DIFFICULT TO PIG AND TO INSPECT OFFSHORE PIPES

K. Reber, Innospection Germany GmbH, Stutensee, Germany
S. Hartmann, Innospection Ltd., UK
A. Boenisch, Innospection Ltd., UK

Introduction

When it comes to a fast, non-intrusive, complete and meaningful inspection of an offshore pipeline in-line inspection (ILI) has been the method of choice for several decades now. However, not all pipelines, piping or other tubular structures can be inspected with in-line inspection tools (pigs). The method is usually limited to looping flow lines or export pipelines, specifically designed for ILI operation. The remaining structures are often summarized under the buzzword “non-piggable”.

The typical ILI viewpoint is to consider the piggability under either the aspect of pipeline design or pipeline operation. Typical piggability issues in pipelines under pipeline design aspects are launching/receiving facilities, bends, and internal obstructions. The other aspects are operations-related. ILI may be impossible due to too high/low flow, too high temperature and other. In both cases ILI solutions can still be conceived and realised by either changing the pipeline or by adapting the pig. The latter is the technically more interesting solution for service providing companies. ILI providers are busy in designing and already offer tools for multiple diameters, for bi-directional operation and tools with special insertion techniques. Also there are many solutions available that use a cable operated tool and/or a crawler type tool. Discussions on solutions for unpiggable pipelines usually focus on these types of solutions.

There still remains an area of inspection tasks that can be summarized under “Not at all piggable”. For either technical or financial reasons, a pig-like solution may still remain unfeasible. In some cases the involved technical risk may also convince the involved parties to refrain from any ILI adaptation. In these cases either key-hole solutions or external inspection may remain the only option. The distinction between a key-hole solution and a pig-based inspection can be made by the aim to reach a 100% coverage in the latter case. For other inspection types a lower inspection coverage is usually accepted.

In addition to these topics there is another category of reasons, why a pipeline may be considered unpiggable. This concerns problems that are due to the available inspection technology and the inspection task. Other authors have named piping suffering from this problem rather uninspectable than unpiggable. This accounts for the fact, that a pigging operation is not related to an inspection, but the passing of a pig. If a pig can pass, but the pipeline is not inspected, because available inspection techniques do not detect defects, the pipeline is uninspectable. Figure 1 is giving an overview of the different categories of inspection.

