

CASE STUDY:

ARTEMIS®: Through-Coating Inspection for Large-Diameter Subsea Pipelines.



Norske Shell A/S contracted TSC Subsea to perform a diverless, ROV-deployed baseline wall thickness inspection on multiple subsea pipelines and spools in the Ormen Lange field, offshore Norway. The inspection targeted mainline sections at approximately 860 metres water depth.

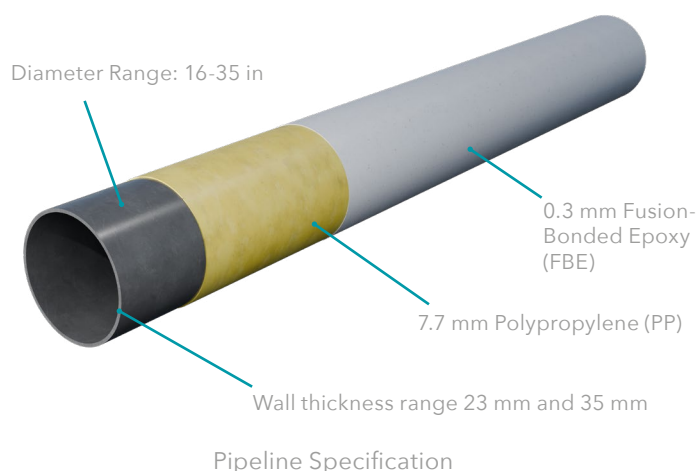
A primary objective was to assess areas expected to become dead legs as a result of future pipework rearrangements. These dead legs, along with the commingling point for flow back to Nyhamna, have been assessed as susceptible to Flow-Assisted Corrosion (FAC), Top-of-Line (TOL), and Bottom-of-Line (BOL) corrosion. The main pipelines from field to shore are piggable and an inline intelligent pigging operation was performed in 2023. Combining the ILI with Artemis enabled both validation of inspection outcomes and the establishment of a baseline which will be repeated for future inspections.

A secondary objective, identified later in the planning process, was to utilise the Artemis tool for inspecting the most heavily operated infield pipelines, which are considered “difficult to pig” due to the need for temporary subsea pig launcher/receiver installation and removal of recently installed spools. Worst-case locations on these infield pipelines were selected and targeted for Artemis inspection during the same campaign as the dead legs on the main import pipelines.

CHALLENGE

The inspection scope presented several technical and operational challenges:

- > **Large diameters:** Required full circumferential coverage on pipelines ranging from 16 to 35 inches in diameter.
- > **Coating and wall thickness:** Scanning through 0.3 mm FBE and 7.7 mm PP coatings, with nominal wall thicknesses of 23 mm (infield) and 35 mm (main import pipelines).
- > **Challenging subsea conditions:** Strong underwater currents at inspection sites.
- > **Dredging restrictions:** To minimise seabed disturbance, no dredging was permitted within 10 metres of pipeline end termination (PLET) covers.
- > **Field joint issues:** Damaged or loose coatings at certain field joints may limit full-scan coverage.



WHY IS FULL CIRCUMFERENTIAL SCANNING CRITICAL?

Full circumferential coverage was essential due to the identified corrosion risks. Both Flow-Assisted Corrosion (FAC) and Top-of-Line (TOL) corrosion may occur across a large internal area, from the 12 o'clock position down to the liquid pool at the bottom of the line. Turbulent flow at the onset of the dead legs was predicted to cause high, continuous shear stress, with the potential to strip the protective, film-forming corrosion inhibitor from the internal pipe surface. This could lead to localised wall thinning at the Bottom-of-Line (BOL).

In dead leg sections, where flow is stagnant or minimal, the lack of continuous fluid movement may hinder proper distribution of corrosion inhibitors and alter the bulk chemistry compared to a normally flowing section. This could result in uneven corrosion rates and localised attack, making a complete 360° inspection essential for accurate integrity assessment.

SOLUTION

TSC Subsea selected the ARTEMIS system as the optimal solution for high-resolution inspection of large-diameter pipelines up to 35 inches. ARTEMIS uses Acoustic Resonance Technology (ART) to deliver accurate, quantitative wall thickness and corrosion data through coatings, with sub-millimetre precision. Other techniques considered included:

- > Computed Tomography (CT) or X-Ray: While capable of scanning through coatings, these methods use radioactive sources, introducing safety risks and additional operational complexity.
- > Conventional Ultrasonics (UT): Requires direct contact with bare steel, necessitating coating removal. This leads to extensive dredging, increased vessel time, higher operational costs, and greater environmental impact.



ARTEMIS® XL and Standard ARTEMIS® Systems

ART does not have these limitations and can inspect through highly attenuative coatings, including the 7.7 mm polypropylene used on these pipelines. Only minimal surface preparation was required to remove marine growth using the ROV's high-pressure water jet, with no coating removal necessary. This significantly reduced vessel time and operational complexity while maintaining high data quality.

