DEFYING DEPTHS

Gordon Davidson and Zach McCann, Sonomatic, UK, examine how new, ultrasonic subsea tools have enabled inspection work at greater depths.

Sonomatic, provider of automated ultrasonic inspection subsea for more than 30 years, has developed a range of ROV-deployed tools that offer significant advantages over traditional diver-deployed systems. These ROV-deployed tools provide many key benefits, among them the ability to carry out inspection work without the need for divers or a dive support vessel, and at much greater depths.

In early 2015, Sonomatic successfully deployed its accurate subsea corrosion mapping approach at a depth of 1435 m, setting a new benchmark for depth with this technique. The inspection was carried out

Figure 1. Inspection carried out using the ROV-iT, an ROV-deployed ultrasonic inspection tool developed by Sonomatic.

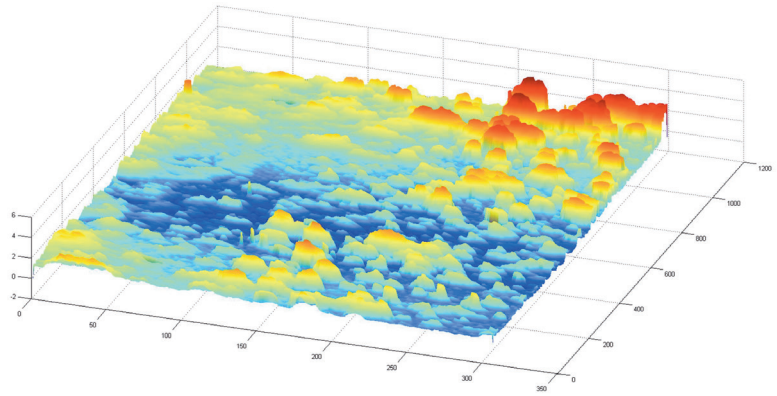

Figure 2. Corrosion map of region of subsea pipeline with internal degradation.

using the ROV-iT, an ROV-deployed ultrasonic inspection tool developed by the company.

A major objective of the inspection was to validate absence of low level degradation so that a case could be made for operation without the need for inline inspection. Since the coverage for the subsea inspection was low, meeting this objective was dependent on providing a highly sensitive inspection with accurate wall thickness measurements on a fine scan increment.

The inspection performance achieved at a depth of 1435 m, through a 3-layer polypropylene coating, matched that in shallow water, demonstrating Sonomatic's capability to deliver its world leading corrosion mapping accuracy even at great depth. The results of the detailed analysis of inspection performance, as achieved in the field, were central to the integrity assessment. This was based on statistical methods developed by Sonomatic for planning and evaluation of targeted inspections on unpiggable gas pipelines. The inspection demonstrated that the probability of degradation, with potential to threaten integrity for the line as a whole, was within acceptable limits.

Sonomatic's industry leading measurement performance was central to ensuring this objective was met and that the result was a substantial cost saving to the client. An inline inspection, which would have relied on a very expensive deepwater launch of the intelligent pig, was avoided. The subsea inspection work was completed safely and within the planned schedule, with Sonomatic's equipment operating effectively and reliablly throughout the campaign.

New techniques for subsea deployment

Sonomatic's ROV-deployed tools have been designed for inspecting pipelines, risers, caissons and structural assets. The tools are adaptable, operating on both horizontal and vertical pipes ranging from 6 - 30 in. dia. A range of ultrasonic inspection techniques can be deployed including corrosion mapping, time of flight diffraction (TOFD), automated shear wave pulse echo and component geometry measurement.

The inspection techniques, and combinations thereof, that are deployed means the following applications can be addressed:

- Verification of ILI tool findings.
- Targeted inspection for unpiggable pipelines.
- Inspection for internal corrosion and erosion.
- Inspection for preferential weld corrosion/erosion.
- Inspection for fatigue or stress corrosion cracking.
- Inspection for wet H_2S damage in sour service.
- Inspection for chloride pitting/SCC in corrosion resistant alloys.
- Inspection of subsea fabrication and repair welds.
- Component geometry measurement including ovality inspection.

