Effective subsea inspection

Ryan Phipps, Subsea Project Manager, Sonomatic, explains how ROV-deployed subsea inspection tools facilitate pipeline inspection in areas and depths previously inaccessible to divers.

There are thousands of subsea pipelines worldwide at depths beyond diver accessibility. These pipelines have, until now, been difficult to accurately inspect ultrasonically from the outside. Externally applied automated ultrasonic inspection is an important element of pipeline integrity management that can provide assurance that degradation is not taking place, and if degradation is noted, fitness for purpose assessments can be performed to provide reliable estimates of remaining life until repair or replacement is required. Accurate external ultrasonic inspection of subsea pipelines at depths beyond diver accessibility is, however, a complex engineering challenge.

This challenge has been tackled through the development of an automated ultrasonic inspection tool, which can be deployed entirely by a remotely operated vehicle (ROV) at depths beyond diver accessibility. The system developed, the ROV-iT, can be deployed by a number of means and can reach depths of 2000 m.

Subsea inspection is one of the main focus areas of Sonomatic and the company has over 25 years experience in this challenging environment. The development and deployment of inspection equipment in-house allows inspections to be optimised for unique operating conditions. A strong capability exists for inspection tool development, covering mechanical design and analysis, ultrasonic inspection modelling, electrical engineering, electronics, software and system integration. Inspection tool design also takes into account the extensive field experience available within the company to ensure developments meet all practical requirements for field use. Subsea inspection, utilising techniques such as corrosion mapping and Time of Flight Diffraction (ToFD), not only on pipelines but also on risers and flexible risers, caissons and structural assets is now possible using the ROV-iT technology.

With recognition of an increasing number of piping systems being deployed at depths beyond diver accessibility, the potential for ROV-deployed inspection options had been explored for a number of years. Following a presentation of several potential ROV-deployed inspection concepts, Sonomatic was approached by BP with a particularly complex project. The project required an ROV-deployed high-resolution inspection system capable of performing zero degree corrosion mapping covering the bottom half of a buried 14 in. pipeline, with a 2 in. methanol piggyback line standing 4 in. above the main line. The pipeline was situated at a depth of approximately 45 m. The location however, was in the southern North Sea, an area well known for strong tidal currents in Winter. This meant that even though divers could reach the depth where the pipeline was situated, safety considerations in adverse weather conditions could be mitigated against by using an ROV as the deployment mechanism for the inspection tool.
In response, an ROV-deployed automated inspection system (ROV-iT 2000) was developed to meet the requirements of the inspection. The complete project - including concept development, ongoing peer review and feedback from the client, detailed design, manufacturing and integration with ROV - was completed in just 8 months. The project was self-funded with an investment of over £600,000 in design and development of tools and control systems.

The project involved several partners working together towards a successful inspection campaign. To start, a sand modelling study was carried out on the pipelines to identify potential locations for sand build-up or dropout with the potential for corrosion and/or erosion. This indicated that areas with undulations had the potential for sand accumulation and specific areas of concern were identified where inspection was necessary to identify any wall loss in the pipeline. An ROV-deployed excavation tool was provided, along with cleaning tools to prepare the inspection surface. Sonomatic was then able to deploy directly onto the pipeline to inspect the designated areas. Once the inspection tool was correctly positioned, it was held in position by hydraulic clamps activated by the ROV pilot. The inspection scan was then controlled by Sonomatic technicians in conjunction with the ROV pilots.

The inspection tool was connected to the control system, which was contained within a pod located on the ROV. All data was transferred back to the surface via the ROV umbilical. This allowed real-time review of the inspection data during collection. Real time analysis allowed further higher resolution scanning to be performed on areas of interest.

Although the system was designed for a specific inspection, the design team focused on creating a flexible tool that could be adapted for other applications. Much of the technology developed for this inspection could therefore be used to address a subsequent enquiry from BP.

The new scope of work was for a line located at 500 m water depth, exceeding the depths achieved by any previous subsea automated external ultrasonic inspection. In this case, the inspection tool would be required to conduct high-resolution corrosion mapping of the full circumference of a 10 in. and a 12 in. pipeline with varying thicknesses of external fusion-bonded epoxy (FBE) coating. ToFD inspection was also required on the pipelines to identify any areas of degradation within the welds and to determine the location of the internal polyethylene liner (as it was suspected that damage may have occurred during installation).

In order to meet the requirements of the proposed inspection, the tool had to be developed in order to cope with the different diameters, the epoxy coating and the increased deployment depth. The inspection tool was required to perform both corrosion mapping and the ToFD inspections on both diameters of pipe.

Figure 1. Sonomatic’s ROV-iT 2000 SP12 on location at a depth of 500 m conducting high-resolution corrosion mapping and Time of Flight Diffraction. Once the inspection is complete, the system is relocated along the pipeline to further pre-designated areas.

Figure 2. The Sonomatic ROV-iT SP12 in transit to an inspection site. Once located, full 360° scans over 1 m can be collected in less than 35 minutes.

Figure 3. The Sonomatic ROV-iT 2000 Sandline during deployment.
The immediate challenges associated with the inspection requirements were the difference in diameter and coating thickness of the pipes and the obvious issue of depth. Due to space constraints on the vessel, only one system with spares could be mobilised (for most operations, Sonomatic mobilises equipment with 100% redundancy). Therefore the final tool had to incorporate all the necessary attributes to successfully complete all inspection tasks, with an added emphasis on reliable operation from the first deployment.

During the development phase of the inspection tool, a number of test samples representing field assets were provided by the client. This ensured the most suitable probe technology was selected and aided in overcoming the engineering issues associated with clamping the tool onto pipelines of different diameters. On completion of the development phase, Sonomatic conducted a number of live trials for the client, demonstrating the ability to meet all the specified inspection requirements. The offshore phase took place in December 2010. The inspections successfully met all the requirements. The ultrasonic responses were affected by the presence of the FBE coating. Sonomatic has, however, developed a range of innovative approaches to accurately measure steel thickness in the presence of coatings. These methods were successful in this application and ensure confidence in the results obtained, providing reliable data on which to base integrity management decisions.

Following experience on the projects mentioned above, high-resolution ROV-deployed subsea ultrasonic inspection tools have been developed for various applications. These are depth-rated to a maximum of 2000 m and can operate on both vertical and horizontal pipework. The inspection tools are capable of inspecting a wide range pipe sizes and inspection lengths. Compact remotely-controlled inspection systems, which will allow inspection of bends and areas with restricted access, are currently under development.

In summary, the ROV-deployed subsea inspection tools developed by Sonomatic, not only allow pipeline inspections to be completed at shallow depths in conditions that would be hazardous to divers, but also allow pipelines inspections to be completed at greater depths than have previously been achieved. The data obtained by the tools allows reliable verification of any reported in-line inspection anomalies and can also be used as the basis for statistical analysis for assessments when coverage is limited. The information provided by the inspection tools ensures that integrity decision-making is aligned to the true asset condition and allows cost-effective subsea inspection for a wide range of situations.