Gulf of Mexico Riser Inspection Using a Self-Propelled Ultrasonic Solution

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Abstract

Inspecting offshore risers using in-line inspection technology is generally a complex operation with inherent risks. However, it is particularly challenging when the risers were not built with standard pigging facilities, like launchers and receivers, or the operating conditions don't allow for pigging operations.

In 2024 a major operator in the Gulf of Mexico experienced such challenges in inspecting its risers and therefore approached ROSEN for an alternative in-line inspection solution. The company operates multiple offshore assets in the Gulf of Mexico, however it operates two risers that were deemed as having a risk of external corrosion in the splash zone. Therefore, the operator required inspections of the risers for potential corrosion at the splash zone down to the seabed so that it could take steps to ensure the safety and longevity of these critical offshore assets.

These pipelines are normally used to transport natural gas from subsea reservoirs to surface facilities. Ultrasonic technology (UT) was defined as a potential inspection solution because of the exceptionally heavy wall thickness of the risers; this required the risers to be filled with a liquid medium which, in this case, was decided to be diesel. However, the risers were considered unpiggable due to the following challenges:

- A lack of pig launchers or receivers
- Only a single access point available
- The company preferred not to use external equipment such as pumps and vessels for fluid circulation.

To overcome the challenges and perform high-quality in-line inspections, ROSEN proposed the use of a self-propelled UT tethered inspection solution. This solution allowed the company to proceed with the inspections independent of flow and without performing major modifications to the risers, therefore reducing the risk and integrity expenses. This paper covers the advantages of the self-propelled approach and then describes the implementation of the solution for the offshore risers, including the validation, testing, and execution. It further describes how the cost-effective solution has provided the operator the necessary pipeline inspection data in order to operate the lines in a safe manner.

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Challenge

Offshore risers play a critical role in the transportation of hydrocarbons from subsea reservoirs to surface facilities. Ensuring their integrity is paramount for safe and efficient operations. Effective riser inspection is not just a matter of operational efficiency; it is a critical safety concern. Risers are exposed to harsh environmental conditions that can lead to both external and internal corrosion, particularly in the splash zone, where a riser is constantly exposed to seawater, oxygen, and marine growth. These harsh conditions accelerate corrosion and can compromise the risers' structural integrity, making it a critical area to monitor.

Inspecting risers can be complex due to their remote location, environmental conditions, and the absence of standard inspection infrastructure. For this particular case, a major operator in the Gulf of Mexico requested that ROSEN inspect two of its 8" risers using an alternative method to conventional in-line inspection solutions. The operator wanted to avoid using external equipment like pumps or vessels to circulate fluid, requiring a tool that could navigate the topside and riser without any product flow. The 8" risers also lacked standard pigging facilities, such as launchers and receivers, making traditional pigging operations impossible. With only one access point on the platform per riser, ROSEN had to ensure the tool could be deployed and retrieved safely while maintaining inspection quality. The lack of subsea modifications or extra support equipment made the task more challenging, requiring a solution that could work independently and fit with the existing setup. These challenges are common in older offshore assets and often push the limits of current inspection technology.

Additional challenges that added layers of complexity included:

- **Remote Location:** Access to the risers required specialized logistical arrangements, including the mobilization of equipment and personnel to the offshore platform.
- **Potential Harsh Conditions:** High winds, waves, and variable temperatures posed risks to personnel and equipment. Weather-related delays and potential equipment malfunctions added to the complexity of offshore operations.
- **Thick Wall Material:** The 8" risers' exceptionally heavy wall thickness (1.250-1.500") limited the range of available technologies capable of accurately detecting and sizing corrosion. This presented a challenge in selecting a solution that could balance measurement accuracy with the operational constraint of the inspection.

