

NAVIGATING DIFFICULT UNDERWATER INSTALLATIONS - AN ILI CHALLENGE

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Abstract

In the world of hydrocarbon pipeline transportation, there are a variety of special fittings in pipeline designs that create challenges for proper in-line inspection (ILI). For example, there are a number of different pieces of equipment for connecting pipelines on the seabed such as end connectors - Hydrocouples and misaligning flanges (MisAligning Flange-MAF), which have a particular internal geometry and represent a challenging obstacle for ILI tools. In many cases these non-standard fittings are unknown to pipeline operators due to the age of the pipeline and/or lack of documentation during their design and construction. This paper describes a customized solution designed specifically for the operator of an offshore multiphase pipeline in the Gulf of Mexico, which allows such installations to be safely negotiated with an ILI tool. This solution makes it possible for pipeline operators to gather data from the entire length of the pipeline for their integrity management, even in the presence of hydrocouples and MAF flanges.

Background / Introduction

In the pipeline inspection industry it has become increasingly common for pipeline features and fittings to present a challenge to perform a proper in-line inspection that allows complete and good quality data to be obtained.

A 12" multiphase pipeline operated by a Mexican client is a good example of this. It is operated in an offshore field which is located in the gulf of Mexico about 32 km off the coast. This pipeline transports production fluids (gas, oil and water) from platform to an onshore battery.

The offshore field covers an area of about 2,035 square km with 33 drilled wells. Existing facilities include three offshore platforms, 14 production wells, four submarine pipelines and ground processing facilities. The field produces 4,000 bopd and 17,000 mscfd of gas.

The pipeline in question was built in 1970 and had successfully been MFL inspected in 2009 by another ILI company, thus it was considered a standard pipeline. In subsequent years prior to the next in-line inspection in 2019, the pipeline had been transferred to a new owner, its current operator.

The 2019 re-inspection executed by the other ILI company was unsuccessful as the MFL inline inspection tool used for the inspection became stuck in the pipeline but could eventually be recovered and pushed out using foam pigs. Divers contracted by the operating company were tasked to investigate the suspected location and was identified an unknown installation at KP 25+000 of the subsea section of the pipeline. The existence of a critical installation remaining was unknown to the operating company, nor was there any documentation on its design.

With this information, 3P Services was approached to design and assemble an ILI tool that would safely pass through this unknown installation and record inspection data of the entire pipeline to provide a status of the current integrity of the pipeline.

Pipeline and unknown installation details

The 12" pipeline transports multiphase fluid with a mostly gaseous content. It extends 32km from Platform to the onshore separation battery, has a nominal wall thickness of 12.7mm and has a single 1.5D bend that connects the Riser to the top site on the platform.

During 2009 and 2019, MFL was identified as the most suitable technology for inspecting this pipeline and multiphase was used as propelling medium. The limited available inspection data of the 2019 recovered MFL tool were analysed and used to locate where the ILI tool had become stuck.

The installation found by the divers who were contracted by the pipeline operator is located at approximately KP 25+000 of the pipeline. The divers dredged the pipeline in order to be able to measure in detail and record photographs of the subsea installation.

