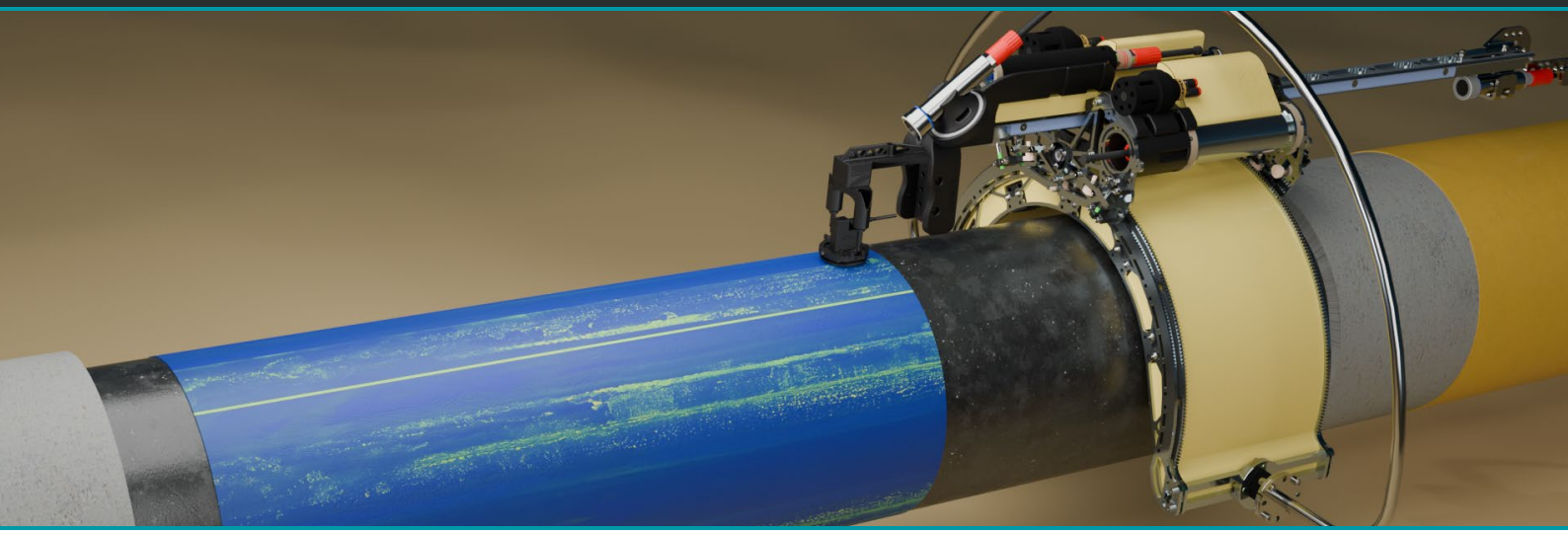
CASE STUDY:

vCompact™ in Action: Corrosion Mapping & Weld Integrity Assessment of Subsea Pipelines



1 CHALLENGE

Map external and internal corrosion of subsea pipelines, verify weld integrity and deploy entirely by ROV to eliminate diver risk.

2 SOLUTION

ROV-deployed vCompact™ scanner with subsea phased array for high-resolution corrosion mapping and ToFD for sub-millimetre weld flaw sizing.

3 RESULTS

Completed inspections ~30% faster than diver surveys with ±0.5 mm sizing accuracy. The fully robotic campaign minimised risk and reduced costs.

1. CHALLENGE

A leading offshore operator in the South China Sea uses subsea pipelines and flowlines to transport oil and gas from wells to production facilities. These pipelines face risks from saltwater corrosion, mechanical stress, and fatigue. Small defects can lead to serious leaks or ruptures, affecting production schedules, increasing maintenance costs, and posing environmental risks. TSC Subsea was tasked with performing an integrity assessment at 15 locations across pipelines and flowlines, with diameters from 8 to 24 inches and wall thicknesses from 9.5 to 20 mm, at depths of 25 to 57 m.

The inspection scope comprised two critical tasks:

- Corrosion mapping, at locations highlighted by prior in-line inspection (ILI) data and other areas of concern.
- Weld integrity assessment, using a fully auditable, recordable advanced NDT method.

Further criteria included:

- Map, detect and measure corrosion on external and internal surfaces with millimetre accuracy.
- Identify and size weld anomalies, including cracks, lack of fusion and pinpoint their exact depth and length.
- Be ROV-deployable, eliminating the risks and costs associated with diver-deployed inspections.

The pipelines were protected by a concrete weight coat (CWC), with a layer of polyethylene which were removed by another contractor, leaving the surface to a SA2.5 standard.

