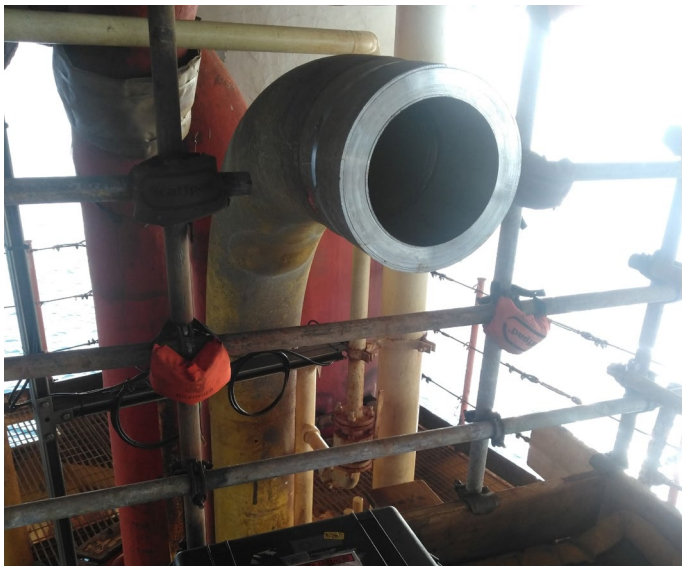
Tethered Robotic Solution for Internal Riser and Pipeline Inspection

INTRODUCTION

bp approached TSC Subsea with a unique challenge: to conduct an internal inspection of an unused riser located on one of their North Sea offshore platforms.

This particular 365 mm (14 in) diameter duplex riser had been installed initially as a spare and had never been put into operation. Due to an upcoming development project, bp aimed to commission the riser for service. However, before proceeding, they needed definitive assurance regarding its suitability.

bp sought a comprehensive, circumferential 360-degree scan of the riser. TSC Subsea provided the solution - a robotic system that could both travel longitudinally along the riser and had the ability to precisely stop and stabilise itself, in order to conduct the detailed assessment required.



THE CHALLENGE

Typical pipeline and riser inspections are conducted externally, which wasn't possible due to the duplex pipe's complex features, including a wall thickness of 48.8 mm (1.9 in), multiple intricate bends, the location, and surrounding obstacles.

The 110-meter-long pipe riser included recessed welds every 10 metres and featured three 90-degree bends. Additionally, it was filled with anti-corrosion fluid and maintained at elevated temperatures with only a single entry and exit point.

Given the intricacy and critical importance of the task, it was decided that a factory acceptance test (FAT) would be necessary to validate the inspection technology and delivery system.

TSC Subsea leveraged its expert engineering team, application specialists, and various toolbox of Non-Destructive Testing (NDT) technologies, including robotic scanners, to tackle the task.

THE SOLUTION

Considering the complexity of the inspection and potential damage mechanisms, the advanced NDT technologies were the clear choice. The selected methods were Alternating Current Field Measurement (ACFM) for detecting surface-breaking cracks in recessed welds and Subsea Phased Array (SPA) for volumetric weld inspection and corrosion detection and mapping in areas of interest.

The major engineering challenge was designing and developing the delivery vehicle, which had to navigate the vertical pipe sections with multiple bends and stop precisely at areas of interest. When in position, the vehicle needed to rotate 360 degrees while maintaining constant pressure on the inspection probe.

TSC Subsea engineers devised a design comprising a pipe crawler that could adapt to varying pipe diameters and negotiate bends regardless of orientation. The custom-built robotic scanner accommodated the ACFM or SPA probes and was capable of 360-degree rotation. Ancillary equipment comprised of technology bottles housing the ACFM or SPA circuitry and a custom umbilical management system.

To validate the system's navigation capabilities under real-world conditions, a replica of the riser was created at TSC Subsea UK. bp also provided a duplex test sample with various hidden defects and notches with various depths to assess NDT inspection technologies and technician proficiency.

The FAT commenced with testing the detection capabilities of the technologies within the sample, starting with ACFM followed by SPA. Both technologies successfully detected and sized all defects within bp's engineering tolerances.

Next, the mock-up riser's navigation was tested. The first run was performed with a dry pipe, providing a clear view of the system's performance in navigating sections, bends, and executing 360-degree rotations. For the second run, the pipe was flooded to simulate on-site conditions. Despite reduced visibility, high-quality cameras allowed precise navigation.

Following a thorough FAT, all parties were satisfied with the results and ready to proceed with the site inspection campaign.

PROJECT HIGHLIGHTS

- ✓ Robotic pipe crawler capable of navigating vertical pipe sections with multiple bends.
- ✓ Multi-technology: ACFM for surface-breaking cracks in recessed welds and SPA for volumetric weld inspection and corrosion mapping.
- ✓ Blind trials both technologies detected and sized all defects within bp's engineering tolerances.
- ✓ The successful inspection allowed bp to proceed with their development project and re-commission the riser.

THE RESULT

TSC Subsea deployed a team of four experts consisting of robotic engineers and NDT specialists to the offshore platform to initiate the inspection. ACFM was the initial technology used, inspecting all 13 welds internally at the root area, covering the top toe, root, and bottom toe. No defects were detected above the inspection reporting threshold.

The SPA inspection employed both a water wedge and a perspex wedge to determine which testing method would yield the best ultrasonic responses. Ultimately, the water wedge data outperformed the perspex wedge, as the latter lacked geometric reflectors. Consequently, the data from the water wedge was chosen and subjected to analysis for the SPA inspection, resulting in the detection of no defects beyond the inspection reporting threshold.

The inspection was a success, allowing bp to proceed with their development project and re-commission the riser. TSC Subsea's tethered solution and expertise was fundamental to enabling bp's to put the riser back into service and deliver their the development project, as planned.

"I would like to express our profound appreciation for the collaboration with bp on this uniquely challenging project. With our tethered internal pipe inspection solution, bp re-commissioned the riser and proceeded with its development project. This project was a testament to our commitment to embracing challenges and pushing the boundaries of what is achievable in subsea inspections. We look forward to future collaborations and further opportunities to demonstrate our expertise and innovation."

TSC Subsea – Frank Luikinga

"The brilliant innovation and collaboration from the TSC Subsea team was fundamental to driving the success of this project from engineering to execution. "

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