ADVANCEMENTS IN PIGGING VALVE & ULTRASONIC TOOL TECHNOLOGIES ALLOW FOR IN-LINE INSPECTIONS OF FORMERLY UNPIGGABLE LINES

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DISCLAIMER

ABSTRACT

On occasion, the value of multiple technologies integrated together can be greater than the sum of their individual parts. When pigging valves were first introduced into the pipeline industry, they offered a novel approach to improve convenience and safety in maintenance pigging programs. Prior to their acceptance in the industry, the only permanent solution for a pigging program involved a substantial footprint on launcher and receiver barrels, which themselves became an idle integrity concern when not in use. Both remote and densely concentrated areas struggled with the infrastructure required for a traditional launching barrel; however, pigging valves solved this dilemma in an affordable manner.

Due to their compact chamber size, pigging valves could not accommodate traditional In-Line Inspection (ILI) tools. Pipeline assessments were limited to traditional methods rather than in-line inspections which would collect a complete wall thickness and geometry profile. Without the ILI inspection, there was a possibility of leaving anomalies undetected.

For the past several years, pipeline operators have been working to address this challenge and have partnered with ILI and valve providers to gain new knowledge and develop working solutions to overcome pigging valve limitations. This paper will present a case study in which modern technologies and technical collaboration led to the execution of a complete pigging program on a previously unpiggable line. This case study will explore the use of custom cleaning pigs and ultrasonic ILI technologies to successfully launch and receive through 8" pigging valves. The combination of pigging valves and ILI technology significantly expands the reach of maintenance and internal integrity programs beyond the reach of what either technology could achieve alone. Technical experts from both the pipeline operator and ILI tool provider will partner to present the inspection methodologies, implementation, and assessment results of this unique inspection.

INTRODUCTION

For decades, pipeline operators have implemented stringent maintenance pigging programs to ensure pipeline cleanliness, optimal product throughput, and pipeline integrity. While these pigging programs have been successful in allowing pipelines to uphold performance standards, the ability to inspect these pipelines using in-line inspection technologies was not possible.

When pigging valves were first introduced into the pipeline industry, the standard approach to maintenance pigging programs drastically changed. These pigging valves offered a safer and more straightforward way to insert cleaning pigs into a pipeline. These traditional pigging valves, however, were not designed for multiple-module tool passability. In addition, traditional in-line inspection tools were not compact enough to fit within the small chamber of the pigging valves. As a result, several pipelines remained unable to be inspected by traditional ILI technologies. Ideally, a maintenance pigging program that incorporates effective in-line inspection would allow for a more holistic approach to pipeline integrity, extending the life of the pipeline while dramatically reducing the risk of failure. Nevertheless, many logistical and practical impediments have, until recently, made the execution of a maintenance pigging and ILI program challenging to achieve.

THE NEED FOR A SOLUTION

While conventional pigging valves have allowed operators to implement safe and effective pipeline cleaning practices, many have not been able to fully utilize an in-line inspection element within their maintenance pigging programs. However, a number of factors have placed an ever-growing need for pipeline operators to find a viable solution to allow the inclusion of ILI.

Previously Installed Infrastructure & Common Problems in the Industry

Until relatively recently, most of the global pipeline infrastructure had not been designed for in-line inspection. With the older pipeline infrastructure, several issues prevented utilization of ILI tools. Line characteristics such as tight or even mitered bends, unbarred laterals, diametrical restrictions, multi-diameter segments, lack of launching and receiving facilities, etc., precluded passability and utilization of modern inspection tools. Conversion of the lines by eliminating these impediments could be costly, dangerous, or even impossible. There may be limitations on areas available for trap facilities. Line restrictions could be located in areas difficult to access by a construction team. Elimination of the restrictions could require removal of the line from active service for an extended period of time. As a result, assessments continued to be limited to traditional inspection methods to ensure pipeline integrity. Since corrosion never sleeps and the assets continue to age and deteriorate to varying degrees, industry desired a better method of integrity assurance for such lines.