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Solution

After reviewing the available options, ROSEN determined that a tethered robotic self-propelled tool would be the best solution to overcome the challenges of inspecting the risers. The robotic self-propelled tool consisted of several key components, including the tool train, and is displayed in **Figure *1***:

- **Propulsions Unit:** The tethered, robotic self-propelled tool uses an electro-crawler module (**Figure *2***) to move through the topside and riser sections. This removes the need for flow or pressure in the risers and eliminates the need for auxiliary pumps during the inspection.
- **UT Scanner Module:** The 96 UT sensors mounted in a rigid ring provide high-resolution data for corrosion detection and assessment (**Figure *3***). The UT sensors are calibrated to detect even minor variations in wall thickness, ensuring comprehensive data collection.
- **Odometer Segment:** During inspection, the odometers measure the tool's axial position and triggered probe excitations and data collection, ensuring accurate tracking within the pipeline. This was essential for correlating inspection data with specific riser locations, providing a clear and precise overview of the riser's condition.
- **Transformer and Interface Units:** These facilitate communication and data transmission between the tool and the topside control system, enabling real-time monitoring and control of the propulsion unit, as well as real-time visualization of UT data during an inspection.

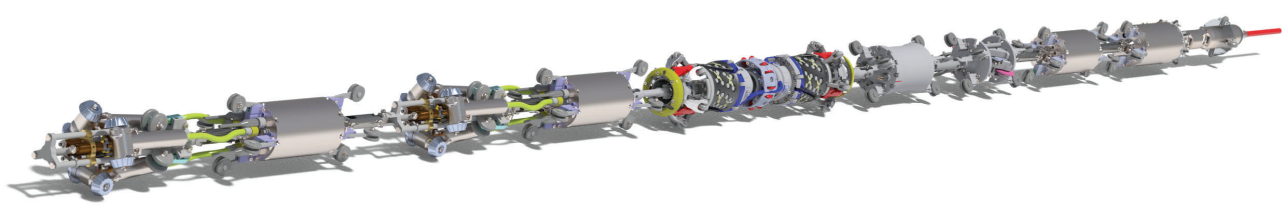

Figure 1: Self-propelled inspection tool

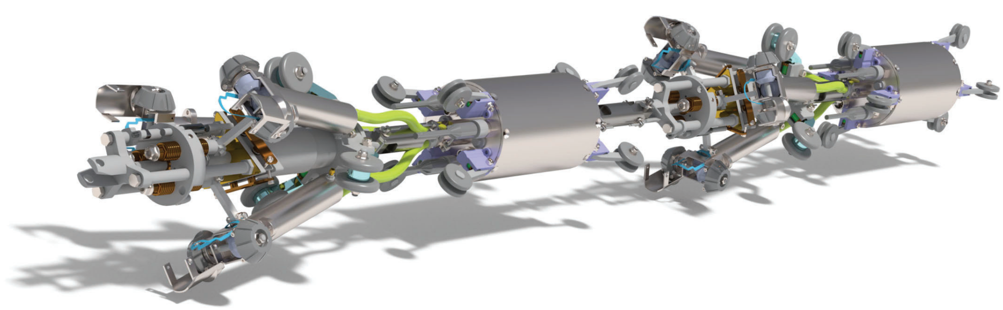

Figure 2: Propulsion unit

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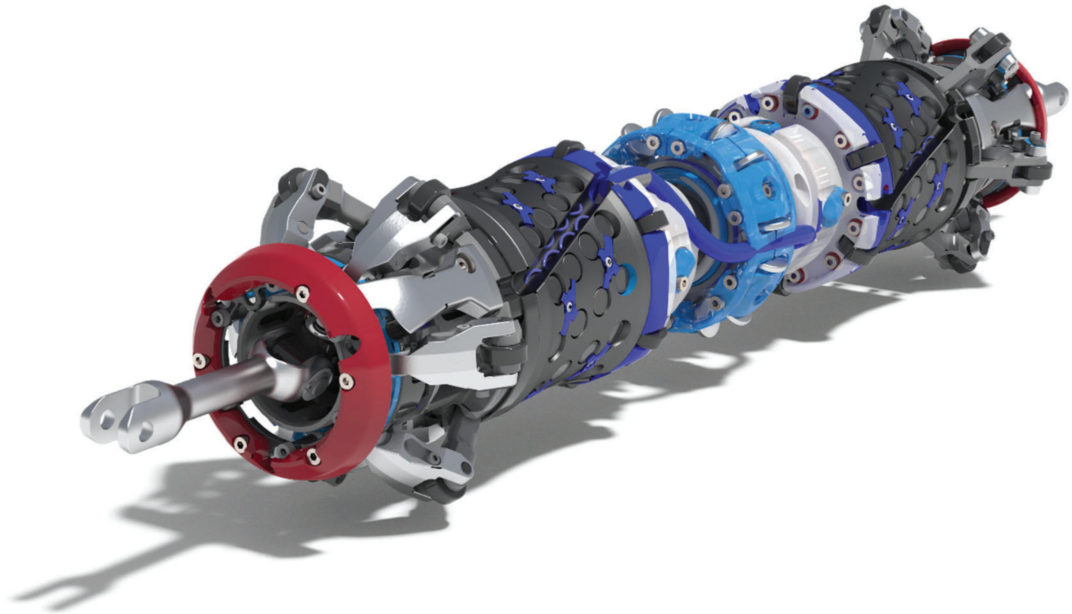

