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A Novel and Practical Methodology for Gas Operators to Apply API Std 1163, In-Line Inspection (ILI) Systems Qualification Standard

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ABSTRACT

To ensure safety and reliability, the Pipeline and Hazardous Materials Safety Administration (PHMSA) included section 192.493, In-Line Inspection (ILI) of pipelines, in the Federal Pipeline Safety Regulations and it was effective on July 1, 2020. This means that when conducting in-line inspection of gas pipelines, each operator must comply with the requirements and recommendations of three documents incorporated by reference in §192.7. One of these documents is API Std 1163.

Addressing in detail each of the aspects of an ILI inspection, with checks and balances, can be an overwhelming and difficult task. This paper provides an easy-to-implement methodology to verify the proper execution of an ILI survey, from the selection of the ILI to the actual validation of the results. It includes a section to validate ILI results for each examined anomaly and, in this way, generate quantitative comparisons to determine if critical anomalies have been classified and characterized using an appropriate level of conservatism. The paper discusses a simple method to determine the acceptance of the survey and its inspection data.

Key words: 49 CFR 192.493, In-Line Inspection (ILI) of pipelines, Verification, Validation, Federal Safety Regulation, ANSI/ASNT ILI-PQ-2017, In-Line Inspection Personnel Qualification and Certification, API Std 1163, In-line Inspection Systems Qualification Standard, NACE SP0102-2017, In-line Inspection of Pipelines

INTRODUCTION

A new regulation for the in-line inspection of gas pipelines (49 CFR 192.493) was effective on July 1, 2020. This means that when conducting in-line inspection of gas pipelines, each operator must comply with the requirements and recommendations of three documents incorporated by reference in §192.7. One of these documents is API Std 1163, In-line Inspection Systems Qualification Standard. The

fundamental objective of this paper is not to re-state the minimum standards that API Std. 1163 presents, but to offer a practical way to assure quality in conducting ILI activities by documenting specific findings in a simple and practical way. The level of detail and practicality described in this paper cannot be provided by the API 1163 document. With this paper, gas operators will have a simple method with examples easy to follow and implement to verify and validate in-line inspections.

Verification and validation are independent activities that are used together for checking that an ILI service meets requirements and performance specifications and that it fulfills its intended purpose. Verification is an internal process and it is intended to check that the ILI service meets a set of design specifications. Validation is an external process. It is intended to ensure the ILI results meet the needs of the gas pipeline operator.

PROCEDURE

The method described in this paper consists in a series of 12 questionnaires each of them to be completed at each step of the ILI service. They are (from G1 to G12):

- G1 Tool Selection
- G2 System Performance
- G3 ILI Planning
- G4 Pre-run preparation
- G5 Run Execution
- G6 Post-run verification
- G7 Data Quality Check
- G8 Preliminary Report
- G9 Final Report
- G10 Analysis Quality
- G11 Tool Validation
- G12 Total Score

G1 Tool Selection

Selecting an ILI tool is an important decision as there are significant costs and risks associated. There are several options in selecting inspection companies and tools/technologies. The inputs to the decision process are complex as they cover a wide range of technical issues (such as detection performance, accuracy, reliability, human issues and cost). It is important to utilize a documented and structured decision process in making the selection of the optimum tool/technology. Figure 1 shows some examples of questions that need to be answered to cover four essential considerations:

- Inspection goals and objectives
- Qualification of performance specifications
- Reliability of the ILI tool

Inspection goals and objectives

The goals and objectives of an ILI shall be defined, with documents such as API Recommended Practice 1160, Managing System Integrity for Hazardous Liquid Pipelines and ASME B31.8S, Managing System Integrity of Gas Pipelines. Goals and objectives shall include, but are not limited to, the detection, classification, and characterization of anomalies and features within the pipeline.