Copyright © 2013 Pigging Products & Services Association

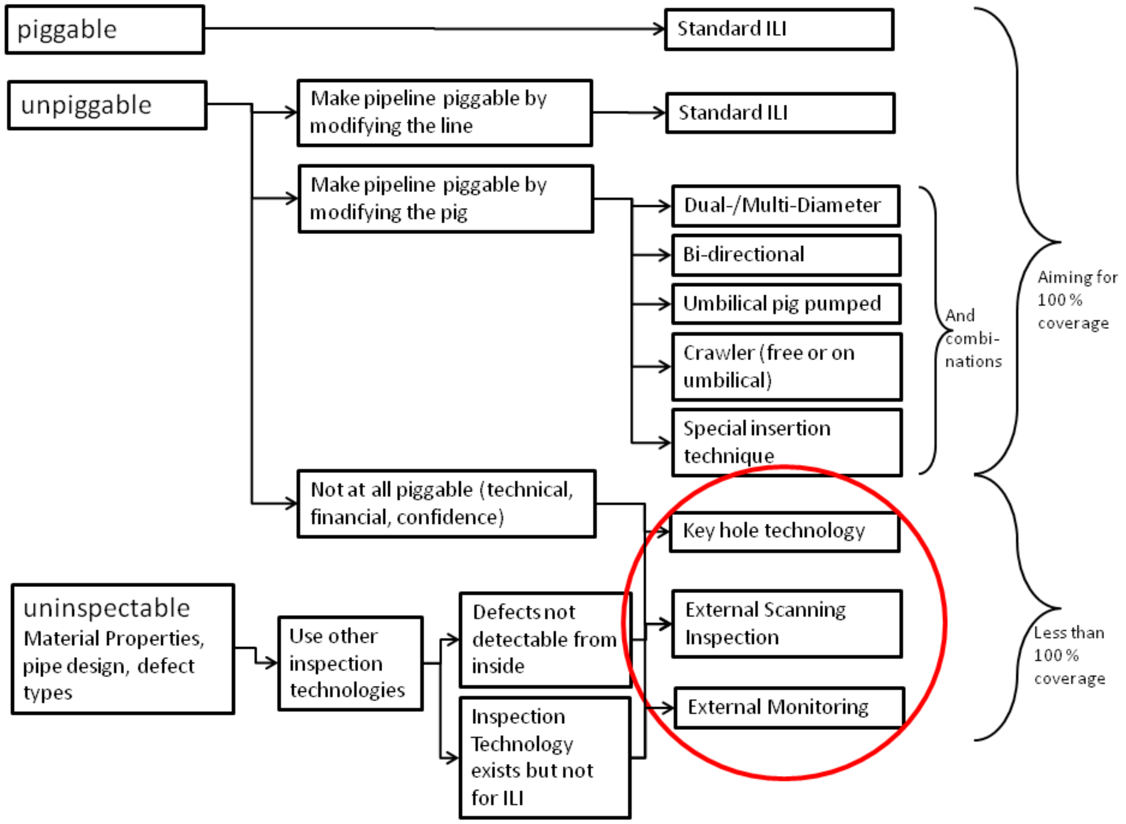

Figure 1: Overview and classification of inspection solutions depending on the inspection environment. Further discussion will be about the inspection methods encircled in red.

If an inspection technology can be redesigned to work on an ILI-tool this inspection task will then become standard ILI operation. This process happens all the time. Here we shall focus on cases where the inspection technique is not “pig-mountable”, or the technology does not work from the inside. This remains the realm of external inspection, in most cases an external scanning technique, but possibly also an external monitoring.

In particular for external inspection the deployment of the inspection device is a major aspect of the inspection operation. In the offshore industry, different parts of structures demand different levels of inspection. The deployment method will very much depend on the exact location of the inspected pipe section. An overview of different deployment methods is given in Figure 2. The two main methods are deployment from top-side or deployment subsea from an ROV or a diver. Recent technical developments aim at avoiding diver operated inspections. If deployed from top-side often rope access technicians will be required to position or clamp a device to the pipe to be inspected. For subsea deployment a work class ROV will position the device on a spot on the pipe, where it will start to move remotely controlled.
Obviously the structures inspected in this manner are not only pipelines, but any tubular components. With such an extension of the inspection scope the issue of inspectable material and material compositions is even more pronounced. The fact that a certain tubular structure is not a pressure vessel does not make a difference for the external inspection.

