NORTH SEA RISER INSPECTION PROJECT

By: Jonathan Hoare, CNR International, Christopher Woodley, ROSEN Group,
Tom Steinvoorte, ROSEN Group

A North Sea Oil Operator operates a pipeline (25km, 130 barg) that imports gas to a central platform operating as a hub in the Northern North Sea, around 386 km north-north east of Aberdeen. The hub platform, together with another connected platform is used for production as well as processing and commingling of oil coming from surrounding fields.

The imported gas provides fuel for the platforms power generation systems, which in turn provide electric power for the platform.

Challenge

The operator experienced a safety issue because the riser topside Emergency Shut Down Valve (ESDV) on the riser that had failed in an open position and the Subsea Isolation Valve (SSIV) situated approximately 230m away from the base of the platform was determined not to be 100% leak tight (pressure increase in the riser measured at 0.03 bar/24 hours).

Due to a combination of the ESDV being in an open position and the SSIV slowly passing, together with virtually no empirical data regarding the internal condition of the riser, it was determined that the riser could not safely import the gas to power the platform; instead the riser was regularly bled to ambient pressure with the gas being sent to the flare. The upstream feeder pipeline remained at 129 barg and could not be depressurised due to the impact this would have on other connected installations.

In order to remedy the situation the Operator embarked on a time critical ESDV valve replacement and required an in-line inspection in order to ascertain the integrity of the riser in order to bring the fuel gas riser back on-line safely. In its current configuration, the riser had been used to initially export, then later import gas, but had also been used prior to this for gas export via a different pipeline for 12 years, with little known about the actual operating conditions.

Since the fuel gas source was not available due to the line not being operational the platform’s generators were fed by back-up diesel using existing storage capacity on the platform,

A fast track solution was required for replacing the ESDV immediately followed by ILI to confirm the riser integrity. The line is however not piggable using conventional uni-directional ILI tools:

- There was not a permanent topsides pig trap installed,
- There were no subsea pig receipt facilities
- There was only one access point from the topside platform pipework,
- The line was not flowing
- The 8 ˝ rigid steel riser is connected to a 10.5” internal diameter flexible pipe subsea which meant the line was dual-diameter
- Complex riser geometry, with three 90-degree bends and two 45-degree bends, with significant horizontal sections between
- Additional subsea valve isolation was ’possible’, but not without considerable risk (valve may not operate, or re-open after completion

The Operator initially contacted ROSEN to discuss a tethered inspection solution, the approach would be to fill the line with liquids and then to perform a bi-directional tethered UT inspection. This option was however ruled out because the tether would mean that the newly installed ESDV valve could not be closed during the inspection, which was considered to be unsafe (SSIV known to pass); in addition, the Operator could not freely flood the riser with liquid as there would be no way to recover the medium after completion of the inspection, and there was no way to manage the return liquids through the existing gas process plant. ROSEN demonstrated technical agility and were able to move quickly and offer an alternative solution.

Solution

Only a few days later the ROSEN team met with the operator and the team finally settled for a free-swimming bi-directional UT inspection. In order to provide a couplant for the UT tool a liquid batch was proposed and since there was no flow possible, the team agreed to a rather unique way to propel the tool:

<u>To pump the bidi UT tool in a liquid batch using an external pump into the riser and return the pig train using nitrogen pressurized against the SSIV.</u>

This approach was a new concept for ROSEN, however the inspection solution was developed by the technical solution lead within the ROSEN Challenging Diagnostics responsible for developing unpiggable solutions.

For the selected approach, it is essential that the tools provide a good seal – if the seal would be compromised, gas would leak into the liquid batch and the required pressure to push back the pig train may not be available anymore. Consequentially the tool would not come out.

Adding to the complexity and greatly to the risk of a successful operation was the fact that the rigid steel riser is connected to a 10.5" ID flexible spool approximately 16m from the final bend of the riser at the base of the platform subsea. During preparatory work offshore, NDT checks were carried out on the topsides riser bend; from this it was found that the construction isometrics were incorrect - these stated a wall thickness of 7.9mm for the bend with the actual wall thickness found to be 19mm. The resultant internal bore change at the top of the riser was an additional complication to the design and operation of the pig train.