Incidents and Consequences

The goal of every operator should be to operate their assets without incident. Nonetheless, history has shown that this does not always happen. With every incident, there are predictable consequences: public concerns for increased safety, reputational damage, high remediation costs, potential for enforcement and associated fines, and potential litigation to name a few. As time continues, these consequences seem to increase in severity for the industry. There is a need for more efficient inspection solutions for pipelines that either have never had a maintenance pigging or in-line inspection program, or have had sound maintenance pigging programs, but were not able to fully utilize in-line inspection techniques.

Changing Regulatory Pressures

Today's pipeline regulations have considerably changed the way operators approach pipeline integrity. For example, the US Pipeline and Hazardous Materials Safety Administration (PHMSA) updated its classifications of high-consequence pipelines, placing more stringent requirements on pipelines transporting potentially hazardous product. The Code of Federal Regulations *Part 195 - Transportation of Hazardous Liquids by Pipeline*, lists internal inspection tools as an appropriate method of integrity assessment [1]. California Government Code 51013 (b) also requires all new pipelines built to accommodate the passage of in-line inspection tools [2]. The regulatory body for pipelines in California is now required to conduct inspections of all pipeline operators and their pipelines annually. Finally, acquiring detailed information about line integrity, beyond what can be gleaned from a hydrostatic test, allows operators to find and resolve issues early, thus avoiding incidents and promoting continued safe operations.

TRADITIONAL PIGGING PROGRAMS & POTENTIAL LIMITATIONS

Traditional maintenance pigging programs have allowed for cleaning pigs to navigate pipelines, but challenges remain depending on which pigging program an operator utilizes for their pipeline. One option when applying a maintenance pigging program is the permanent installation of traditional launcher and receiver barrels. This has been problematic for a number of pipeline operators, however, due to the considerable amount of space required to accommodate a traditional launcher barrel. In many cases, 20 feet or more is required for the installation of launch/receive facilities, which can be challenging to realize for pipelines in areas where very little space is available. To circumvent these spatial constraints, most maintenance pigging programs use short launcher barrels that can be as short as 5 feet in length. Although this alleviates some constraint issues, it also limits the tool type and size that can fit into the launcher, making traditional ILI very difficult and challenging. Traditional permanent launching facilities also add infrastructure to the pipeline asset, which then also needs to be maintained long-term, and adds an additional element of potential risk.

Another approach used to implement maintenance pigging programs is the installation and dismantling of temporary launcher and receiver barrels. This can be an effective methodology for maintenance pigging, but often includes significant interruptions to normal operation. In many cases, the installation and dismantling of temporary facilities can turn a days-long project into a weeks-long project. Due to the considerable efforts and extended downtime associated with temporary launcher/receivers, this option can be considered extremely tedious, albeit necessary.

While a few options are available to conduct maintenance pigging, none of these options allows for an in-line inspection to be conducted in conjunction with a pipeline cleaning pig run. For years, operators struggled with this challenge, until a potential solution was developed – the permanent pigging valve coupled with miniaturization of electronic components in a small format ultrasonic ILI tool.

POTENTIAL INTEGRITY VERIFICATION & INSPECTION TECHNIQUES

Piping systems within facilities are usually inspected per the criteria specified in API 570 "Piping Inspection code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems" and other applicable laws and regulations [3]. They can also be inspected via Direct Assessment, Hydrostatic Pressure Testing, Guided Wave Ultrasonic Testing, or In-Line Inspection. In-Line inspection is one of the most efficient and accurate ways to inspect the integrity of a piping system or pipeline. Other forms of inspections are valid, but may not give as much information or are limited in application for a piping system or pipeline.

Direct Assessment

Direct Assessment is a four-part program in which all four parts must be completed to be considered a valid test method. The four parts of a Direct Assessment program are spelled out by National Association of Corrosion Engineers (NACE) and

American National Standards Institute (ANSI) via ANSI/NACE SP-0502 "Pipeline External Corrosion Direct Assessment Methodology" and are Pre-assessment, Indirect Inspection, Direct Inspection and Post-assessment [4]. Direct Assessment is usually used for underground pipeline systems where engineering analysis is a large portion of the initial two steps. Then multiple locations are selected to be directly assessed via non-destructive evaluation such as ultrasonic testing. The final step brings all the information gathered and inspection reports together to provide a final assessment of the line. The downsides of Direct Assessment are that (i) only a small number of locations are inspected directly, (ii) the timeframe to conduct this inspection is extended due to data gathering, (iii) it requires additional resources to conduct the data gathering and engineering analysis, and (iv) only a small portion is inspected so the remainder of the line remains un-inspected. For facility piping this is an extensive process and key elements could be missing during the process such as material properties, installation dates, or previous inspections.

