Hydrostatic testing is often the preferred method of inspection for ageing pipelines, sometimes due to limited data. This has raised questions about the ability of inspection tools to successfully navigate the pipeline.

In the case studies presented below, an ultrasonic inline inspection (ILI) was performed in conjunction with the hydrotest. There were two key advantages to this method. First, the ILI was performed while taking advantage of the downtime and water fill associated with the hydrotest. This minimised the operational impacts and associated costs. Second, performing both an ILI and a hydrotest allows for the advantages associated with both inspection methods. This improved the ability to effectively manage risk on the pipelines.
**Project overview**

A large pipeline operator had a significant number of gas lines that required hydrotesting as part of its integrity management programme.

In an effort to minimise the time and cost spent looking for leaks and ruptures, a pre-assessment ILI tool was used prior to strength testing some segments in order to locate potential leak or rupture locations; including metal loss defects, dents, third-party damage, miter bends, taps etc. Quest Integrity was contracted to perform the ILI work using Quest Integrity’s InVista™ ultrasonic ILI technology.

The first step in implementing this new programme involved selecting specific lines that would provide the greatest return to the integrity programme with the ILI tool data. To prioritise the lines included in the pre-inspection programme, a selection matrix was developed. This included variables such as test segment length, vintage of the majority of the test section, history of leak or third-party damage, accessibility and site specific conditions. After accounting for these parameters, the strength test programme ran a pre-assessment ILI tool on 13 tests, totalling 32.5 miles.

**Challenges**

The challenges facing this pipeline operator’s strength test programme were substantial. The company had a significant number of pipeline segments – being conducted simultaneously – to test in multiple regions but also had to maintain utility services to its customers.

When evaluating these segments, each one had its own unique set of problems. Project timing, scheduling resources and downtime were all factors in planning. Additionally, most of these pipelines were ‘service lines’ with varied histories. Some used older construction and repair practices, including miter bends, acetylene welds, chill rings, pressure control fittings and dual diameter nominal sizes. Moreover, in some cases, the only option for ILI was a bi-directional tool due to the pipeline’s configuration limitations.

Compounding the effort was that testing was being conducted in multiple regions within the pipeline operator’s system network. The contractors and sub-contractors used had to be shared between regions. Project managers for each region were responsible for keeping the hydrotest and ILI on schedule and on budget. Good communication and awareness of changing conditions had to be maintained with all contractors and suppliers. Timeframes and planning for each test would vary depending on personnel availability, weather conditions, equipment availability, regional permitting and test results.

The post-ILI processes were also demanding and only a very tight window was given to analyse the results, provide an immediate report, locate and repair any anomalies. After initial data was provided, the results were evaluated and vetted thoroughly in order to determine whether any of the potential defects would or could fail the hydrotest. If anomalies need to be targeted or repaired, these excavation locations were located using ILI GPS co-ordinates. The potential failure points were marked above ground, excavated and repaired, where required.

**Benefits**

The benefits of incorporating an ILI programme while conducting a hydrotest are plentiful. The couple of additional days required for an ILI provide pipeline operators with an abundance of new and current information about their assets. The additional information and data, in turn, helps to develop a longer term strategy for managing the entire integrity programme. The information also adds value and assists in remediation and repair planning cathodic protection effectiveness, MAOP evaluation, pressure ratings review, updating alignment sheets and segment records, and integrity management budgeting and planning.

The programme also benefitted from having a documented ILI pigging plan for tackling each section. With each section having unique challenges, having experienced onsite ILI personnel to provide support and guidance was critical. This minimised and prevented delays to the strength test programme schedule by diminishing the line configuration/ILI compatibility issues, segment cleaning questions and lowering the potential of stuck tools. Furthermore, onsite personnel could assist in managing a dynamic and changing schedule. The ILI was only a small part of the overall strength test programme. The availability of ILI personnel to discuss and manage schedule changes helped keep the programme on track.

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*Figure 1. A corrosion anomaly.*

*Figure 2. Crew launching Quest Integrity’s ILI tool.*
With most pipeline operators, failing to maintain the 'on-the-shelf' assets that are required for pigging and with the majority of hydrotest contractors not having pigging equipment compatible with ILIs, a unique support package was developed for each segment. This package included ILI pigging barrels for launching and receiving ILI tools and cleaning pigs. Valves, pressure gauges, tracking equipment and personnel were also included in the package. Each pipeline had unique elevation changes, low pressures and special configurations, which demanded the use of customised batching pigs that were specifically tailored to each segment.

