ILI tool testing

Recommended Practice

POF 330

Version January 2026

Foreword

This document has been reviewed and approved by the Pipeline Operators Forum (POF) and is based on knowledge and experience available from POF members and others at the date of issue. It is stated however, that neither POF nor its member companies (or their representatives) can be held responsible for the fitness for purpose, completeness, accuracy and/or application of this document.

This first edition has been issued with the intent of soliciting comment and input from pipeline industry stakeholders, and it is intended to produce an updated version within around 1 year of publication.

Comments on this recommended practice and proposals for updates may be submitted to the Administrator at specifications@pipelineoperators.org with the form which is available on the POF website (www.pipelineoperators.org).

Contents

1 Introduction

API 1163 [1] requires qualification of ILI tool performance specifications. The methodology used to qualify the performance specification is required to be based on at least one of the following methods:

a. verified historical data;
b. full-scale tests from real or artificial anomalies; and/or
c. small-scale tests, modeling, and/or analyses.

However, tool data sheets provided by the vendors cover general cases. Specific features and pipeline solutions might benefit from more detailed information regarding inspection tool capability to get a successful inspection. In such cases, a tailor-made test program can provide the necessary information about the detectability and reporting of features with different sizes and shapes.

This document is a guideline for verification of ILI tool performance through testing and can be used by an operator to define a successful test program. In some cases, sections in the guideline can be omitted or sections can be added according to needs.

Full-scale testing can also be used to verify piggability of specific geometrical features in pipelines such as diameter changes or fittings such as bends, tees and wyes. This guideline does not address piggability in detail; however, it can easily be included in a test scope and tested at the same time. Additionally, a piggability test might require additional spools to represent all critical sections of the pipeline.

2 Definitions and abbreviations

2.1 Definitions

For the purposes of this document, the definitions in POF 100 [2] and the following apply.

Essential variable	Important parameters affecting POD, POI and accuracy of inspection data
Loop	Combination of pipe spools put together to reflect the variables to be tested
Small-scale test	A controlled evaluation conducted on a reduced scope to assess performance of the tested tool
String	Straight length of pipe spools connected together

2.2 Abbreviations and acronyms

For the purpose of this document, the following abbreviations and acronyms apply:

CNC	Computer Numerical Control
EDM	Electrical Discharge Machining
EMAT	Electro Magnetic Acoustic Transducer
ILI	In-Line Inspection
MFL	Magnetic Flux Leakage
NDE/NDT	Non-Destructive Examination/Non-Destructive Testing
POF	Pipeline Operators Forum
POD	Probability Of Detection
POI	Probability Of Identification
TDC	Top Dead Centre
UT	Ultrasonic Testing

3 Test definition

3.1 Objectives

The operator should define the objective of the test, which could include:

- Confirmation of a published ILI tool performance specification (in full or for a specific metal loss anomaly class, e.g. pitting) (Objective #3 in Figure 1).
- Extending the validity of an existing ILI tool specification beyond current limits (e.g. higher speed, higher wall thickness, other essential variables) (Objective #2/4 in Figure 1).
- Establishing a performance specification for a new anomaly type or metal loss anomaly class (e.g. pinhole) (Objective #4 in Figure 1).
- Demonstrating passage of specific features in a pipeline such as bore restrictions, tees & wyes (Objective #1 in Figure 1).

In each case, the objective might be to verify the full performance specification (POD, POI and sizing accuracy) or individual aspects (e.g. POD for a specific anomaly size).