Similar inspection criteria to Direct Assessment would be the API 570 "Piping Inspection code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems" criteria. The criterion is tailored for inspection of facility piping and follows the Direct Assessment methodology. The potential drawbacks associated with API 570 criteria are similar to Direct Assessment in that only a small fraction of piping is directly inspected via Non-Destructive Evaluation.

Hydrostatic Pressure Testing

Hydrostatic Pressure Testing is another test methodology common among pipeline systems. It allows for the system to be pressure tested for four to eight hours depending on the characteristics of the pipeline. The advantage is that the entire system and all potential flaws are pressure tested over its normal operating pressure while holding that pressure for an extended period of time. However, this only proves the integrity of the pipeline or piping system at a specific moment in time. Also, the system is tested in water which is a corrosion mechanism. For a crude system this might not be as much of an issue; but, for a refined products terminal water can be catastrophic for quality assurance and control. Not to mention while conducting the test, the terminal (or at least the piping system) must remain down between four to eight hours. If multiple systems need to be tested, then multiple outages will have to be taken to test the whole terminal. This is a heavy disruption to facility operations.

Guided Wave Ultrasonic Testing

Guided Wave Ultrasonic Inspection is a Non-Destructive Testing method which allows inspection of large segments at one time. This method can be used on underground or aboveground piping but has distance limitations on how much linear piping is inspected per guided wave acoustic shot. The inspection is also limited by the geometrical characteristics of the piping system. A system with multiple 90-degree bends will not be able to traverse as far a straight linear run. The acoustics of the inspection can also be impacted by the coating, soil or laterals off the piping system. The main drawback with Guided Wave is that all inspections need to be proved with traditional ultrasonic testing because Guided Wave only gives qualitative data, not quantitative. Potential cost savings could be negated with repeated inspection over the same area of the guided wave inspection.

In-Line Inspection

Magnetic Flux Leakage (MFL) and Ultrasonic (UT) in-line inspection, also commonly referred to as "smart pigging," or "intelligent pigging," are in-line inspection technologies that use indirect and direct measurement of the pipe wall, respectively, to identify potential defects. Utilizing up to hundreds of sensors, these tools travel the interior of a pipeline, taking measurements of geometry and metal loss features.

Ultrasonic in-line inspection technologies provide considerably more inspection data than most integrity verification techniques. Rather than taking approximate measurements of pipeline defects, ultrasonic inspection tools take absolute wall thickness measurements, providing exact damage calculations, rather than estimations. Because of this, ultrasonics are considered a hugely reliable inspection method for pipeline data collection.

While ultrasonic inspections are the most comprehensive of the inspection and integrity methodologies available to a pipeline operator, such inspections are also the most invasive. Unlike other methodologies, this Non-Destructive Evaluation (NDE) technology must be physically inserted into the lines. Until recently, this either involved expensive permanent launcher and receiver locations with an expansive industrial footprint, or a temporary launching solution that required the line to be out of service for a given length of time.

RESEARCH FOR MAINTENANCE PIGGING PROGRAM OPTIONS

Although the pipeline industry has been using hydrostatic pressure testing method on unpiggable lines for years, it has desired a more advanced method to distinguish anomalies in pipelines. According to the pipeline industry's collective experience, ILI has always been the most efficient way to identify defects in the pipeline. However, several impediments precluded industry from using modern assessment technology. Andeavor's research for a solution to this dilemma led Andeavor to Argus Machine, who were primarily being used for maintenance pigging in remote, upstream locations.