The pipelines tended to be located in 'high consequence areas' with high population densities. Some lines had dramatic elevation changes with multiple pipeline diameter transitions. The availability of water and storage as well as the need for consistent flowrates required batching procedures that were developed to minimise risk and manage batch speeds. Section planning also included strategies for AGM deployment, including identifying appropriate locations, GPS surveying, development of maps and marking the sites.

Case study one

Line details
This first strength test involved a dual diameter pipeline of 6 in. x 8 in. It was 4.82 miles in length and had numerous wall thicknesses, including 0.172 in., 0.188 in., 0.280 in. and 0.322 in. The line was split into two segments based on the line conditions, which required two hydrotests and ILI runs.

Line challenges
One of the principal challenges for this pipeline was that the as-built documentation on the section was limited. While PCF fittings and miter bends were known to be in the line, their exact location and number had not been confirmed. Bends within the line had the potential to be mitered at varying degrees. The dual diameter nature of the project added to its complexity with regards to inspection, flowrates and pressures. The pipeline had a dramatic elevation change with a low point of 456 ft and a high point of 1370 ft. The hydrotest contractor had limited experience with conducting an ILI and did not have adequate ILI assets for facilitating the ILI launchers and receivers. Scheduled compliance and timing were critical to the project’s success and the return-to-service date needed to be worked towards closely.

Solution and results
A comprehensive and documented plan, which took into account all stakeholders and their concerns, was created. A strategy was developed starting with configuring the line for ILI, which included launching and receiving barrels, pumping/flow considerations and a batching programme. A pump was selected based on the flow or speed requirement for the batch pigs and ILI tool. Additionally, the pump had to provide an adequate head pressure in order to compensate for the elevation changes and differential pressure requirements for the batching pigs and ILI tool, as the flow must be continuous and consistent for the entire process.

Quest Integrity’s ultrasonic ILI tool – InVista – was selected based on its unique navigational abilities. The procedure that was created also included the type of batch pigs to run, the amount of water between pigs, the flowrates, head pressure to be expected and the launch and receiving sequence.

The line segments were inspected with detailed datasets provided. During the inspection, the batching process was monitored and the pigs were tracked.

The results were evaluated and a list of anomalies to be investigated was created. Using the rapid GPS service, these locations were identified for evaluation, excavation and repair. The total timespan from the completion of the ILI, through data analysis to GPS locating of anomalies, was less than 48 hrs. The strength test was completed and the line then returned to service.

Case study two

Line details
This second strength test involved a 10 in. pipeline. The line segment was 2.97 miles in length and had numerous wall thicknesses, including 0.219 in., 0.250 in., 0.281 in. and 0.312 in. The line also included tight bends and some potentially unknown fittings.
**Line challenges**

This line had many unknowns, ranging from potential miter bends to old service taps. The mitered bends had unknown angles and radiiuses and the taps were located at various points along the pipeline. However, the exact locations were unknown. This pipeline was located within a city and ran under city streets. Additionally, it was operating in environmentally sensitive areas. Limited work space, city permitting and traffic control were additional logistical issues that had to be overcome. As with any project, timing was critical to complete both the testing and return-to-service, but city permitting limited working hours and road closures. Regional hydrotest contractors had limited ILI experience and, as such, ILI expectations and requirements had to be reinforced during the project planning and execution phase.

**Solution and results**

Project planning was critical. Having a comprehensive and documented plan was essential for success. A strategy was developed by the operator, the local general contractor, Quest Integrity and the municipality to conduct the work within a given timeframe.

The inspection was completed and the data evaluated for potential leaks or repairs prior to the hydrotest phase. After the data was evaluated, it was determined that no repairs were necessary prior to the hydrotest. The hydrotest was conducted and a pressure drop was detected. Using the ILI data, GPS co-ordinates and identifying all of the areas with significant metal loss, the client was able to locate and test each point for a potential problem. Using a tracer gas leak detection process, the likely locations were pinpointed, probed and ruled out, which helped to expedite troubleshooting.

**Conclusion**

The pre-inspection initiative adopted by this operator was a key component of the overall integrity programme. The added cost and time was minimal compared to the knowledge gained about the pipeline. Initially, the goal of this programme was to identify potential areas of concern prior to the execution of strength tests. However, the additional value of running an ILI in conjunction with a strength test (hydrotest) programme has proven to be great. Particularly for lines with limited records, the information assists with updating alignment sheets, confirms segment nominal pipe thicknesses and segment lengths. It also assists in remediation and repair planning, cathodic protection effectiveness, MAOP evaluation and pressure ratings reviews. The information can also be used throughout the organisation for generally enhanced decision-making, in areas such as integrity management, budgeting, new construction and statistical analysis.