THE CHALLENGE OF INSPECTING PIPELINES WITH 'UNKNOWNS'

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Knowing how to inspect pipelines that lack information, often deemed critical by ILI vendors, can be a challenge. 'Unknowns' are often caused by a lack of documentation for older pipelines with no previous ILI history. After the initial field development and high production phase, older fields are often sold by the integrated oil majors to smaller independent operators, specializing in extending the productive lives of these fields. This can result in a loss of operating 'memory', especially when changes are made to the operations team.

Independent operators often have a smaller Integrity Engineering Department than the majors (or none at all) and are therefore more reliant on outside engineering companies for integrity and maintenance services. Important records could be lost over time or not transferred when an asset changes ownership. Furthermore, repairs and modifications to assets could go undocumented, further exacerbating integrity and maintenance efforts. In the current climate of cost cutbacks, valuable operations experience is being lost due to headcount reductions, leaving behind smaller integrity teams with a diminished knowledge base to safeguard pipeline assets.

Uncertainty can also stem from inconclusive information such as contradicting drawings or inspection reports of the same pipeline showing conflicting information. Confirmation of the actual layout or pipe dimensions becomes especially challenging in an offshore environment. A damaged gauge plate could indicate a restriction, but does not provide information on the location or the nature of the restriction. Gauge pigs frequently indicate false positives, incorrectly showing that there is a restriction in the pipeline. The appearance of a restriction or inconclusive documentation can be the hold point that prohibits an inline inspection to proceed. These 'unknowns' are what defines these pipelines as un-piggable.

It can be challenging to mitigate the risks posed by these 'unknowns' and acquire the inspection data required to establish the pipeline integrity. A visual inspection could confirm the actual situation, however, in an offshore environment, this can be easier and cheaper said than done. Visual verification, even when the location is known, can be hampered by:

- Low visibility
- Entrenched pipe (Fig. 1)
- Ballast weight
- Shifting sediments
- External coating or insulation (Fig. 2)

Based solely on receiving a damaged gauge plate, the defect could be located at any section of the pipeline or there could be multiple locations involved, making visual verification extremely challenging.

Figure 1: Pipeline partly buried in the seabed

Figure 2: Removal of concrete coating

Even after extensive efforts, there is no guarantee of a conclusive answer. Incomplete evidence after a partial verification does not resolve the uncertainty. All things considered, visual inspection of subsea infrastructure can be time-consuming, resource-draining, and interfere with other ongoing projects, with space and personnel limited on offshore platforms.

A different approach can be considered that removes doubt and acquires data in a single sweep. The risk posed by potential restrictions can be mitigated by using an ILI tool with a large operating envelope. For example, a tool with a collapse factor of 25% can accommodate a high degree of uncertainty in pipeline bore. Through careful ILI tool selection, the risk of a stuck or stalled tool can be minimized. Differentiating characteristics to be considered include:

- *Surface riding vs. non-surface riding sensors* – surface riding sensor arrays are susceptible to damage when encountering high-lows or tees.
- *Differential pressure required to propel the tool* – low DP across a tool lacking hard seals could cause it to stall instead of becoming lodged at the location of the obstruction.
- *Bi-directional capability* – this can allow a stuck or stalled tool to be returned to the start of the line. While data would be incomplete in this scenario, an exact location of the obstruction would be provided, removing part of the uncertainty.

Case study 1:

This case concerns inline inspection of a 10/12” SCH 80 dual-diameter, 1.1 km subsea pipeline, mainly situated below the mud line. During previous ILI campaigns in the same area, several reduced bore valves to 8” had been encountered in 10” lines. Being in shallow water, there was potential for anchor damage in this area and the client estimated that this could be the case for this pipeline.

The project was planned for a single mobilization, but in two stages. The first stage was an exploratory run to confirm the minimum ID of the pipeline. The tool was set up to be able to collect ultrasonic wall thickness data in the 12” section with the ability to collapse to 8”. This allowed reasonable data to be collected without the risk of a stalled ILI tool scenario.