Figure 3: UT scanner unit

The inspection tool connects to an umbilical winch and a topside computer, allowing real-time control and data analysis. This setup has an advantage over free-swimming tools, as technicians can monitor the tool's progress, adjust sensor settings, and perform additional passes if anomalies are found to ensure thorough inspection. The system is shown in **Figure *4***. While a portable office container is preferred for operating the tool, space on offshore platforms is often limited, requiring temporary shelters to be set up instead.

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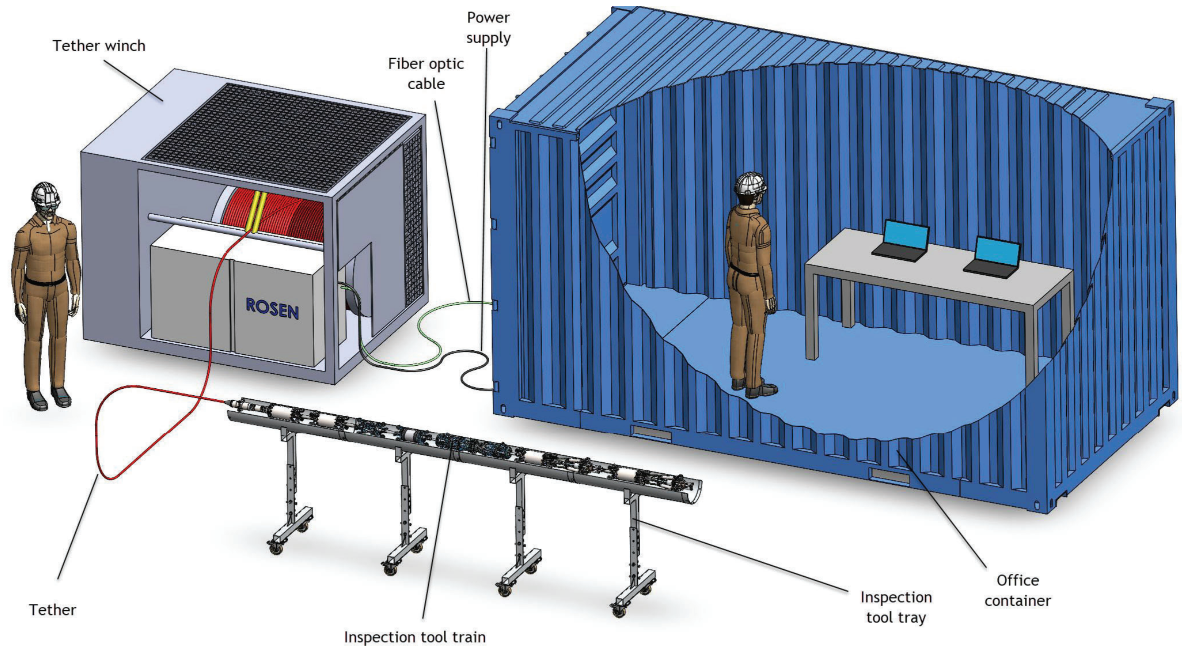

Figure 4: Complete self-propelled system

Based on the technical details of the risers, a design requirement review was conducted with ROSEN's in-house design team. The tool design was tailored to fit the specific riser geometry and installations. Once the design was finalized, the tool assembly began, which included the crawlers, sensor carrier, and wheel plates for all electronic modules. Upon completing the assembly, function tests were carried out according to standard preparation procedures. Below is a summary of the key tests performed:

- Visual mechanical check of all topside and subsea modules
- Upload and verify correct parameter settings
- Sensor alignment and verification tests
- Full-scale test of the UT scanner in test-pipes including artificial defects
- Tool orientation test using the pendulum system
- Odometer rotation test to ensure accurate tracking
- Centralizing wheel and odometer adjustments to fit the internal diameter of the risers
- Confirm the direction of crawler wheel assemblies
- Motor function test to verify operation and measure current drain
- Verify tool pull force and required pull-back force for safe operation

These tests ensured that the inspection tool was properly assembled and fully functional before deployment, minimizing the risk of errors during the actual inspection.