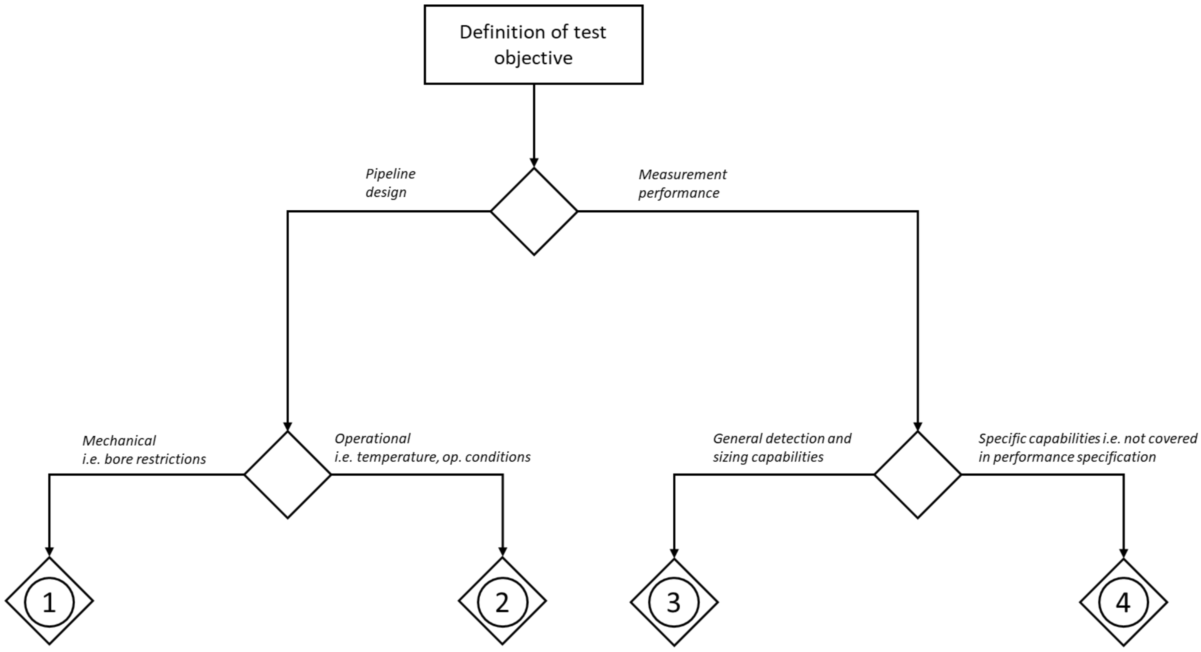

Figure 1: Test Objectives

3.2 Type of test

The operator and contractor should agree the type of test required to meet the test objectives for the ILI tool technology employed. The main types of possible test are:

- Dry pull test
- Submerged pull test
- Pump test

Dry pull tests are typically suitable for mechanical and magnetic ILI tool technologies including geometry, MFL and EMAT tools.

Submerged pull tests are typically used for UT ILI tool technologies that require liquid coupling.

Pump tests are performed using a pressurised test string or test loop filled with water. This provides the liquid coupling required for UT ILI tools.

Pump tests could also be performed in other fluids if required to demonstrate ILI tool performance in a specific fluid (e.g. high-pressure gas, carbon dioxide or hydrogen).

The operator and contractor should also agree on whether the test will be blind, open, or partially open, which determines whether the contractor is aware of the included defects. Experience shows that performance can be improved when a sample of truth data is provided to the ILI service provider.

For blind tests, external anomaly locations should be concealed using non-metallic material followed by painting or coating to ensure proper masking.

4 Test set-up

4.1 Test sites

ILI service providers have their own test facilities suitable to perform most types of tests. Independent testing can be performed at commercial test sites or at an operators own test site where available.

4.2 Pipe spools

The operator should define the number, type (SMLS, HFI, SAW), diameter, grade and wall thickness of the pipe spools to be used for testing. When testing for verification of tool performance for a specific pipeline the effect of deviations from pipeline parameters should be assessed and the test spools should represent the range of pipe types, thicknesses and grades present in the pipeline system.

4.3 Test anomalies

The operator should define the type, number, shape and size of anomalies to be included in the test spools.

The number of anomalies is important to achieve the required statistical confidence in the tool performance. The number of anomalies included in the test can be easily increased by passing the ILI tool through the test spools multiple times during the test.

The range of anomaly sizes and shapes should be selected to cover the full range of the ILI performance specification and/or to represent specific critical anomaly sizes of interest during pipeline operation. Anomalies smaller than the stated detection capability should also be included in order to validate POD. It should be considered to extend the feature size and shape beyond typical expectations to assess the degradation rate and better understand the implications of feature size and shape.

Internal, external and mid-wall features should be included as appropriate.

Anomalies should be included in the pipe body and also in the vicinity of seam and girth welds (if applicable). Smaller anomalies should be positioned at various orientations and spaced apart to evaluate the tool's ability to distinguish between them and assess orientation-specific performance, especially if the tool is tested without rotation and will rotate during operation.

4.4 Natural and manufactured anomalies

Natural anomalies (in pipe samples removed from operating or decommissioned pipelines) are useful in characterising/improving performance of ILI systems for real defects that may have been challenging for past inspections to detect or size accurately.

Manufactured anomalies can be more precisely characterised by NDE and enable demonstration of ILI performance differences with changing anomaly size and shape.

Anomalies are typically manufactured using electrical discharge machining (EDM) or CNC machining, or by manual grinding/buffing. Machining of anomalies can create a work-hardened layer which could affect the performance of magnetic ILI technologies. The work hardened layer should be removed as far as practicable (e.g. by sand blasting or etching).

4.5 Assembly of test string

Depending on the type of test, the test string may be constructed using fully welded joints, tack welding or flanged joints. A flanged test string or test loop allows more flexibility to change the test configuration with respect to modification to enable tests of enlarged scope.

The location of TDC should be visibly marked on the anomaly spool(s) to ensure that it is connected into the wider test setup in the correct orientation.