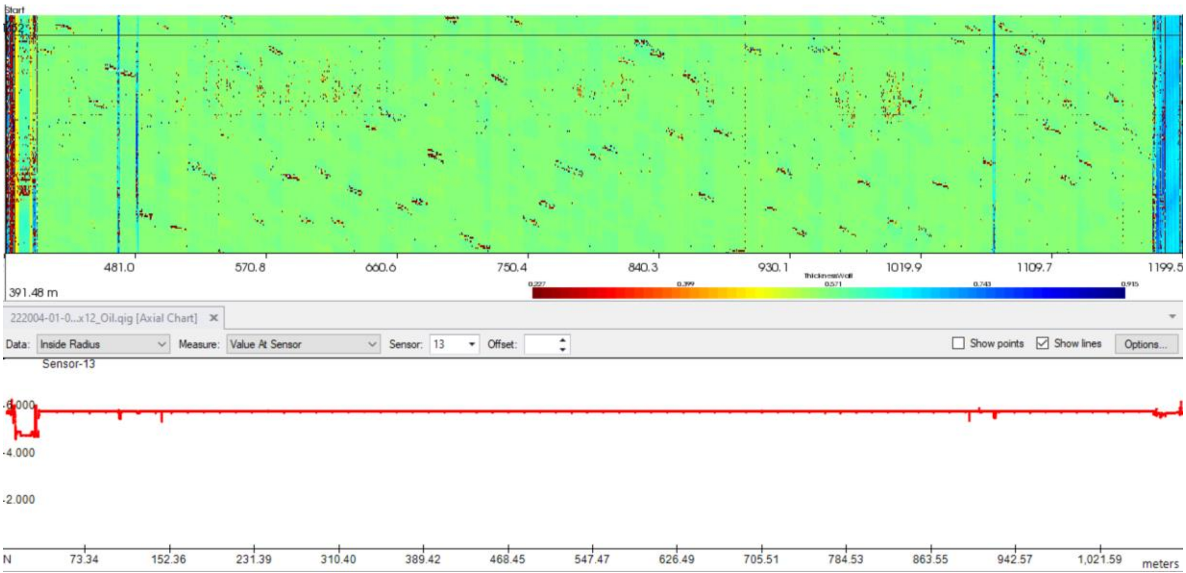

Figure 3: Wall thickness and inside radius view of the entire pipeline (with min. 9.5” ID)

Immediately after the run, the data was assessed by the on-site ILI inspection team and the minimum bore during the run was confirmed to be 9.5” (Fig. 3). With clarity regarding the minimum ID, a less conservatively sized tool could now be deployed into the line for the second stage to gain higher resolution data. This two-stage approach minimized the risk for the client and maximized the quality of the data collected.

Case study 2:

A gauge pig run had been performed in a 14-inch crude oil pipeline situated between two offshore platforms, prior to the first inline inspection of the pipeline. The gauge plate indicated that there was a restriction in the pipeline, with a minimum ID of 255 mm. This was a concern for the client which caused the ILI contractor, who had already mobilized to the platform, to abandon the inspection.

Although the documentation appeared to be up-to-date and with no indication of a reduced ID, the client suspected that a replacement with a reduced ID had been made without proper documentation. This was in part derived from the roundness of the reduction on the gauge plate (Fig. 4). The gauge pig (Fig. 5) had been set up with minimal clearance between the 305 mm diameter gauge plate and the pipe wall, measured at 311.4mm ID.

Figure 4: Measurement of the gauge plate

Figure 5: Standard Steel mandrel Gauge pig with added brushes

Instead of launching an extensive campaign to find the potential reduction using divers or ROVs, the asset owner elected to inspect the pipeline using an ILI tool with a large enough operating envelope to accommodate the ID variations displayed by the gauge plate (Fig.6). This would allow high-quality data to be collected without the risk of a stall.

	Measured Pipeline ID (mm)	ILI tool ID range (mm)
Min	255	225
Max	311.2	325

Figure 6: Expected pipeline ID range and operating envelope of the ILI tool

After performing the ILI run, the data was assessed onboard the platform in order to identify the reduction(s) in the bore. Ovality was observed all throughout the main pipeline between the platforms (Figs. 7 and 8). This could have occurred during the installation of the pipeline via a pipe laying vessel.