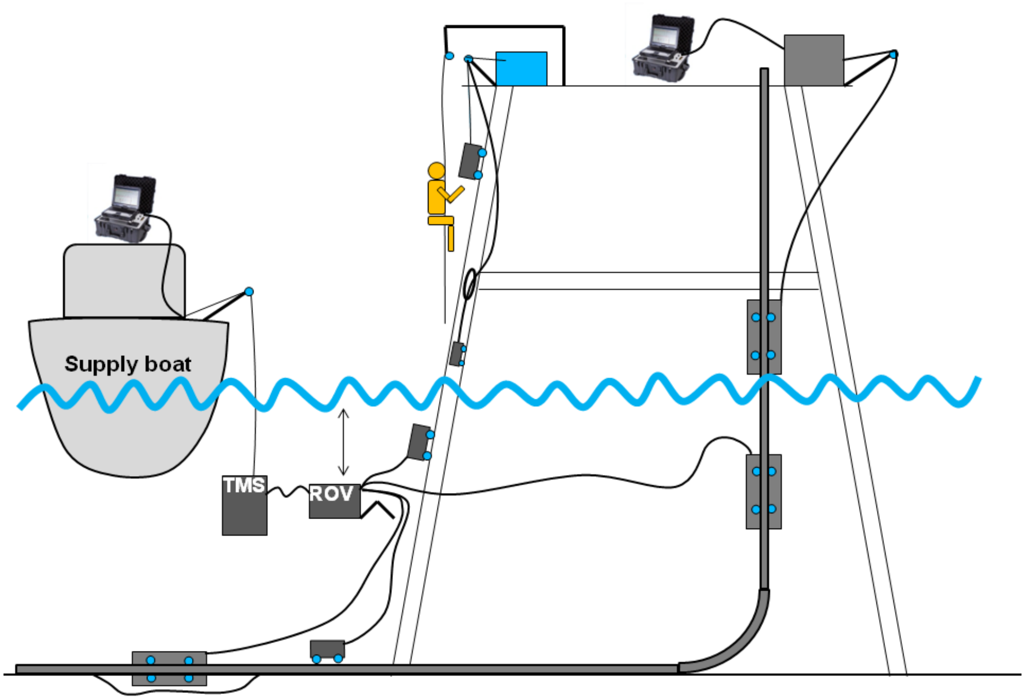

Figure 2: Different methods for deployment depicted

To illustrate the inspection technique, as well as the deployment challenges a few case studies shall be presented. At Innospection SLOFEC in combination with UT spot checks has been found to be an adaptable testing technology for the various tasks described above. The SLOFEC technology has been described before [1]. In essence it consists of an eddy current technology under simultaneous magnetization of the pipe to be inspected. This allows for the inspection of wall thickness reductions and can be used not only for bare carbon steel pipe, but also for a combination of metals and polymers. The polymer itself, which can be a coating or another structural part of the pipe, is not inspected, but also does not impede the inspection of the metallic parts.

Case Studies

Internal Leg Inspection

The task had been to inspect the inside of a platform leg for corrosion type defects. Access was only possible through a hole of a size of 15x35 cm. In addition there was an internal cone blocking straight access at the location of the hole. An internal inspection from the top was not possible due to various internal objects. The inspection was required from the elevation of the hole downwards into the water level. An inspection coverage as high as possible was desired. The access to the leg is shown in Figure 3.

Figure 3: The access for a keyhole inspection of a leg

The devised inspection tool was required to be sufficiently narrow. It is shown in the right part of Figure 4. In its final configuration is consisted of a SLOFEC unit for corrosion testing, a camera for visual inspection and a PEC unit for quantitative wall thickness testing. PEC stands for Pulsed Eddy Current and is also widely used in the testing of offshore structures [2].

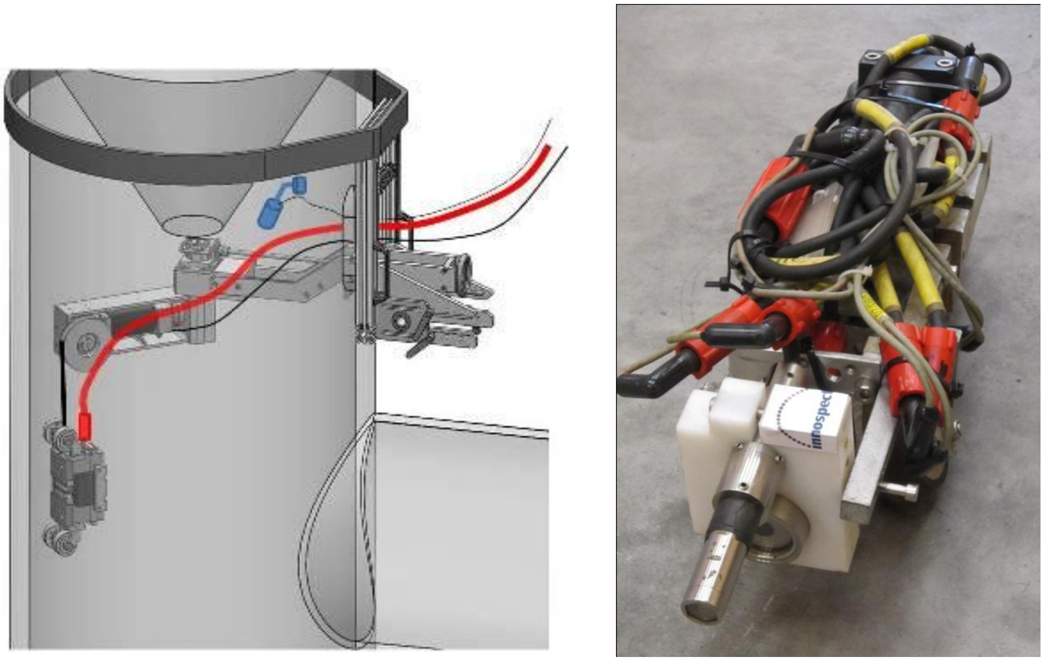

Figure 4: Left: The arm to mount the scanner on the hole. The scanner (right) could be lowered into the leg by the means of a steel rope. The pulley was inside the leg.

The left of Figure 4 shows the device that allowed for mounting the scanner internally near the hole and also allowed for swiveling the scanner around the internal surface.

Riser with external Monel cladding

The task in this case consisted of the inspection of a riser which was externally clad with a Monel alloy. Monel is an alloy with high Nickel content. Nevertheless it is not magnetic, but electrically conductive. It shows excellent resistance against corrosion.