Andeavor was researching ways to maintenance pig their facility lines with Quest Integrity when Argus became part of the discussion. Andeavor questioned whether it was possible to expand the scope of the maintenance pigging effort and develop a pigging-valve-compatible ILI tool to conduct a full ILI assessment. Once Andeavor was committed to installing Argus valves, Quest Integrity started working on a single-module tool. To facilitate the ILI tool development, Argus Machine loaned Quest Integrity two 8" Pig Valves to ensure that the ILI tool design and geometry functioned seamlessly with the pigging valve.

Pigging valves have been around for almost 50 years. These valves have been installed on numerous lines around the world and have been successful in running various types of maintenance pigs. Argus pigging valves are very simplistic in operation as compared to the usual trap facilities. Their simplicity and ease of use contributes to increased frequency of utilization and safe operation. In addition, the footprint required for these pigging valves is far less than the barrel style launcher, allowing for applications where traditional facilities would not be possible.

FACILITY CHALLENGES FOR TRADITIONAL MAINTENANCE PIGGING PROGAM

Traditionally, industry pipeline facilities and logistics terminals do not have internal maintenance pigging programs. The main issues are that facilities have limited available space, additional maintenance is required for the launching and receiving equipment, heavy process interruption, high cost of initial installation, restrictive line characteristics, and the availability of other methods for inspection.

For most facilities, space is limited. Space used for 20-foot launcher and receiver barrels could be space used for additional assets for a terminal or space needed to complete facility maintenance. Another option is a 5-foot launcher barrel and receiver, but the traditional in-line inspection tools will not fit and would still require a complete skid install. In most cases, a launcher and receiver are not going to be practical to install inside a facility because operators would need multiple receivers and launchers for numerous lines. Argus valves, as shown in Figure 1, are an in-line solution which do not take up additional area. They can be installed in tight areas and need only small modifications to existing piping systems.

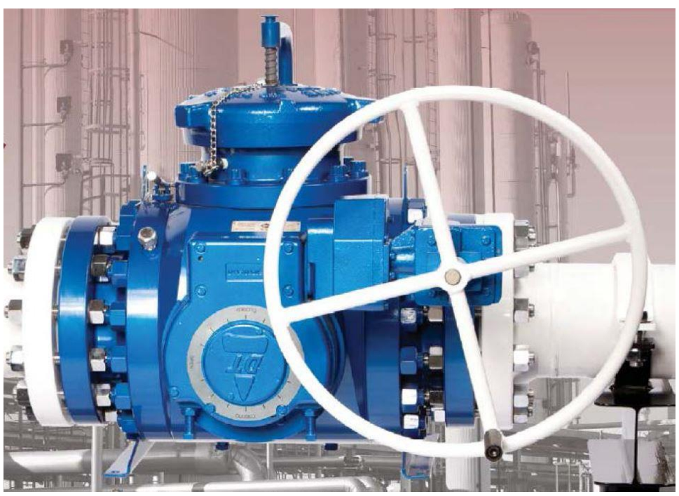

Figure 1: Argus Pigging Valve [5]

If traditional traps (launcher and receiver) were installed, they would also need to be maintained. Since the system cannot itself be inspected via in-line inspection, additional inspection would need to be conducted on the launchers, receivers, valves and piping. This would drive up the costs for individual facilities, depending on the number of traps installed. The Argus system, on the other hand, employs only two valves, which simplifies installation and eliminates any costs for valve inspections.

The biggest impact to a facility with a traditional maintenance pigging program would be the disruption to operations. Conducting a pig run, whether it is a maintenance or a smart tool run, is not a simple process. At the minimum it requires field verifications, initial Lock Out Tag Out (LOTO) to open the launcher and receiver, removing LOTO and finally returning to normal operations. This does not include any company specific tasks that may be needed to be completed while conducting a pig run. On the other hand, Argus valves are double block and bleed valves, so they can serve as their own LOTO which simplifies the process. Once the valve is closed, the pig is inserted into the valve cavity, and once the valve is opened, the pig is launched to start the run. It is as simple as opening and closing a valve.