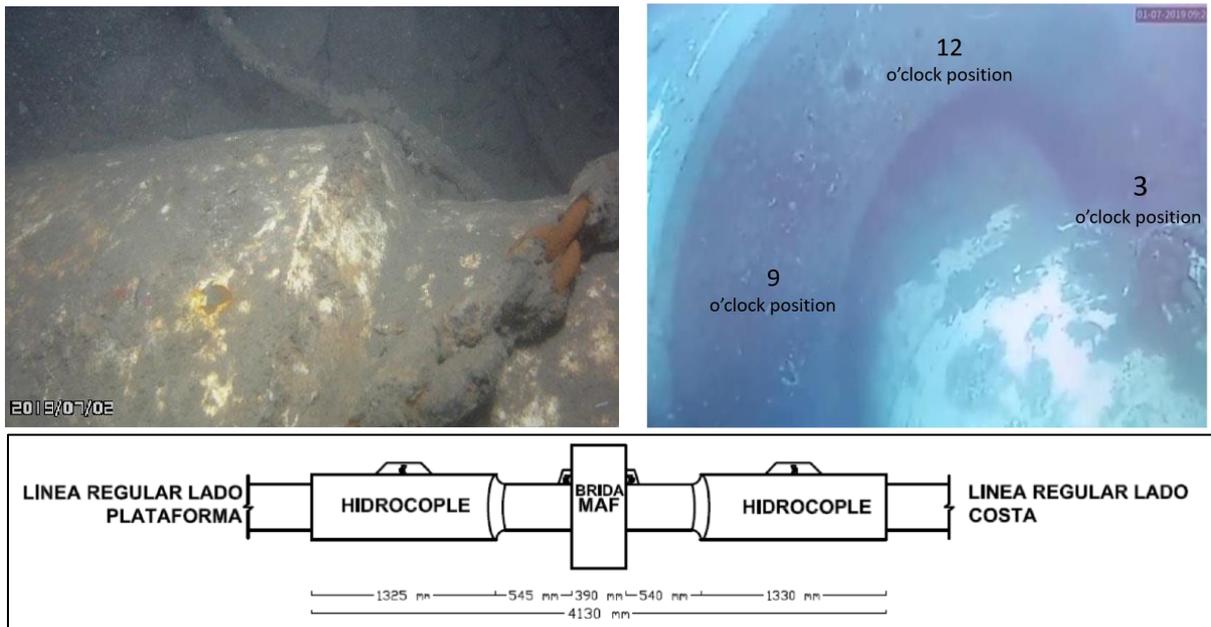


Figure 1-3: Subsea Installation Overview

The installation found by the divers, consisted of two hydrocouplers in combination with a misaligned flange (MAF), which is used by many pipeline operators to carry out repairs or replacement of offshore pipeline sections in reduced time and cost. The MAF flange allows a linear deflection of the pipe of approximately 10° in the horizontal plane.

The Pipeline End Connectors (PECs) are installed over the end of a bare pipe to provide a structural connection point. The connectors can be installed on a cut pipe end from which the concrete coating and all other coatings, such as sastic and coal tar enamel, have been removed.

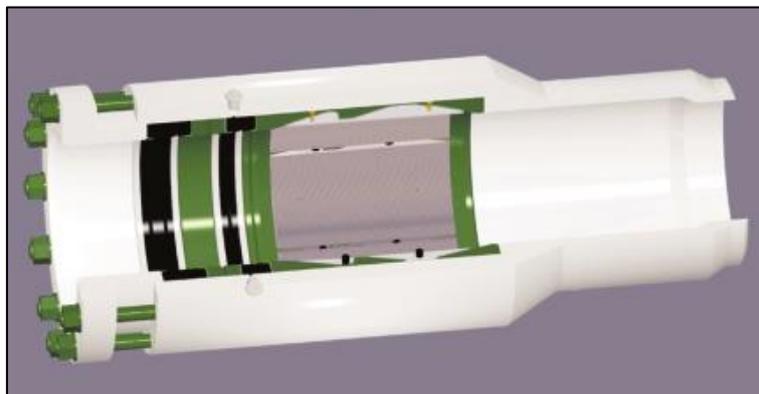


Figure 4: Pipeline End Connectors "Hydrocouple"

The MisAligning Flange (MAF) is a metal-to-metal sealed ball and-socket connector for bolting together two misaligned pipelines. The MAF reduces installation time by allowing divers to make the connection without lifting and aligning the pipe ends.

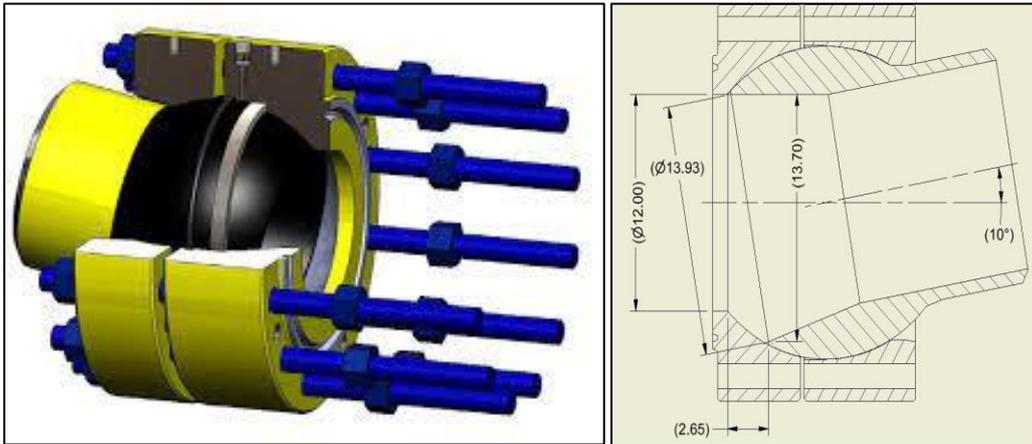


Figure 5-6: Misaligning Flange - MAF

The hydrocouple represents sharp edges and severe changes of the internal diameter (ID) of approximately 33.6mm. On the other hand, the ball swallow configuration on the MAF flange has a local ID expansion of 49mm; this, compared to the nominal ID of the pipe, results in an ID difference of almost 2". The combination of these fittings presents a challenge for proper and safe in-line inspection with standard ILI tools for both vendor and operator. 3P Services worked closely with the operator to design and build an MFL tool capable of negotiating the challenging features present in the pipeline without the need for changes to the pipeline configuration or operating conditions.