The riser had to be inspected for external corrosion, i.e. metal loss in the interface between Monel and steel. The particular interest was in the splash zone. The device had to be attached below a riser clamp, which is shown in the right of Figure 5. ILI in risers is usually possible, if the corresponding pipeline is piggable. However, the data often shows poor quality, as the speed is uncontrolled.

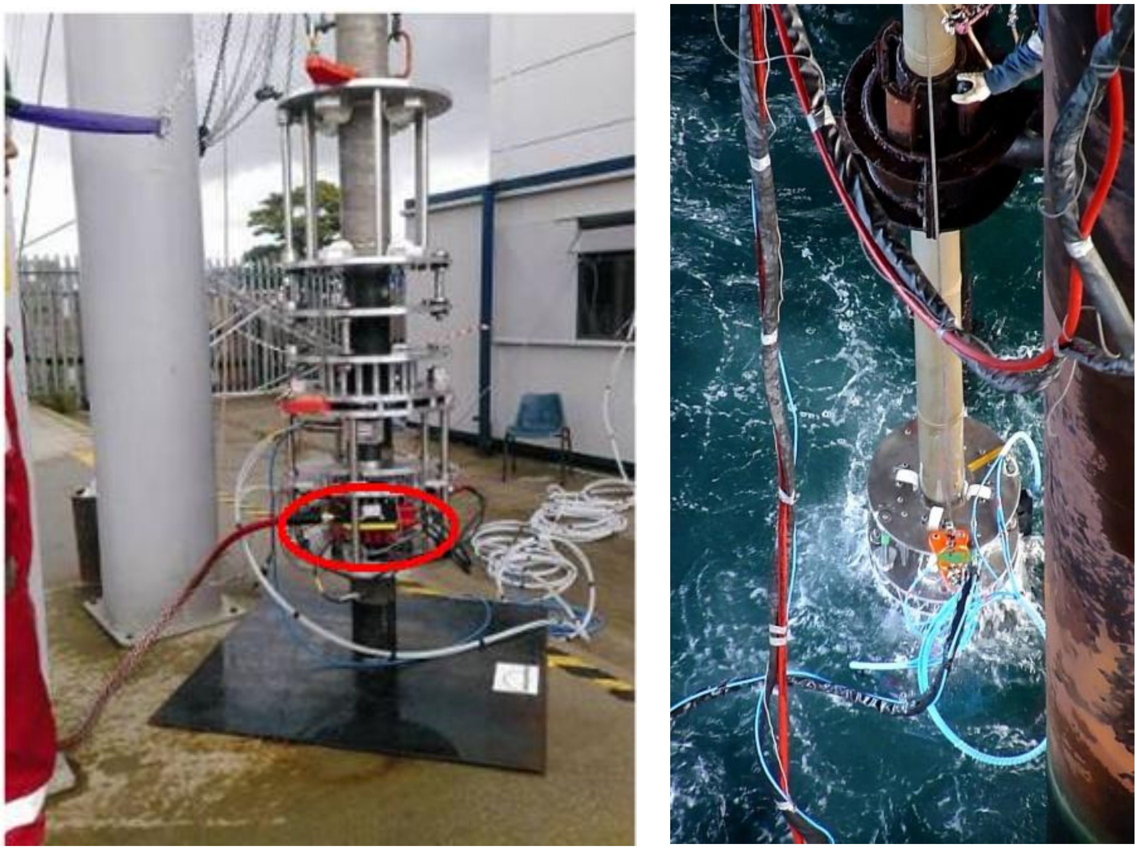

Figure 5: Left: The inspection device for a mock-up testing. The red encircled spot shows a SLOFEC device scanning in the circumference. The right shows the device being deployed from top-side and performing its inspection in the splash zone.

The left of Figure 5 shows the device being tested. The scanner itself is shown in the red circle. The cladding had overlapping parts with the overlap welded in the circumferential direction. The scanning had to be in the circumference, because signals originating from the weld would have masked defects underneath. Scanning in the axial direction of the riser would have been a much easier task. The device consists of a lower rotating part and an upper stationary part. Both parts can be opened to allow for clamping onto the riser.

The SLOFEC technique can be adapted to measure through layers of conductive material, if the material is not magnetic. In addition cameras observe the scanned area. Workshop verification tests have shown, that metal loss in the carbon steel riser can indeed be observed in this manner. In the particular project it was possible to show the absence of defects.

The technology also demonstrates the principal ability to inspect internal CRA lined or cladded pipe.