This innovative, double block and bleed valve has several benefits where it has the capacity to:

- Optimize production and mitigate corrosion through rapid and effective liquids sweeping and debris removal via maintenance pigging
- Reduce emissions by more than 80% compared to traditional launching method
- Reduce the space required for pigging facilities due to a significantly smaller footprint
- Decrease field construction time due to reduced requirement for infrastructure
- Minimize training and maintenance costs due to functionally simple design
- Reduce the number of valves required in the pigging facility as the double block and bleed construction facilitates use this as a traditional block valve
- Enhance safety for operations personnel with non-impact cap and wrench
- Adapt to batch, corrosion inhibition programs

Although there are several benefits in using this technology, some limitations were also considered:

- Limited Pig Selection
    - Not all kinds of cleaning pigs can be used, simply because of space limitations within the valve cavity
- Limited Debris collection
    - This kind of system only works for a true maintenance program. For lines with heavy debris, the valve cavity's limited space may not allow for adequate debris collection.

One of the biggest challenges for installing conventional maintenance pigging equipment into a facility is the high cost of installation. Traditional pigging equipment is an engineered design system and is unique to every piping system. They all have similar components, but every piping system is different and requires engineering analysis on a case by case basis. Engineering design for the traditional pigging equipment can encompass the initial location to place the skid, radius of any bends off the skid, foundation design, pipe class, return or pump back lines, system characteristics, and product characteristics.

SELECTION OF THE LINE

The pipeline Andeavor selected is an 8-inch diameter line, installed in 1961. It transports oily water between two of Andeavor's facilities in California, as shown in Figure 2. It is 2,007 feet in length, with a Maximum Operating Pressure (MOP) of 720 PSI. The Normal Operating Pressure of the line, however, is only 50 PSI.

This line was considered for this application for several reasons. First, as noted previously, the line had been in service for several years with the oldest section installed in 1961. Although the line had passed several hydrotests in the past, recently completing a test at 1080 PSI, there was a desire to obtain an additional assurance of integrity to ensure continued safe operation. Second, although the line is short in length, it traverses through or near several high consequence areas (HCAs) and busy streets and highways. Third, the line is buried in soil with a high water table. Fourth, it has low, non-turbulent flow of oily water which can allow Microbiologically Influenced Corrosion (MIC) to form. Fifth, the line had never been pigged before, having always been assessed with a hydrotest. Configuring this line to at least initiate maintenance pigging to remove debris, build up, and potential MIC was very desirable. Finally, the line characteristics were amenable to ILI conversion with its short length, single diameter, and no laterals.

PIGGING VALVE INSTALLATION

The first step of the Argus Valve installation was determining where to install the launcher and receiver valves on the chosen line.

Figure 2: Selected line for Argus Valve Installation

At the shipping terminal, the engineering team identified two locations for the potential installation of the Argus system, one inside a vault and one outside the same vault. Due to limited space in the vault and its depth, the team decided to install the valve outside the vault above ground as shown in Figure 3.

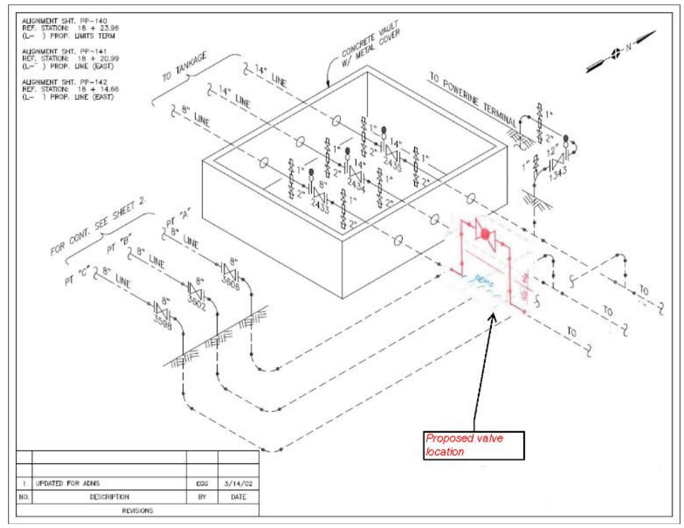

Figure 3: Launching Valve Location above Vault

For the receiving location, a small modification was completed on two 45-degree bends to allow for proper mechanics of the valve and ergonomics for the operators. This is denoted by the model in green in Figure 4.