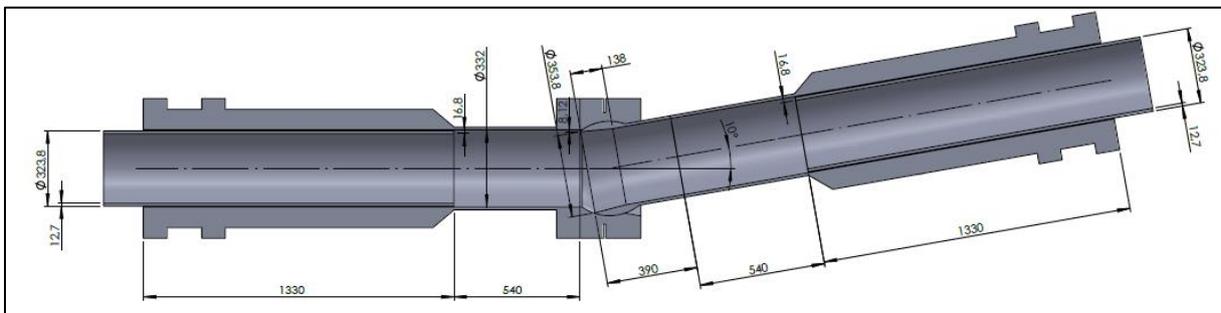


Figure 7: sketch of the subsea installation

Design and tool assembly

The particular geometry of the subsea installation precluded the use of standard MFL tools, therefore it was necessary to design and assemble a customized MFL tool specifically built for the characteristics and challenges of this pipeline, thus enabling safe passage of the MFL tool and ensuring logging and data quality along the full length of the pipeline.

The requirement for the customized 12" MFL tool was that it had to be flexible enough to negotiate a minimum bend radius of 1.5D and at the same time have the ability to properly seal up to an internal diameter of 14".

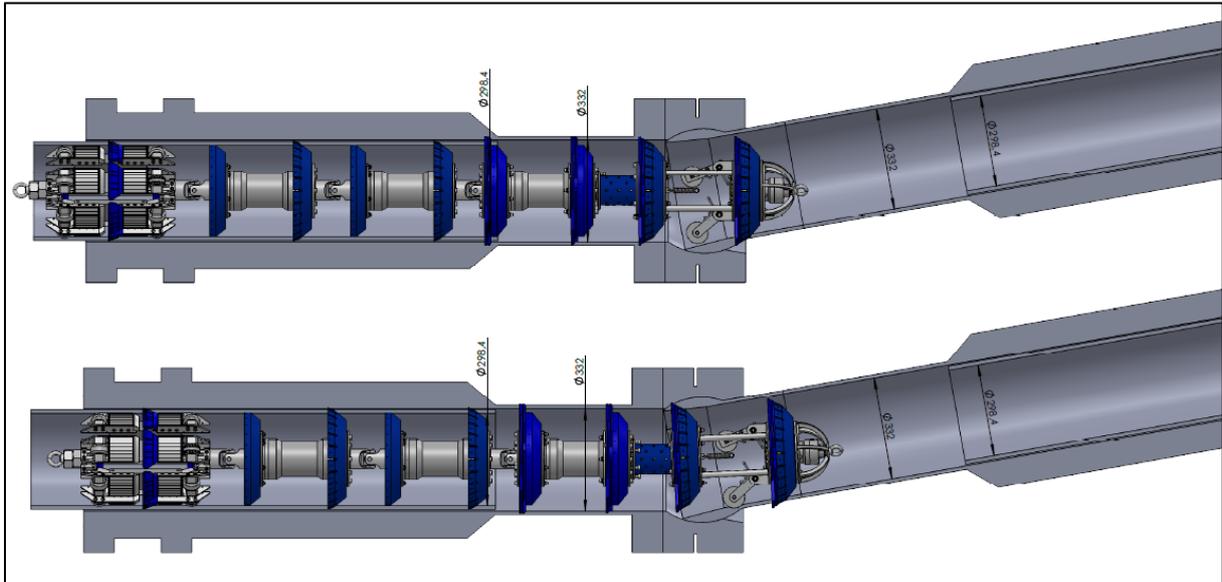


Figure 8: simulation of the tool passing through installation

A central point in tool design was the pulling module of the MFL tool needed to be long enough to pass through the critical ID changes while ensuring proper sealing especially during the passage through the expansions. The pulling module consisted of two sealing modules connected by a reinforced joint to withstand the action of one sealing module pushing the one in front.