Qualification of performance specifications

The gas pipeline operator must analyze the goals and objectives of the inspection and match relevant facts known about the pipeline and expected anomalies with the capabilities and performances of each ILI tool. The ILI vendor should provide the tool performance specification that will answer questions such as:

- What are the accuracy and detection capabilities of the ILI tool (i.e., probability of detection, classification, and sizing)? The answered values should match the expectations.
- What is the detection sensitivity, what is the minimum detectable anomaly size specified for the ILI tool? The answered values must be smaller than the size of defect anticipated to be detected.
- What are the identification capabilities? the ILI tool must be able to differentiate the targeted defect types from other types of anomalies.
- What is the sizing accuracy? It must be enough to enable evaluation, or, when applicable, remaining strength determination.
- What is the location accuracy? It should enable locating anomalies.

For each item, type an "X" as applicable in the appropriate column.					
Pass	Cond.	Fail	N/A	Quality Check Items	Comments
X				1 Has the most critical expected anomaly type on the pipeline been identified?	
X				2 Have you considered more than one threat occurring on a section of pipeline at the same time?	
X				3 What are the dimensions of critical anomalies for this pipeline?	
X				4 Is the inspection tool selected capable of assessing the specific threat on the pipeline?	
X				5 Have the performance specification for the selected tool been reviewed to verify that the tool is capable of detecting and sizing the target anomalies? Have the different available resolutions, accuracies and precision been evaluated?	
	X			6 Have the required POD, POI, and tool accuracy (tolerance, certainty and confidence level) for the target defects been identified?	
		X		7 Has a person not previously involved in the running of the inspection verified that the selected tool is adequate to the job?	
X				8 Have any limitations in the sizing and/or detection of the expected anomaly types been identified?	
X				9 Are the dimensions of potentially injurious defects for the pipeline greater than the minimum detection and thresholds of the selected tool?	
	X			10 Do you understand the capabilities and limitations of the specific tool selected for the ILI?	
10 Select, from the drop down menu below, the targeted anomaly type or feature type on the pipeline:					
Strain					
11 ILI Technologies that both detect and size selected type of anomaly or feature:					
Geometry Tool					
12 ILI Technologies that <i>only detect</i> the selected type of anomaly with <i>no</i> sizing available:					

Figure 1. Example of a tool selection questionnaire

Reliability of the ILI Tool

The reliability of the ILI method must be evaluated based on analysis of the following questions:

- What is the confidence level of the ILI tool (e.g., probability of detecting, classifying, and sizing the anomalies)?
- What is the history of the ILI tool performance verified through past excavations? What is the operational success rate and history of failed surveys? What is the ability of the tool to inspect the full length and full circumference of the pipe section? What is its ability to indicate the presence of multiple-cause anomalies (anomalies other than those for which it is primarily designed, such as the detection of dents by a metal-loss tool)?

G2 System Performance

The questions in Figure 2 can be used to assess the performance of a selected ILI tool to ensure not only that the technology can detect and size the anomalies, but also that the inspection system is able to deliver quality data as demonstrated by its history of successful runs.

Pass	Cond.	Fail	N/A	Quality Check Items	Comments
				1 Is the selected inspection system able to deliver quality data as demonstrated by its history of successful runs with the same type of anomalies targeted with this ILI?	
				2 Is the tool experimental and there is no established history or it has been demonstrated to have deficiencies in addressing the target threat?	
				3 Has the selected tool been previously run in any other operator's pipeline successfully? When? Where?	
				4 Did the ILI vendor supply relevant documentation demonstrating successful performance testing? Did the vendor provide certifications of at least one Level II ILI Tool Operator to accompany an ILI tool for on-site technical support and service, at least one Level II ILI Data Analyst to grade logs, and at least a level III ILI Data Analyst to review for quality, accuracy and adherence to the specifications and regulations?	
				5 If this is an untested technology/tool? Will there be ample and extensive validation?	
				6 Other	

Figure 2. System performance questionnaire

G3 ILI Planning

The success of an ILI inspection depends on adequate planning and preparations. Making sure that all prior tasks are performed correctly, i.e. cleaning targets must be met prior to the inspection to avoid degradation of the data quality or even complete loss of data. Adequate planning makes the difference between a successful run and a fail run.