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In addition to the in-house testing, ROSEN conducted a blind test demonstration at a specialized engineering facility near Houston, TX before transporting the equipment offshore. The test pipe, designed to simulate the risers' heavy wall thickness, included artificial defects to validate the tool's performance under realistic conditions (**Figure *5***). A screenshot of data collected during the testing is included in **Figure *6***.

Key Outcomes of the Testing:

- **Reliable Detection:** The self-propelled tool successfully identified artificial defects of various sizes and depths, demonstrating the precision of the UT sensors.
- **Accurate Sizing:** The data collected during the test allowed for detailed sizing of detected anomalies, verifying the tool performance specifications.
- **Operational Readiness:** The blind test validated the tool's mechanical and electronic components, confirming its readiness for deployment.

The testing phase also provided an opportunity to fine-tune the settings and ensure alignment with the specific requirements of the offshore environment. This preparation was critical in building confidence with the operator and ensuring a smooth execution of the offshore inspection.

Figure 5: Test pipe

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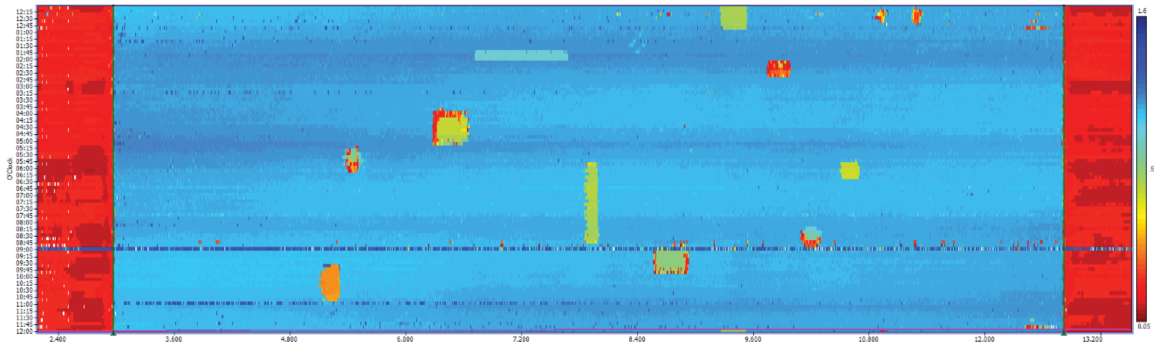

Figure 6: Test pipe data

The offshore inspection took place in Summer 2024. Before the inspection began, the office habitat, umbilical winch, and inspection tool were set up on deck and connected to the offshore power grid for power supply. The inspection tool on the platform is displayed in **Figure 7**. Once everything was in place, final tool testing was carried out. During this time, the risers were filled with diesel, providing a liquid couplant to ensure accurate UT data collection of the pipe wall. With the risers topped up, the tool train was inserted through the topside entry flange of the first riser.

To prevent product egress, a customized blind flange with a feed-through socket was installed on the launcher spool. This temporary enclosure sealed tightly around the cable while maintaining low friction, reducing the load on the crawler and tool train during data collection. Once sealed, the inspection commenced, with the tool navigating through the topside section and riser before reaching its end position at the seabed. At this point, new settings were uploaded to the tool for data collection during the return run, resulting in two complete sets of data. Although the crawler can move in both directions, the tool train was pulled back to topside using the winch, as low pull-back forces were expected. After completing the inspection of the first riser, the equipment was repositioned to begin the inspection of the second riser that was inspected using similar approach. Both inspections were successfully completed in the shutdown schedule.