The system provides 700 mm axial coverage and full 360° inspection per placement. It achieves this using four transducers mounted on two arms positioned 180 degrees apart. Each arm holds two transducers. With a 180-degree rotation, full circumferential coverage is completed.

TSC Subsea mobilised a team of four personnel: three NDT specialists and one tooling technician. They deployed both the standard ARTEMIS system and, for the first time, the ARTEMIS XL, which can inspect pipelines ranging in diameter from 6 to 35 inches. Shell played a key role in the original development of the ARTEMIS system in 2014, and later, Norske Shell A/S supported the creation of the XL variant to address a critical technology gap in inspecting larger-diameter pipelines without coating removal.

Preparation: Dredging was carried out as required, followed by high-pressure water jet cleaning to remove sediment and marine growth. All operations were monitored and validated by TSC Subsea technicians and Shell representatives onboard.

Deployment: The ARTEMIS system was deployed using a Merlin WROV via the wet-mate method. The ROV connected to the tool using its manipulators to activate hydraulic and power systems. The tool was handled using grab bars, allowing the ROV to move freely in strong currents without disturbing the inspection. After each scan, the ROV repositioned the tool for the next scan or transferred it to a new inspection location.



ARTEMIS® Performing Full 360° Circumferential Inspection

RESULTS

The inspection achieved its objectives, collecting high-quality data at 34 subsea locations and establishing a robust baseline for future integrity monitoring.

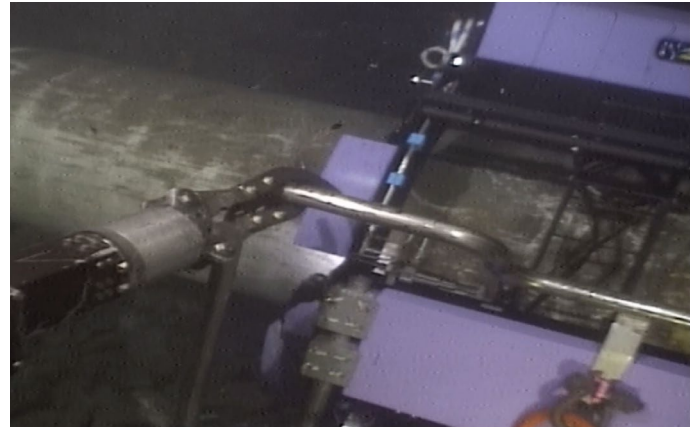
- > **Inspection completion:** All planned scans were executed, achieving near-total coverage, with only minor reductions in areas affected by coating damage.
- > **Complete coverage:** With each placement, ARTEMIS achieved 700 mm axial scans with full 360-degree circumferential coverage.
- > **Data quality:** High-resolution ART data provided comprehensive baseline wall thickness profiles across all inspected pipelines and spools.
- > **Operational efficiency:** The inspection campaign was completed within five days, achieving high tool uptime and minimal vessel time, attributed to ARTEMIS's ability to perform through-coating inspection without removal.
- > **Safety and integrity:** No personnel injuries or significant operational incidents occurred. The inspection confirmed the integrity of all targeted pipeline sections, supporting Shell's proactive subsea asset management strategy.

CONCLUSION

The subsea baseline inspection for Norske Shell A/S demonstrated the capability and value of ARTEMIS Acoustic Resonance Technology as an innovative solution for subsea integrity management.

By enabling accurate, through-coating wall thickness measurements without surface preparation, ARTEMIS eliminated the need for coating removal and extensive dredging, reducing vessel time, operational costs, and the project's carbon footprint.

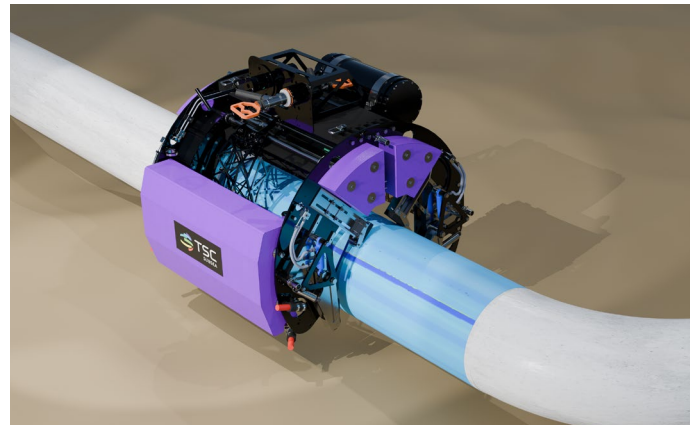
The campaign delivered high-quality baseline data for ongoing integrity monitoring, while highlighting the role of advanced, ROV-deployed NDT technologies in improving safety, efficiency, and environmental sustainability in subsea pipeline inspections. It also proved to be an effective alternative to inline inspection for targeted locations.



ROV Manipulator Positioning the ARTEMIS® on the Pipeline



Pipeline with 0.3 mm FBE and 7.7 mm PP coatings



3D Model with ART Wall-Thickness Data Overlay, Showing Seam Weld as Dark Line

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