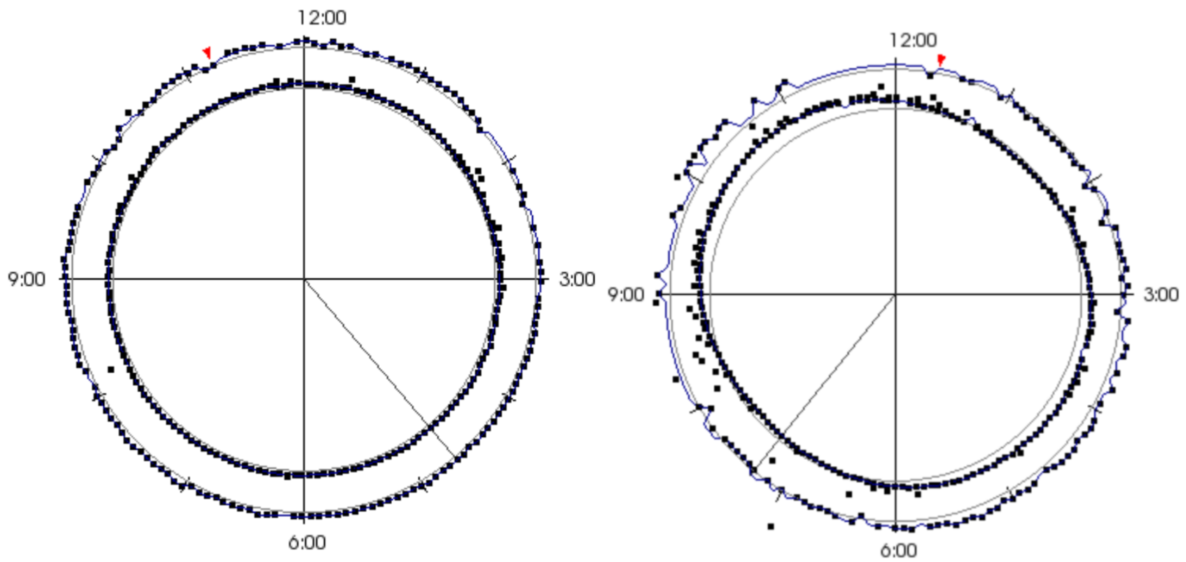

Figure 7: Cross section of the riser pipe (left) and main pipeline on the sea floor (right)

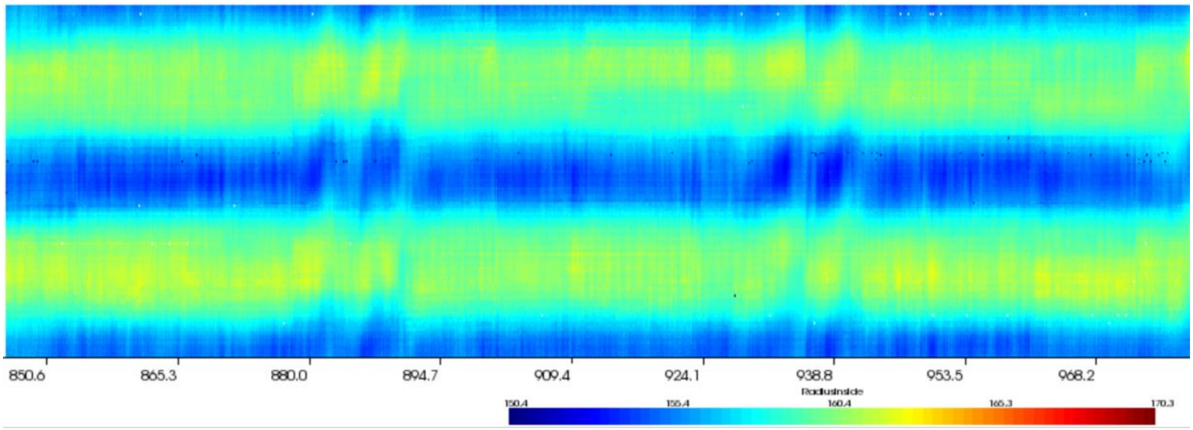

Figure 8: Ovality was encountered for the entire length on the seabed

Furthermore, several bends in the pipeline were found to be overbuilt, with measured wall thicknesses of 31mm reducing the ID to 292mm at these locations. In fact, the minimum ID encountered throughout the system was in a tee at 280mm, nearly 10% bigger than the worst-case presented by the gauge plate. The combination of these ID reductions, combined with the unforgiving setup of the gauge pig, resulted in the damage to the plate but did not provide a true reflection of the profile of the pipeline.

The margin of error due to the minimal operating tolerances of the original ILI contractor was very slim, with a gap of only 3.2mm between the gauge plate and the pipe wall. Selecting an ILI tool with a wider operating envelope allowed the inspection to take place after the initial delay.

Summary

The challenge of inspecting pipelines with ‘unknowns’ can be offset using ILI tools capable of navigating a broad range of inner diameters. With the lack of information, the risk of project delays and damage to tools and equipment increases substantially. Selecting an ILI tool with a wider operating envelope can greatly reduce the risks associated with “unpiggable” pipelines, allowing for the acquisition of inspection data to establish accurate integrity and maintenance plans.