Subsea Pipeline with Concrete Weight Coat (CWC)

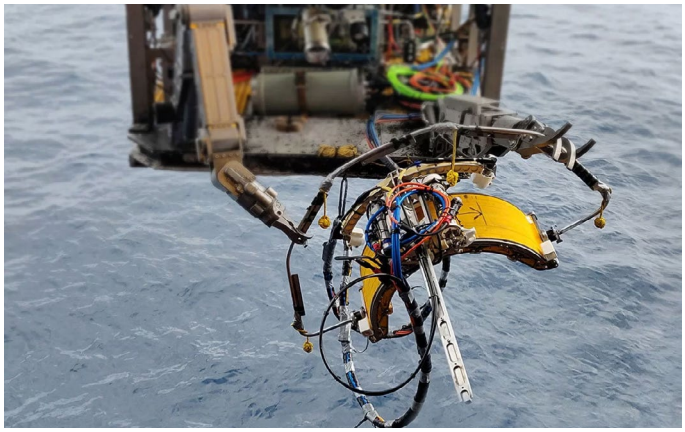
2. THE SOLUTION

TSC Subsea's streamlined approach to pipeline and flowline inspection integrates Subsea Phased Array (SPA™) for detailed corrosion mapping, and Time-of-Flight Diffraction (ToFD) for weld integrity assessment. Both SPA and ToFD use ultrasonic waves but serve different purposes:

- SPA™ produces a volumetric and multiple-angle ultrasonic beam to build high-resolution data sets for the detection of surface and sub-surface defects. Perfectly suited for the detection of corrosion, erosion and general wall loss
- ToFD deploys a pair of ultrasonic probes, one transmitter and one receiver, positioned on opposite sides of the weld. By measuring the diffraction of pulses from the tips of planar defects (e.g. cracks or lack-of-fusion), ToFD can pinpoint and size such flaws with sub-millimetre accuracy.

Robotic Deployment

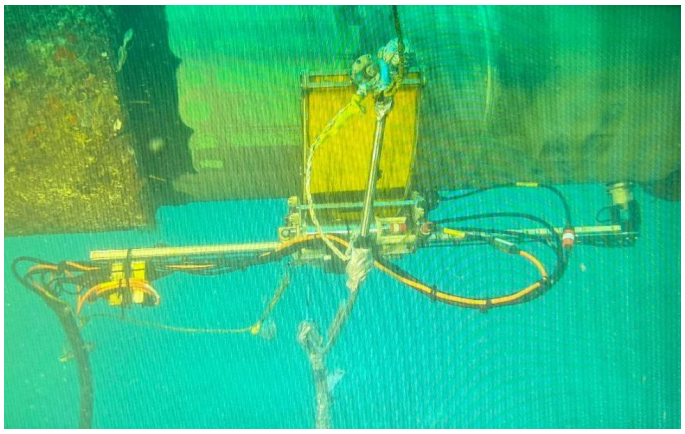
TSC Subsea selected the vCompact ultrasonic scanner with phased-array technology for this challenge. The compact, motorised unit provides 360° circumferential drive and features a retractable probe arm, making it ideal for raster scanning. Its interchangeable magnetic body accommodates pipe diameters from 89 mm (3.5 in) to 3,000 mm (118 in), offering multi-tech flexibility that reduces inspection costs, improves efficiency, and lowers personnel on board (POB).



ROV-deployed vCompact™

Methodology

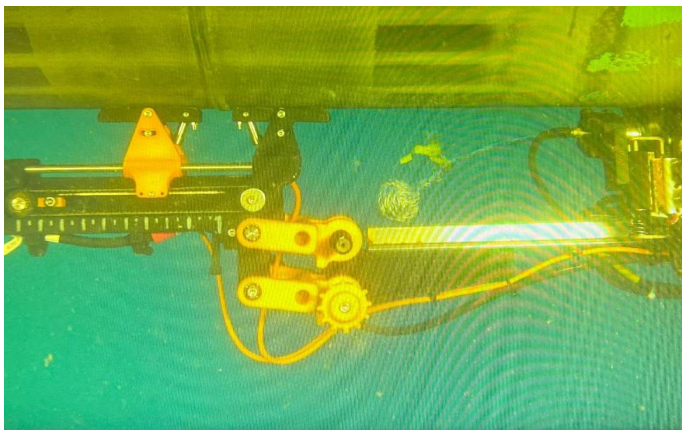
Phase 1: Preparation: A team of two NDT technicians and two robotic engineers mobilised in 12-hour shifts to maintain continuous operations. Before the inspection began, the team calibrated all equipment to ensure accuracy and data reliability. Once complete, the ROV picked up the scanner with its manipulator arm, dived to the target location and placed the scanner on the pipe.



vCompact™ in SPA™ mode

Phase 2: Subsea Phased Array (SPA™): The vCompact's motorised scanning arm extends to 550 mm with 64 axially aligned probe elements, maximising coverage and resolution for corrosion, erosion, and damage mapping. It performs a circumferential scan, retracts 50 mm, and repeats until fully retracted. The ROV then rotates the scanner to repeat the process around the pipe. Smaller pipes require two rotations; larger ones need three for full coverage.