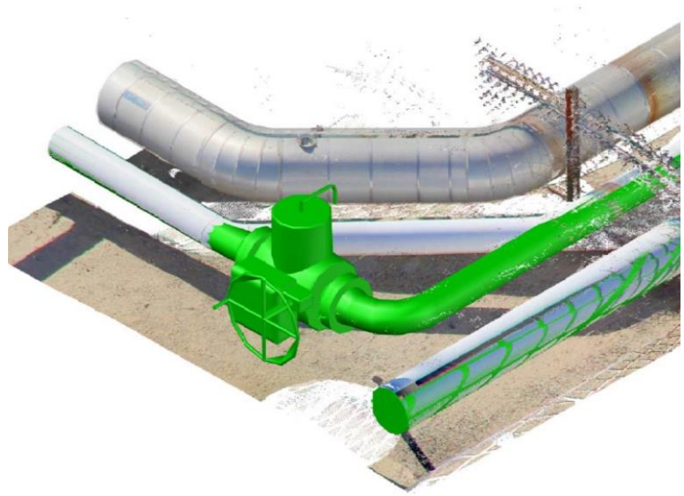

Figure 4: Receiving Valve Location with Modification

With the locations determined, the configuration required two spools to be fabricated offsite per company standards. After the spools were installed, the entire line was hydrostatically tested to validate the tie-in welds.

OPERATION OF VALVES

The Argus valves are operated in 6 steps for launching and receiving pigs. The 6 steps for launching are shown in Figure 5. The steps for receiving are the same, but in reverse.

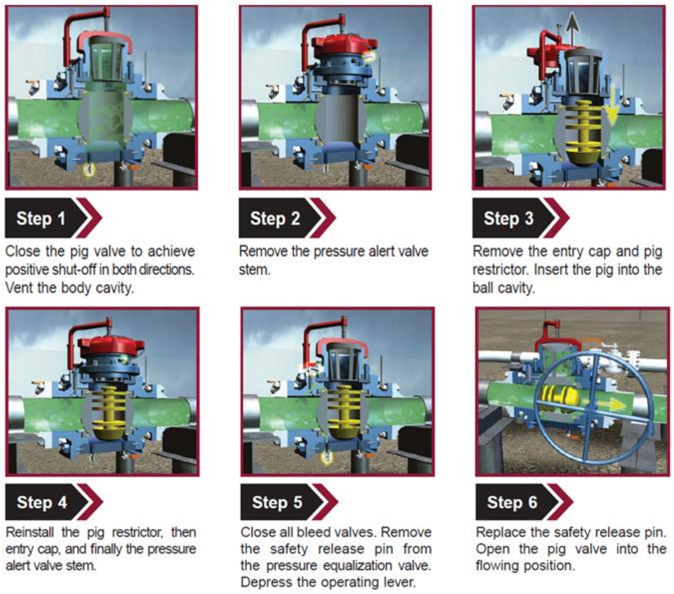

Figure 5: 6 Steps of Launching/Receiving an Argus Valve [6]

ULTRASONIC ILI TECHNOLOGY DESIGNED FOR PIGGING VALVES

The small cavity length and nominal pipe diameter of a pigging valve has been the primary hindrance for traditional MFL and ultrasonic In-Line inspection tools making use of the transformative technology beyond maintenance pigging applications. Both the length of the tools and the diameter of the driving cups needed to pull the weight of traditional technology have prevented these tools from being launched or received in such a unique manner. The In-Line inspection technology for this project was designed specifically to fit in the cavity of a pigging valve.

InVista™ is an automated bi-directional inspection technology used to carry out the inspection of Nominal Pipe Size (NPS) 2-inch (DN 60) to 24-inch (DN 600) pipe. Applying non-contact ultrasonic technology, InVista obtains internal bore dimensions (radius/diameter) and pipe wall thickness measurements. The tools contain onboard electronics which digitize and store the data samples during the pipeline inspection. This technology enables in-situ location of pipeline features, such as valves, tees, repair patches, etc., as well as the identification and dimensioning of pipeline anomalies, such as corrosion, erosion, wrinkles, pitting, denting, bulging, and ovality.