The tools are developed and built around Sonomatic's extensive field experience with challenging subsea inspections and integrate proven Microplus ultrasonic systems and software with bespoke in-house designed scanner hardware. The

ultrasonic system is located in a subsea module mounted on the ROV-iT to allow high reliability digital transmission of data via the ROV's communication systems. After positioning by the ROV, the scanner is fully controlled by the inspection team topsides. The ultrasonic system is highly configurable for each specific application and provides a comprehensive range of presentation formats including A, B, C and D-scans. The data is analysed real-time using Sonomatic's proprietary software routines and analysis algorithms to allow accurate and reliable results to be provided in the form of single or composite images for each inspection location. The full data sets, including individual A-scans, are also stored for detailed post inspection analysis and comparison with previous data.

The inspection systems are designed for use with work class ROVs, and can also be used with both wide-angle video camera on a multiplexer and with LED lighting systems, which are pressured-rated to 2000 m. The tools are connected to the ROV via a short umbilical, which supplies all electrical and motion services. Data is transferred in real time back to the surface through the ROV umbilical and no additional cabling is needed.

Key features:

- Subsea deployment of a range of advanced ultrasonic techniques with proven industry leading performance.
- Subsea deployment of alternating current field method (ACFM) for surface crack detection.
- Inspection for a range of degradation mechanisms including corrosion, erosion and cracking.
- Inspection for internal liner detection and component geometry determination.
- Flexible riser inspection.
- Full 360° coverage.
- Scan lengths of 1 m.
- 2000 m depth-rated.
- Horizontal and vertical scanning.

Key benefits:

- Cost-effective inspection.
- No dive-support vessel (DSV) required.
- Deepwater inspection capability.
- Diverless operation reduces personnel risk.
- Fully ROV-integrated operation.
- Work class ROV deployable.
- Rapid inspection process.
- Detailed verification of ILI data.
- Accurate data for fitness for purpose assessment.
- Quality data suitable for statistical analysis in support of integrity management.
- Ability to reliably determine degradation rates for use in remaining life assessment.
- Effective monitoring of known damage.

Integrity support

In addition to provision of the subsea inspection service, Sonomatic assists clients with ensuring the inspection provides the best possible information on which to base integrity decisions. This includes assistance with the following:

- Defining the inspection performance requirements so the integrity objectives are met.
- Demonstration and qualification of inspection performance, including detailed technical justifications for critical applications.
- Determination of the coverage requirements and locations for limited coverage inspections where the aim is to ensure the inspection provides sufficient information to assure integrity.
- Statistical simulation studies to assess the performance of candidate inspection strategies (techniques, coverage and locations) so that the optimal approach can be adopted.
- Analysis of inspection performance achieved in the field. This is based on detailed analysis of the raw data to establish performance metrics.
- Statistical analysis of data to validate absence of degradation.
- Statistical analysis for low coverage inspections to estimate the worst case conditions in areas not inspected.
- Analysis of ILI verification data and statistical analysis of ILI data sets to provide more accurate feature depths, corrosion growth and remaining life estimates.
- Fitness for purpose assessments using standard code based methods, probabilistic approaches and nonlinear finite element modelling based on the inspection data.

Research and development

As the amount of subsea infrastructure grows and existing infrastructure ages, there is a growing need for subsea inspection. Sonomatic is investing heavily in research and development in this area and is bringing to market a number of new techniques for subsea deployment. These include shear horizontal electromagnetic acoustic transducers (SH-EMATs) and dynamic response spectroscopy (DRS). The technique based on SH-EMATs has been developed for rapid screening of subsea pipelines and structures for degradation in the form of wall loss. This will allow more rapid inspection in situations where the aim is to cover large areas. DRS is an ultrasonic technique that uses lower frequencies and is able to provide quantitative inspection of steel wall thickness through thick and/or attenuative coatings. These new techniques enable Sonomatic to more widely address the market needs for inspection and are opening up new applications.