Inspection of flexible riser

The issue of inspecting flexible risers is complex and has been discussed before [1]. They are a good example of uninspectable pipeline, as pigs have been passing through flexible riser often. The inspection of flexible risers is of utmost importance. A considerable number of flexible risers are known to have damage in the outer sheath. This will lead to degradation and reduces the calculated lifetime. The degradation mechanisms usually consist of water ingress, flooded annulus, and corrosion in the armored wires and reduced fatigue life time. The deployment method is also of major interest. In the project shown here the riser had to be inspected near the splash zone, but to water depth at least to -20m. The scanning is done in the axial direction. Since the scanning needs to cover the full circumference and the orientation of the device on the riser needs to be defined, the device can also rotate on the riser. The left of Figure 6 shows Innospection's MEC-HUG™ tool that uses hydraulic power to run axially and circumferentially on the riser pipe.

The MEC-HUG™ tool is equipped with buoyancy block on top visible in Figure 6. Once the tool is submersed, it floats and freely moves in water by the hydraulic motors. The steel rope remains attached for safety reasons but is no longer required to steer the tool. Encoder wheels on the tool allow for positioning the device. The right in Figure 6 shows an excerpt of the inspection report. The typical helical structure of flexible riser pipe is visible. The full circumference is scanned with different tracks. They are later concatenated to yield the full picture. With a given datum point any position on the riser can be reached and reinspected.

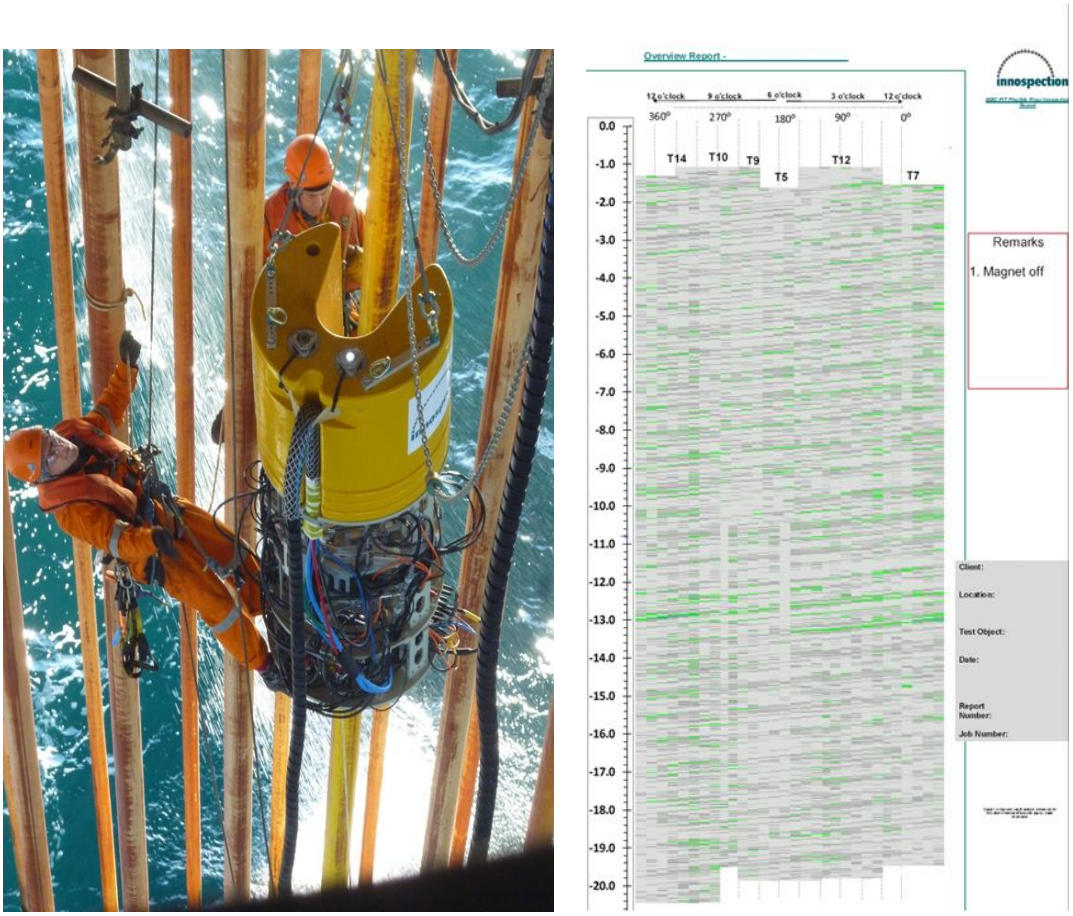

Figure 6: Left: The MEC-HUG™ tool being attached to the riser. It runs in axial an circumferential orientation. The inspection is performed while running axially. The data is shown on the right.