Known in the industry for being a light and flexible technology that is propelled through flow rather than a pressure delta, the 8” InVista technology had to be specially rebuilt from a three-module tool down to a single module; a form which is similar in shape, length and weight of the specialized cleaning pigs designed for the Argus pigging valve. As such, Quest Integrity’s engineers were able to combine the onboard electronics into a compact single-module design, while maintaining the data resolution and navigational capabilities.

Features of this technology include:

- Complete overlapping coverage of pipeline geometry and pipeline metal-loss features in a single pass
- Navigates back-to-back bends with >90° short radius turns
- Navigates bore restrictions, step changes
- Lower pressure differential requirements function in low flow or limited flow conditions
- Identifies significant wall thickness changes and pipeline wall loss
- Accommodates single entry/exit, line stoppage, plugged valves
- Traverses bottom unbarred tees, wyes and miter bends
- Lightweight, hand-held intelligent pig reduces safety and operational risk
- Ultrasonic inline technology measurement delivers accurate, repeatable results

The significant effort of miniaturizing a tool into a fraction of the volumetric space was not without trade-offs. Specifically, battery space is necessarily limited. Current battery and processing thresholds give the present 8” design a range of up to approximately 18 miles. Rather than using odometer wheels to track distance measurements, the single module technology tracks velocity throughout the run to tie location to the features in the data. Finally, during the inspection run the tool must be immersed in a single-phase liquid with good sound propagation properties. Water is a common liquid used, but the immersion ultrasonic transducers can perform the inspection in a variety of homogeneous liquids such as seawater, diesel, kerosene, gasoline and certain types of crude oil.

TOOL SPECIFICATIONS AND PERFORMANCE

Prior to the performance of the ILI inspection, a detailed review of the newly designed tool’s specifications and performance was performed. The 8-inch single module inspection tool was proven to accurately collect inspection data while operating within a pipeline featuring a pigging valve. This verification process was conducted by comparing the inspection data of the new 8-inch tool with the data collected by a standard 3-module ultrasonic inspection tool that exhibited proven defect detection results. Both ILI tools were run through a pipeline test loop with known defects. The 8-inch single module tool identified and measured all defects within the pipeline test loop and was verified by the inspection data collected by the proven 3-module ILI tool (see Figure 6).

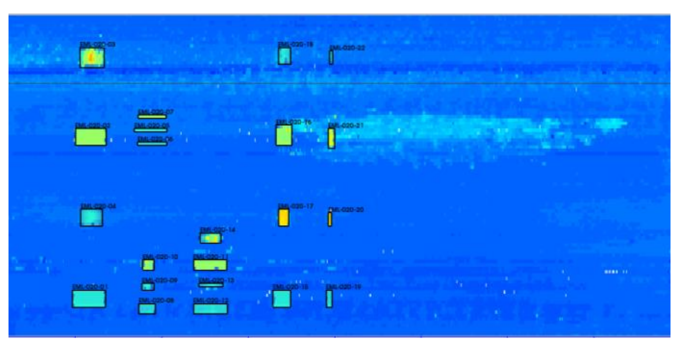

Figure 6: Inspection data for 8-inch single module tool matched the POI and POD capabilities of the proven 3-module tool.

Provided the InVista technology operates below its maximum recommended velocity of 6.00 mph (2.68 m/s), the below table identifies the sizing accuracy of both metal loss and geometry features in the pipe wall, weld and HAZ (see Table 1).

The POD of the Quest Integrity inspection tool fleet has been verified by multiple blind tests conducted in partnership with pipeline operators [7], as well as comprehensive in-house testing to verify 90% POD.

Wall Thickness Depth Sizing Tolerance	0.64 mm
Dent Depth Sizing Tolerance	0.381 mm
Length Sizing Tolerance	9.5 mm
Width Sizing Tolerance	9.5 mm
Minimum Area for Sizing (POD >=90% with wall loss >=0.64mm)	161 mm^2 (Based on minimum resolvable anomaly dimension of w=12.7mm and l=12.7mm)
Dent Depth at POD = 90%	0.5%
Ovality at POD = 90%	1.0%
Axial Location Accuracy (from nearest ref.)	1.0% - dependent upon flow conditions
Circumferential Location Accuracy	5°
Direct wall thickness measurement range: 1.27 mm – 50.8 mm	

Table 1: Tool specifications and POD for the InVista 8-inch single module tool.