In addition to the PU cups, serrated discs of the same material were used to ensure sealing on the upper bore and to keep abrasion low on the nominal bore.

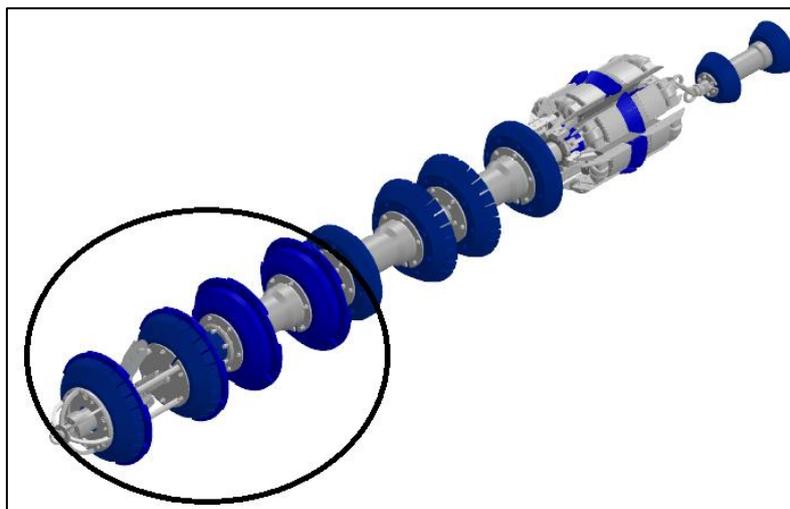


Figure 9: double pulling module with reinforced joint

Some changes have been made in the design and assembly of the magnetizer unit to prevent the sharp edges of the diameter transitions from damaging the tool's magnetiser or causing the yokes or other external parts of the magnetiser to break off.

For this purpose, thicker armour plate and long chamfered side plates were considered to smoother overcome the ID transitions.

In addition to the intelligent MFL Tool a "Dummy/Profile" tool with the same design was built in order to check the safe passage of the tool through the subsea installation and reduce the risk of a tool becoming stuck.

The dummy tool was assembled with the design of the MFL tool, however the magnetiser unit of the tool was replaced by aluminum plates in order to simulate the hard bore of the MFL tool.

Inspection experience / Inspection execution

The inspection of the pipeline had to be carried out in the product that is conveyed by the pipeline in normal operation, multiphase (gas, oil and water). The gas content in this inspection medium was considerable. In order to ensure the smooth passage of the ILI tool through the 1.5D bend located on the topside of the launch platform, a small liquid batch was used to launch the tool from the topside into the sealine. This was intended to minimize the risk of getting the tool stuck in the bend thus compressing the gas behind the tool and increasing the pressure until it can be negotiate the Riser.

Prior to the MFL run, the dummy tool was run successfully. No significant damage to the gauge plates indicated a lack of critical restrictions for the identically sized magnetizer of the MFL tool. No significant changes in flow rate or pressure could be recorded during the run of the dummy tool. The subsequent intelligent inspection tool was launched using the same procedure.



Figure 10: Dummy tool after the run

During the MFL tool run the pipeline operator had about 4m³ of water available, which corresponds to the filling of approximately 50m of pipeline. The fully liquid batch was used to pump the ILI tool from the launcher through the topside piping into the riser. The operator continued to propel the tool with the multiphase product until the conclusion of the MFL run.



Figure 11: MFL tool after the run

The tool was received in excellent condition, the run was successful, the quality and completeness of the data was checked by the field technician and the analysis department in Germany. No significant changes in flow rate or pressure were recorded during the tool run.

Inspection Results

After successful inspection, data was obtained over the entire length of the pipeline. Prior to this inline inspection by 3P Services, no usable data beyond KP 25 was available to the client since the year 2009. Several critical metal loss features were reported downstream of the sequence of subsea installations at KP 25.

A possible verification of reported indications is currently being assessed by the operator.