The inspection solution was to cover as much of the riser as possible with the target of obtaining data at the base of the riser, but not to enter the flexible spool due to the overbore because the tool would lose seal and the pigs would not come back out. Without sufficient data to support an integrity assessment of the riser it would be unlikely the Operator would have resumed gas import. Corrosion modelling had predicted that the most likely locations for there to be internal corrosion would be the horizontal sections of the riser.

Ideally, the tool location would be confirmed using subsea pig detectors but this would require ROV assistance, which was not possible given the time available and the weather conditions at the time of the inspection (mid-November).

The distance the tools travelled was therefore determined in an indirect way – by accurately measuring the pumped volume and comparing with riser fabrication drawings and the UT distance recorded by the ILI tool during progressive runs.

But how much volume should be pumped? In order to ensure the majority of the riser could be expected whilst minimizing the risk of the front sealing pig or worse the UT tool entering the flexible, the running procedure was formalized using client supplied bore maps and drawings of the riser and then optimized and calibrated by performing multiple runs in the riser. A key parameter of course was ensuring quality UT data given that the tool was running in a MEG/water batch with a high seal pig running ahead compressing the nitrogen pre-packed in the line to act as a spring to return the tools.

It was agreed at planning and procedure stage that the riser would be inspected in pre-defined distances using multiple launches of the ILI tool. Each intermediate UT tool recovery was subject to a tool data download, data acceptance review and upload to ROSEN server by the ROSEN offshore engineers. The project support team compared the recorded tool distance with the expected volume pumped and a comparison of the actual UT tool stopped position from reviewing the signals in welds and bends with the client drawings.

Key parameters for the operational procedure are seal and differential pressures over the tools and overall pig train, these values were obtained during a compact testing schedule prior to mobilization using a mock-up of the 8" riser.

Figure: BiDi 8" High res UWD tool

In order to provide access to the riser a temporary pig trap was provided by ROSEN. As driving medium a mixture of MEG and water was used. It was estimated that a total of 4-5 runs would be required to ensure sufficient inspection coverage is achieved in a safe manner.

Offshore Execution

The first task was to replace the ESDV valve. This activity was undertaken by others
Once the line was prepared, the temporary launcher with reducer was installed.

Inspection of the Riser

Testing of the behavior of the batching and ILI tool through the riser mock-up allowed data to be gathered on the differential pressure required which in turn was used to develop the offshore pigging procedure.

Nitrogen was pumped into the riser at 40 bar prior to the start of the pigging operation in order to pack the line. Next the seal pig was introduced into the temporary launcher then pumped 10-15 meters into the riser topsides, using a fixed volume of MEG and then returned by choking the MEG pressure. The sealing pig was removed and condition checked. An external pig tracker was used to confirm pig location.

This initial pig run using the seal pig provided confirmation that pumped volume/ pig tracking was operating as expected.

Next the pig train consisting of high seal pig and UT tool was launched and pumped for a total of 20 m into the riser. The train was returned and the UT tool data was downloaded and the recorded distance from the tool was compared to flow data from the pumping spread and confirm that the procedural volume and distance pumped matched the riser isometric drawings.

The operation was a repeated at a number of pre-agreed distances (77m, 120m) backed up with procedural control.

One of the key drivers behind this sequential approach was to understand the behavior of the two pigs (high seal pig & ILI tool) in the riser, especially during the transition through the pipe bends, in order to maintain the separation between the pigs during the return up the riser (to avoid clashing). We would have liked to reduce the separation to a minimum, in order to maximize the inspection coverage, but it had to be maintained at 10 meters.

Ahead of the final inspection run to capture as much riser as possibly safely; the Operator, pumping vendor and ROSEN worked together to agree the final inspection distance and adjusted the procedure accordingly based on the knowledge gained on the incremental inspection distances.

The final inspection run was completed with the distance the ILI tool recorded being 173m into the riser stopping a safe distance from the flexible riser (distance to riser-flexible flange was 194m). The UT Tool was safely launched and received and the data checks undertaken to confirm acceptability. The data was transferred using wi-fi from the platform on to ROSEN’s server and due to the criticality of the project, ROSEN data experts provided 24 hour coverage during the scope resulting in the final report of the metal loss recorded by the ILI tool being issued to the client less than 48 hours after the inspection tool was recovered from the pipeline so that the client could return the pipeline to service without further costly delays. No corrosion-related metal loss anomalies were detected in the riser section inspected.