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Figure 7: Tool on site

Benefit

The project illustrated how the tethered self-propelled tool simplified the offshore inspection by reducing logistical demands and costs. The tool's ability to navigate independently minimized the need for extra equipment, making deployment faster and ensuring the inspection caused minimal disruption to operations. These benefits had both financial and safety benefits for the operator. This inspection method also reduced environmental impact by avoiding subsea modifications or fluid displacement, resulting in a safer and more sustainable process. The precise control provided by the tethered system highlights the industry's focus on responsible practices, balancing efficiency and environmental considerations.

The inspection results gave the operator valuable insights into the condition of the risers, allowing them to implement targeted maintenance. The high-resolution UT data, as shown in **Figure *8***, provided a clear picture of wall thickness variations and corrosion locations, enabling the operator to make well-informed maintenance decisions.

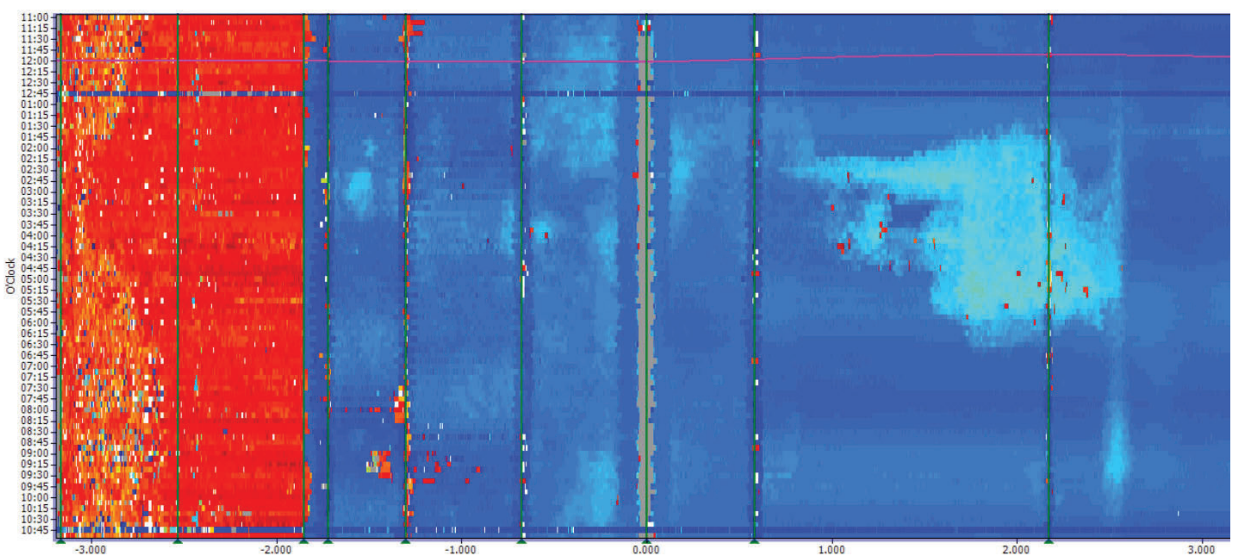

Figure 8: Corrosion in Splash Zone, Riser 1

The success of the project highlighted the value of collaboration and innovation. ROSEN's expertise in creating custom solutions helped build trust in the inspection technology, strengthening the partnership and setting the stage for future projects. The project demonstrated how tailored approaches can address complex challenges, reinforcing trust in both the technology and the team behind it.

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Beyond the immediate results, the project has broader implications for the industry. It shows how advanced inspection technologies can help manage risks associated with aging offshore infrastructure. The tethered self-propelled solution serves as a model for future projects, showing how custom engineering and adaptive strategies can overcome significant constraints and deliver accurate, actionable data for asset management. As offshore operations become more complex, innovative inspection solutions will be critical to ensuring the safety and long-term integrity of key infrastructure. This project also marked ROSEN's first self-propelled offshore inspection in the Gulf of Mexico, expanding the company's services in the region. While this was a first for the Gulf, ROSEN has a proven track record with the same technology, having conducted more than 100 offshore inspections over the past 20 years in areas like the North Sea, Canada, Australia, Asia, South America, and Africa. In addition to its offshore work, ROSEN has built a strong onshore presence in the U.S., inspecting more than 30 pipelines with self-propelled technology since 2018. This blend of global expertise and local experience shows ROSEN's ability to adapt and deliver custom solutions for aging infrastructure across diverse environments.

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