeline is due to be replaced, or shut down in due course, a temporary repair solution may be considered sufficient. In such cases, a split-sleeve clamp with only sealing capability but without mechanical may be installed on the pipeline. For temporary repairs, many companies prescribe a maximum operational limit of 12 months. At the end of this period, a permanent repair solution must be provided or the pipeline will be shut down.

For pipeline sizes up to 24 in OD and operating pressures up to 150 bar repair clamps can be found in stock, available for immediate delivery. For larger diameters and/or higher pressures, customised repair clamps are designed, manufactured and tested to meet the requirements of each specific project.

The first step in performing a minor repair is to provide sufficient space 360 degrees around the pipeline. This can be achieved by either dredging or by using pipe lifting frames. The next step is the removal of any concrete and/or anti-corrosion coatings, as well as any weld caps, in order to achieve a smooth, linear and circular pipeline surface. A repair clamp can now be installed on the pipeline.

In shallow waters, divers will tighten a number of bolts in a specified sequence to ensure the compression of

elastomeric seals and the actuation of the mechanical grips. In deep waters, the clamp is configured with either ROV compatible bolts, or the bolts are completely replaced by a hydraulic module.

MAJOR PIPELINE REPAIRS

A repair which cannot be achieved using a split-sleeve repair clamp is classified as a major pipeline repair. In such cases a damaged section of the pipeline needs to be removed and replaced by a spool section. The connection between the old, undamaged section of the pipeline and the new repair spool is achieved using special subsea pipeline connectors. These types of repairs require either a total pipeline shutdown or the isolation of the damaged section using piggable plugs or plugs inserted through hot taps.

As in the case of minor repairs, the first step is to provide adequate space around the pipeline. In shallow water, dredging is the more economical solution, with pipe lifting frames being used only where dredging is not feasible. In deep waters, pipe lifting frames are required to provide support of the damaged pipeline and alignment with the repair spool. Before cutting the damaged section, any concrete and anti-corrosion coating needs to be removed from the cutting areas. Several cutting methods are available, including mechanical orbital cutters, diamond wire cutters and chop saws.

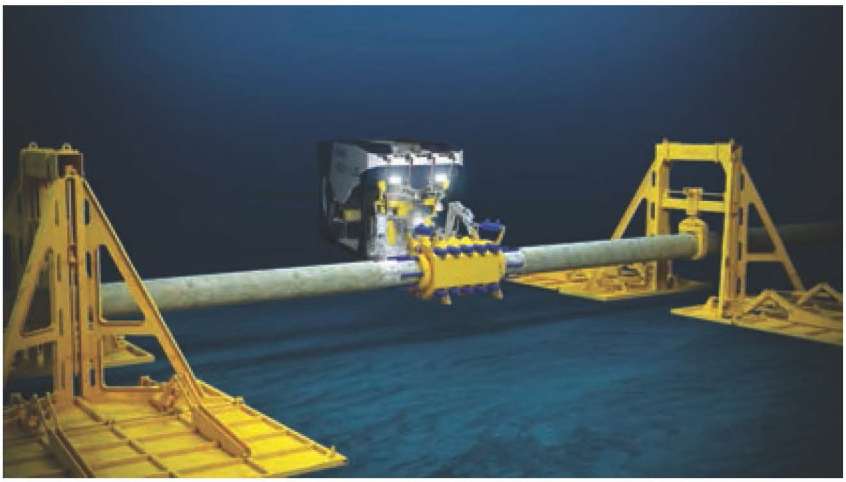
After the damaged section is cut and removed, the pipe surface must be cleaned to bare metal, and weld caps need to be removed, as well as any internal or external burs that can damage the elastomeric seals of the pipe connectors.

The connection between the old pipeline and the new repair spool can now be achieved using subsea pipeline connectors which can provide either a flanged end for connection to a flanged pipe spool, or can be used in a special back-to-back arrangement to connect two square cut pipe ends.

Once actuated, the subsea pipeline connectors will provide full sealing capability using two separate seals with an annulus test port to verify the functionality of the seals prior to restarting the pipeline, as well as withstanding full pipeline axial, bending and torsional loads.

Special consideration must be given to what happens to the removed damaged section, which can vary in length from a few metres to several kilometres. Where feasible, shorter sections are lifted from the sea floor for disposal and recycling, but longer sections may be abandoned on the sea bed, subject to detailed environment impact assessments.

In some cases, due to seabed topography or the movement of the pipeline due to residual stresses, the two exposed ends of the cut pipeline may be misaligned, making it impractical or even preventing the mating of flanges between the subsea connector and the repair spool. In such cases, misalignment ball flange connectors can be used to correct for axial misalignment up to 10 degrees at each end.



Use of pipe lifting frames to assist installation of repair clamp

After the installation and testing of the connectors, the pipeline is lowered back onto the sea bed, where pipe lifting frames have been used, or a dredger is employed to fill back and level the seabed under the repaired pipeline section. Where the additional weight of the connectors is a concern, concrete or steel mud mats can be placed on the seabed.

EMERGENCY PIPELINE REPAIR SYSTEMS

Due to the significant environmental and operational impact of pipeline failures, and considering that the lead time for some pipeline equipment can be six to eight months, pipeline operators often decide to have in stock a full range of emergency pipeline repair inventories, including as a minimum one permanent repair clamp and two subsea pipeline connectors for each pipeline size in operation. For deepwater locations, the emergency pipeline repair systems also include at least two pipe lifting frames.

PROJECT MANAGEMENT

A subsea pipeline repair is a complex operation which requires an experienced project manager who is able to coordinate input from engineering, inspection and logistics departments as well as to ensure availability of a vessel with lifting facilities and capability to support diving and/or ROV operations.

All tools and equipment must be subject to regular testing and maintained in good operating condition. Specialised equipment may need to be modified, hired or custom-built. The successful completion of a pipeline repair depends on having qualified divers and ROV operators, with prior experience of pipeline repair projects.

To prevent lengthy downtime, operators should have detailed plans in place to cover a variety of pipeline repair scenarios as well as build relationships with reputable companies which can respond quickly in case of emergency. ■

Author's Biodata

Marian Copilet is a graduate of Polytechnic University in Bucharest, Romania. For the last 25 years, he has been involved in both upstream and downstream sectors of the oil and gas industry, with a focus on subsea umbilicals and oil and gas pipelines. He is now based in KL, at Oceaneering International Asia HQ, where he is head of Technical Solutions Group for Asia Pacific.

IEM DIARY OF EVENTS

Title: Pre-AGM Talk on "Do We Need Malaysian Consultants in Mega Projects?" A Personal Perspective from a Practicing Professional Engineer

22 July 2017

Organised by : Consulting Engineering Special Interest Group
Time : 9.00 a.m. – 11.00 a.m.
CPD/PDP : 2

Kindly note that the scheduled events below are subject to change. Please visit the IEM website at www.myiem.org.my for more information on the upcoming events.