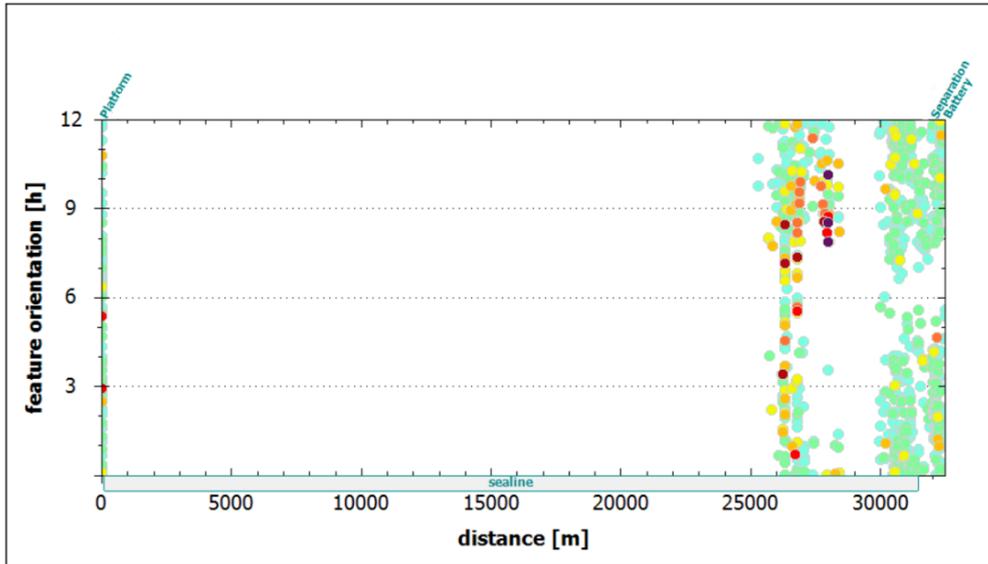


Figure 12. Distribution of external metal loss over the pipeline length and circumference

A number of internal metal loss indications were reported. A trace of metal loss in the bottom half of the pipe can also be observed in the data recorded by the MFL tool.

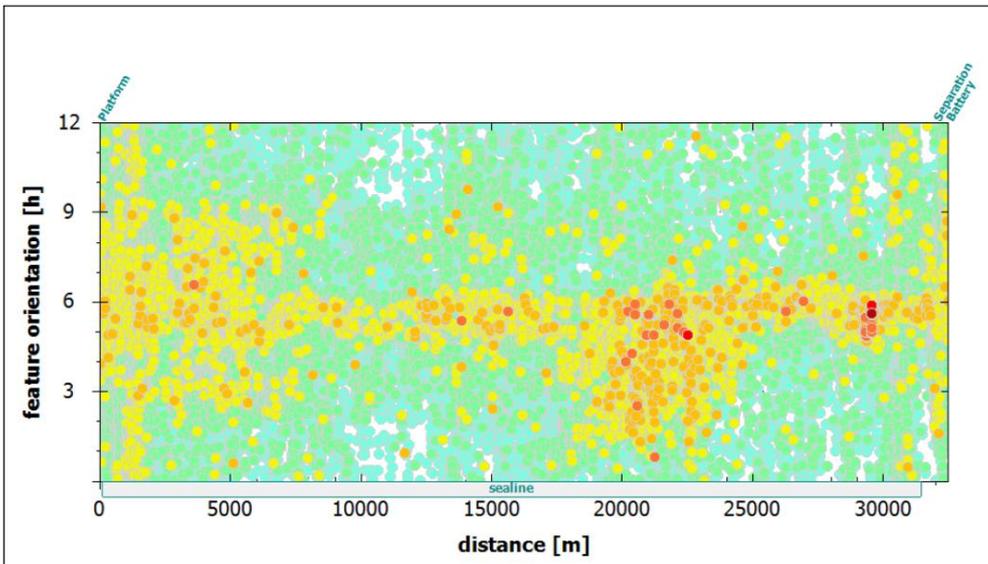


Figure 13. Distribution of internal metal loss over the pipeline length and circumference

The execution of the inline inspection with 3P Services' MFL tool allowed the operator to perform a full integrity management of his asset and take measures to operate the pipeline safely.

Conclusion

Acquisition of new assets can be a challenge for pipeline operators, as in many cases former operators do not enclose every detail of their asset configuration, and often do not document the changes made to their assets.

Not knowing the design and configuration of a pipeline, its fittings and installations leads to navigating the unknown and unexpected.

Based on the investigative information provided by the client, 3P Services designed and assembled a customised intelligent MFL tool for this pipeline which allowed the particular internal geometry of these fittings to be negotiated in conjunction with the offshore pipeline characteristics and provided important information on the integrity of the full length of the pipeline. Due to the installation, this had not been possible during the in-line inspection in 2019.

The close collaboration between 3P Services and the client led to the successful inspection of the pipeline.