Phase 3: Time-of-Flight Diffraction (ToFD): For weld inspection, a dedicated add-on attaches to the vCompact's retractable arm. This enables operators to adjust the probe-centre separation (PCS) remotely from the control room, without resurfacing. As optimal PCS varies with wall thickness, incorrect settings can degrade sizing accuracy. When a flaw is detected, the robotic arm fine-tunes the PCS on the fly to adjust the ultrasonic focal point, ensuring accurate defect positioning and sizing.



vCompact™ in ToFD mode

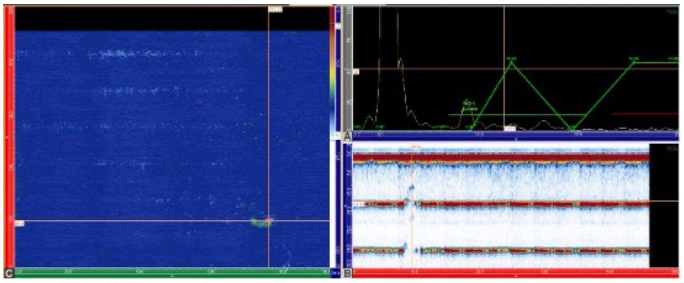
Phase 4: Data Analysis and Reporting: The findings from the SPA and ToFD inspections were analysed in real-time, providing the client with immediate feedback on inspection progress. This was followed by a comprehensive report outlining the pipeline's condition

3. THE RESULT

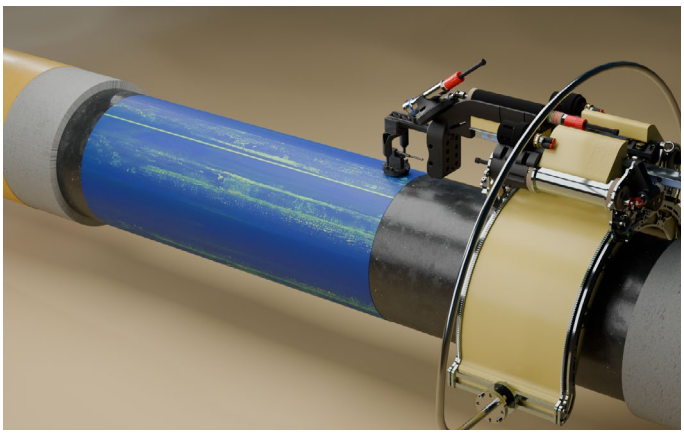
The combined SPA™ and ToFD campaign delivered:

- **High Confidence:** Detection probability above 95 % for flaws ≥ 1 mm,
- **Efficiency:** Along with the highest quality data, robotically controlled inspections are nearly 30% faster and safer than diver-based surveys and aren't limited by the maximum allowable time divers can spend underwater, as well as decompression time.
- **Actionable Insights:** The client received a comprehensive integrity report that detailed the location of each defect, along with detailed sizing and remaining wall thickness measurements.

The integration of Subsea Phased Array and ToFD data allowed the client to forecast the progression of defects and recommend proactive maintenance strategies.



SPA sample data displaying A, B, and C-Scans



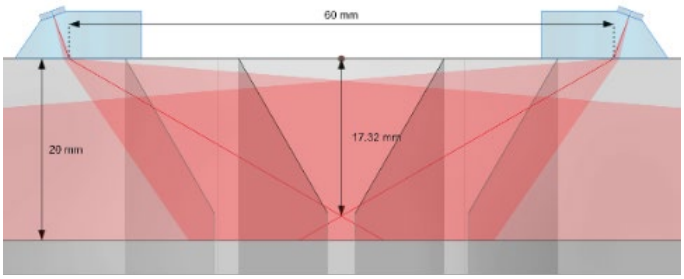
3D visualisation detailing SPA™ corrosion mapping data

CONCLUSION

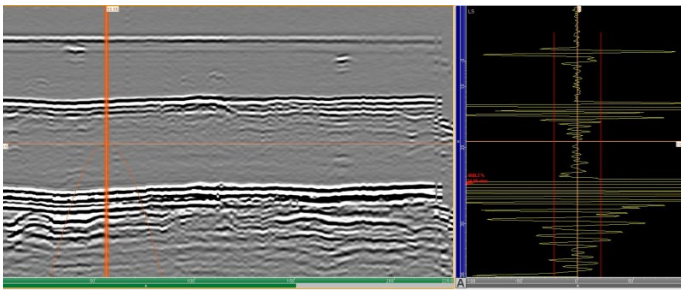
By leveraging the ROV-deployed vCompact™ scanner with SPA™ and ToFD techniques, TSC Subsea delivered a comprehensive, high-accuracy assessment of its subsea pipelines and flowlines.

This fully robotic approach minimises operational risk, eliminates the need for divers, cuts inspection time and reduces the need for vessel support, thereby lowering personnel on board and fuel consumption. With reliable, data-driven maintenance strategies, the client can now plan interventions more efficiently, extend asset life and protect the marine environment.

The case study emphasises the importance of adopting advanced technologies to ensure the safety and functionality of critical infrastructure while promoting more sustainable operations.



ToFD probe setup



ToFD sample data

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