Unpiggable Subsea Pipeline

In this project the task was to inspect an unpiggable subsea pipeline. It was deemed possible that the pipeline suffered from top-of-the-line corrosion. Hence the focus was on the top position for inspection. The coating consisted of a 3-layer Polyethylene with a thickness of a few mm. Sections of several meters were to be inspected. A rough cleaning had to be performed prior to inspection. The inspection tool is a modified MEC™-CombiCrawler. It is seen lying in front of a Work class ROV in the left of Figure 7. Again it is equipped with buoyancy to ensure no resulting torque is exerted on the tool when running on the pipeline. This allowed to tool to also run stable in the 11 and 1 o'clock position.

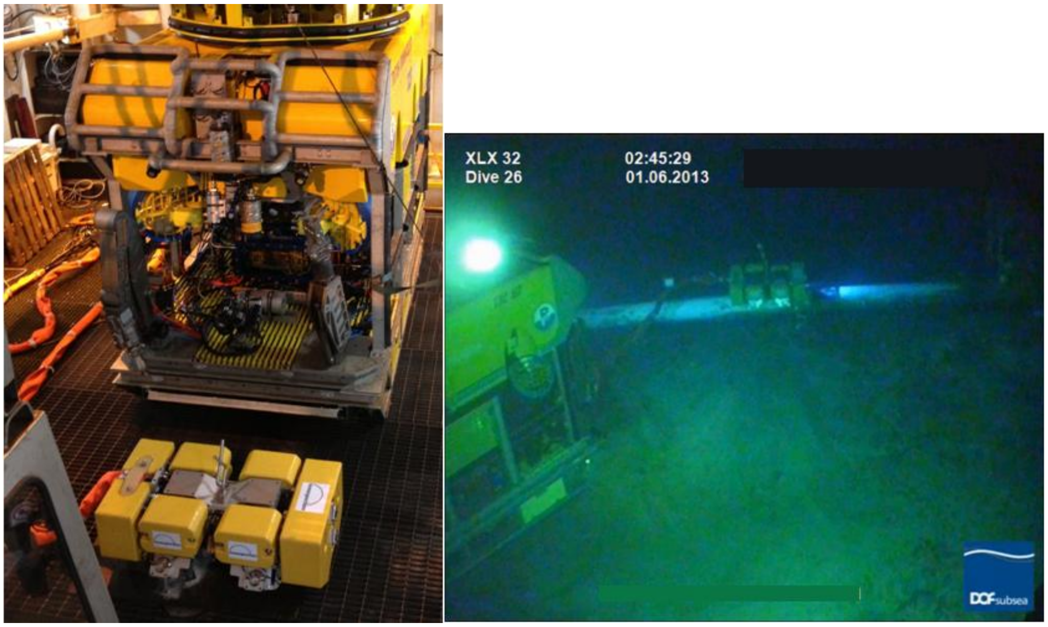

Figure 7: Left: the inspection tool (modified MEC™-CombiCrawler) lying in front of a work class ROV. Right: Tool deployed on subsea pipeline scanning over the pipeline.

The right in Figure 7 shows the tool running on the pipeline performing an inspection using SLOFEC and UT Wall thickness measurements. The tool remains connected with the ROV over an umbilical. The data is transferred through the ROV in real-time.

Conclusion

There are various reasons why pipelines or other tubular offshore structures are difficult to inspect. In-line inspection is a matured and widely accepted method to gather integrity related information. Structures, where only external solutions will yield meaningful results, are of particular interest, as this constitutes an emerging inspection market.

Compared to standard ILI many of the solutions are still in an early stage of development. Nevertheless new methods and means of deployment yield important information. Eddy Current Testing in various configurations in combination with ultrasonic wall thickness measurement has shown to be a promising technology for difficult to pig and to inspect pipes.

Bibliography

[1] K. Reber and A. Boenisch, "Inspection of Flexible Riser Pipe with MEC-FIT™," in *PPSA Seminar*, Aberdeen, 2011.

[2] P. Couzen and I. Munns, "Pulsed Eddy Current Corrosion Monitoring in Refineries and Oil Production Facilities – Experience at Shell," in *ECNDT*, Amsterdam, 2009.