Gas lines often operate at speeds well in excess of the maximum allowable ILI speeds. This is a primary consideration for magnetic flux tools in gas lines. Variable bypass (speed control), available on certain tools, should be used to address this issue. The use of this feature requires a more complicated procedure (e.g., lengthening of the tool and limiting the bend capability of tools). The ramifications of using variable bypass should be considered carefully. In some cases, fixed bypass is put into a tool to reduce the inspection speed and keep debris loose and circulating. The addition of fixed bypass should be done with caution. In certain situations, the addition of too much fixed bypass could result in insufficient drive to move the tool along the line. All these factors must be assessed and weighed against the need to reduce product throughput and the possible need to flare. The questions in Figure 3 can be used to ensure that proper procedures are followed prior to run an ILI tool.

Pass	Cond.	Fail	N/A	Quality Check Items	Comments
				1 Review temperature/pressure profiles, geodetic, bend measurement, and wall thicknesses data to set up a tentative date of inspection	
				2 Has the pipeline being pigged before? Confirmed piggability (ruled out the presence of miter bends, pipe diameter changes, small bend radius, back-to-back bends, etc.)	
				3 Verify presence and dimensions of traps, availability of necessary equipment and enough area for maneuvering in front of traps (estimate weight of ILI tool)	
				4 Verify that tees are barred and measure distance between close tees	
				5 Verify that all valves are piggable and that they can be completely open (full bore)	
				6 Confirmed that all check valves are located in the same direction of the inspection and that they can be locked open	
				7 Begin a pipeline cleaning program for ILI, and record debris type and amount	
				8 Fill out pipeline questionnaire and provide bid packages	
				9 Obtain ILI quotes, performance specifications, fill out pipeline questionnaires supplied by ILI vendors (see Pipeline Questionnaire attached to this form), and preparation of MSAs	
				10 Request Level II and level III certifications of tool operators and data analysts for this job	

Figure 3. ILI Planning questionnaire

G4 Pre-run preparation

There are several questions that need to be thoroughly answered to ensure that the ILI tool is in good working condition, i.e. that the tool's mechanical components perform as designed. The ILI vendor shall define and document necessary steps to prepare and validate proper operation of the ILI tool prior to an inspection run.

Figure 4 shows examples of the questions that need to be answered to verify that the tool is in good working condition. These questions are divided into two categories:

1. Function checks
2. Mechanical checks.

Function Checks

The first parameter is the pre-run function checks which is a group of activities that ensure the functional integrity of the tool prior to loading the ILI tool into the launcher. Some examples of pre-run function checks are:

- Appropriate initialization of all components
- Adequacy and availability of the power supply
- Confirming that all sensors are operational
- Confirming adequacy, and availability of data storage
- Confirmation that all components of the inspection tool are properly initialized

Pass	Cond.	Fail	N/A	Quality Check Items	Comments
				1 Ensure that a function checklist is provided by the ILI vendor in advance of the ILI.	
				2 Are all components correctly initialized?	
				3 Is the tool in explosion-proof mode (is a certification required?)	
				4 Is the tool in launching mode?	
				5 Are all sensors operational?	
				6 Does the tool has the correct battery capacity for the estimated time of the inspection run?	
				7 Does the tool has adequate storage capacity for the amount of data expected based on the conditions of the pipeline?	
				8 Ensure that a pre-run mechanical checklist is provided by the ILI vendor in advance of the inspection.	
				9 Perform a general visual inspection, confirming good pressure seals around electronic components, ensuring adequate integrity of cups, and ensuring all wheels are intact and moving appropriately. It is recommended that the checklist be appended with photographs of the tool to document the condition of the tool before the launching	

Figure 4. Pre-run preparation questionnaire

Mechanical Checks

The second parameter is the pre-run mechanical checks which is also a group of activities that are carried out to ensure the mechanical integrity of the tool prior to loading it into the launcher barrel. As such, pre-run mechanical checks are expected to be largely visual (see Figure 5).

Some examples of mechanical checks are:

- General visual inspection
- Confirming good pressure seals around electronic components