FIELD EXECUTION

To test the functionality of the Argus pigging valves, and the passability of the line, Andeavor planned to initially run several maintenance pigs through the line. As shown in Figure 7 below, from left to right, the first two pigs were low density foam pigs, followed by a medium density foam pig, and then a poly pig. The first low density foam pig run yielded a torn, damaged pig saturated with oily debris. With every subsequent pig run, there was a reduction of debris in front of the pig. The photos of the runs were sent to Quest Integrity to verify that the line was ready for a smart tool. Once the poly pig (last pig on the right) emerged with acceptable abrasion and continued reduced debris in the front, Quest Integrity analysts were confident that the tool with 25% tool/ID clearance would pass. Line cleanliness was also examined and accepted by Quest Integrity to ensure the line was clean enough to obtain good ILI data.

Figure 7: Maintenance Pigs

This maintenance pigging practice was able to clean the line and remove about 50 years of debris build up, enhancing line integrity. This created a clean passage for the Quest Integrity UT smart tool. Now, it was time to conduct the ILI assessment of the formerly unpiggable line. The test plan called for a maintenance run with a poly pig to ensure that the line was clean before running the smart tool. Furthermore, there was a contingency plan in place to run the Quest Integrity tool a second time in case the data was not acceptable.

The poly pig completed the cleaning run from one terminal to another in about 10 minutes with no issues. Due to the length of the run being so short and the line's location, no Above Ground Markers were used to track the pig. Several minutes later, the smart tool was launched and received in about 9 minutes with no issues. Quest Integrity analyzed the data in the field and confirmed the captured data met the acceptance criteria. As the smart tool was launched, traversed the line without getting stuck, was received, and the data was acceptable, the ILI run was considered a success. There was no need for a contingency run.

IN-LINE INSPECTION RESULTS

The modified Quest Integrity InVista in-line inspection tool assessed the line for metal loss anomalies and deformations. As the modified tool did not sacrifice any detection or identification capability, the tool performance was expected to be in line with previous Quest Integrity ILI tool performance. In fact, the client list provided standard ILI assessment reporting data (feature number, feature type, odometer, length, width, depth, etc.) for all features. One exception to the standard data set was the lack of GPS coordinates for feature location. To locate the features on the line, the ILI analyst used a combination of odometer readings, geometric features (e.g. elbows), and alignment sheets. Upon review of the client list, the features reported generally were found to be as expected for a line of its age and service. The assessment reported the line contains internal corrosion anomalies, one low-level plain deformation anomaly, and no external corrosion anomalies. In 2018, the anomalies will be addressed via excavation, non-destructive evaluation, and after quantification of the actual geometry, an appropriate mitigation. Further, with the line exposed and the actual feature geometry data in hand, an "as called" to "as found" comparison will be made to more accurately assess tool performance.

OVERALL PROJECT CONCLUSIONS

The primary goal for this venture was to determine whether two disparate technologies could be brought together to improve and assess the integrity of a challenging pipeline. With the installation of the Argus pigging valves, Andeavor was able to perform maintenance cleaning runs on this line without the excessive down-time associated with temporary traps. The development of an ILI technology that can operate within a pigging valve multiplies the value of these systems to pipeline operators. Ultrasonic technology will allow operators to easily identify pipeline unknowns on legacy infrastructure (varying pipe schedules, bend radii, pipeline path through congested corridors, etc.) as well as pinpoint potential integrity threats that may be missed by hydrotests or qualitative/sample-based NDE methodology, and then prompt these locations to be mitigated or monitored as needed. Through this lens, the historic pigging project combining cleaning and In-Line Inspection technology through a pigging valve system was a success.

ACKNOWLEDGMENTS

Andeavor Logistics and Quest Integrity would like to gratefully acknowledge Argus Machine Co. for their contribution in this project.

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