4.5.1 Dry pull test

The test string for a dry pull test should consist of a loading funnel, acceleration section, constant speed test section (containing the test anomalies) and deceleration section. The acceleration section should be long enough to ensure the ILI tool reaches a constant speed before entering the anomaly spools

The ILI tool should be pulled through the test string using a speed-controlled winch. Distance, velocity and pull force should be continuously recorded during the test pull for subsequent comparison with ILI tool velocity data.

Depending on the design of the ILI tool, it can be possible to perform the test using only battery, electronics and sensor modules of the tool (i.e. if the tool includes a separate tow module, this can be omitted for the purposes of the pull test).

The test string should have an anchoring arrangement to resist the pulling force of the winch.

4.5.2 Submerged pull test

A test string similar to that used in a dry pull test should be submerged in a water bath. Care should be taken to remove all air from the test string before the pull test commences.

Submerged pull tests are typically only suitable for slow tool speeds.

4.5.3 Pump test

Design of the test loop should consider:

- Finite or continuous loop.
- Tool loading and unloading arrangements (pig trap, blind flange, removable spool).
- Venting and draining requirements.
- Arrangement for allowing water contact with sensors requiring coupling medium.
- Pump capacity, with respect to required pressure and flow speed
- Acquisition & disposal of water.

Pump tests can also facilitate confirmation of piggability of specific pipeline features (e.g. tees, wyes, bore restrictions).

4.6 Documentation of size and location of features in pipe

NDE should be performed to determine the true locations and dimensions of the test anomalies (truth data). The NDE technique used should be sufficiently accurate in comparison to the ILI system, allowing NDE tolerances to be considered negligible.

Destructive testing can also be performed for complex anomalies following completion of the test.

The truth data should be presented in a format allowing easy comparison between different sets of ILI data, for example a pipe tally in accordance with Appendix 5 of POF 100.

5 Test protocol

The operator should produce a written test protocol detailing the testing to be carried out, including:

- Tool selection.
- Tool velocities (covering full range of performance specification and including one speed above the maximum specified - typical velocities for MFL tools are 0.5, 1.5, 2.5, 3.5 and 5 m/s).
- Number of runs for each defined velocity (to provide sufficient data for subsequent statistical analysis – typically around 100 per anomaly type).
- Run direction (consider running through the anomaly spools in both directions if practical).
- Angular position of tool (for pull tests, the ILI tool should be rotated a few degrees between runs to enable validation of the angular anomaly positioning capability).

6 Test preparation

6.1 Schedule

A realistic schedule should be set for the test execution.

- A well-planned dry pull test programme can typically complete approximately 6 pulls per hour (with the same ILI tool).
- Pump testing in an end-to-end (not continuous) loop can typically achieve 3 – 4 test runs per day.

In pull testing it is typical for the ILI tool to remain active between pulls with data downloaded for all runs at the end of the test programme, while for pump testing it is typical for each run to be standalone with data downloaded each time the tool is recovered from the loop.

6.2 Personnel

Sufficient resource should be available to achieve the planned schedule.

- For dry pull testing, typical resource requirements are 3 – 4 people (test supervisor, ILI tool technician, winch operator, forklift driver).
- For pump testing, typical resource requirements are 3 people (test supervisor, ILI tool technician, loop operator). Some job roles can be shared due to the slower pace of testing.

6.3 ILI tool setup & commissioning

The ILI contractor should set up and commission the ILI tool in advance of the test using standard procedures.

6.4 Pull test

The inside of the test string should be lubricated using liquid soap (or similar) to reduce the required pulling forces.

A retrieval line should be attached to the rear of the ILI tool before launch and used to return the winch cable to the start of the test string following completion of the pull.

6.5 Run acceptance

The ILI contractor should carry out standard post run checks to confirm data quality.

7 Analysis and reporting

7.1 ILI Data Analysis

The ILI contractor should analyse the recorded data using standard processes.

For pull testing, when there is no launcher valve to define the start of the run, a zero point should be defined. This may be a girth weld or an artificially created identifiable feature (e.g. drill hole pattern) included at the leading end of the test string.

ILI contractor should be informed of the approximate distance of the start & end of the anomaly spools, to minimise analysis time by excluding non-applicable joints.

7.2 Reporting

A pipe tally and anomaly list should be provided in the format defined in POF 100.

If the test programme includes multiple ILI technologies, reporting format (separate or combined anomaly list) should be agreed in advance dependent on the test objectives.

8 Assessment of results

The POD/POI for each anomaly type/class should be calculated in accordance with API 1163, using truth data.

Unity plots for each anomaly type/class should be produced for assessment of sizing accuracies and development/validation of a performance specification.

9 References

1. American Petroleum Institute, *In-Line Inspection Systems Qualification*, API Standard 1163, Third Edition, September 2021.
2. Pipeline Operators Forum, *Specifications and requirements for in-line inspection of pipelines*, POF 100, November 2021.