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In-Line Inspection of Pipelines

ABSTRACT

This standard practice outlines a process of related activities that a pipeline operator can use to plan, organize, and execute an ILI project. This standard is applicable to carbon steel pipeline systems used to transport natural gas, hazardous liquids including those containing anhydrous ammonia, carbon dioxide, water including brine, liquefied petroleum gases (LPG), and other services that are not detrimental to the function and stability of ILI tools. This standard is maintained by Task Group 212.

KEYWORDS

in-line inspection, pigging, pipelines, nondestructive testing.

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Foreword

In NACE standards, the terms shall, must, should, and may are used in accordance with the definitions of these terms in the NACE Publications Style Manual. The terms shall and must are used to state a requirement, and are considered mandatory. The term should is used to state something good and is recommended, but is not considered mandatory. The term may is used to state something considered optional.

Since the transportation of hydrocarbons by pipeline began in the 1860s, the primary means of establishing pipeline integrity has been through the use of pressure testing. These tests have been most often performed upon completion of the construction of the pipeline. The completed pipeline segment has been pressurized to a level equal to or exceeding the anticipated maximum operating pressure (MOP). Government regulations have recently specified the test pressures, test media, and test durations that must be achieved for pipelines to be permitted to operate within their jurisdictions. However, until very recently, there have been no such requirements for pipelines to be periodically tested for integrity. Some pipeline operators have traditionally performed periodic integrity assessments in a variety of forms with varying degrees of success.

In the mid-1960s, pipeline operators began to use a form of instrumented inspection technology that has evolved into what is known today as in-line inspection (ILI). ILI is but one tool used in pipeline integrity assessment. The technology has now become so reliable that it holds a prominent place in many operators' integrity programs because when properly applied, ILI provides many economies and efficiencies in integrity assessment at a relatively small risk.

This standard practice outlines a process of related activities that a pipeline operator can use to plan, organize, and execute an ILI project. Guidelines pertaining to ILI data management and data analysis are included. A key companion guide to this standard is NACE International Publication 35100.[1]

This standard is intended for use by individuals and teams planning, implementing, and managing ILI projects and programs. These individuals include engineers, operations and maintenance personnel, technicians, specialists, construction personnel, and inspectors. Users of this standard must be familiar with all applicable pipeline safety regulations for the jurisdiction in which the pipeline operates. This includes all regulations requiring specific pipeline integrity assessment practices and programs.

This NACE standard was originally prepared by Task Group (TG) 212, "In-Line Nondestructive Inspection of Pipelines," in 2002 and was revised by TG 212 in 2010 and 2017. TG 212 is administered by Specific Technology Group (STG) 35, "Pipelines, Tanks, and Well Casings." This standard is issued by NACE International under the auspices of STG 35.

In-Line Inspection of Pipelines

Table and Figure

Section 1: General

1.1 This standard is applicable to carbon steel pipeline systems constructed of Grade B or greater material used to transport natural gas and hazardous liquids, including those containing anhydrous ammonia, carbon dioxide, water including brine, liquefied petroleum gases (LPG), and other services that are not detrimental to the function and stability of ILI tools.

1.2 This standard is applicable to free-swimming ILI tools, but is not applicable for tethered or remotely controlled inspection devices.

1.3 This standard provides recommendations to the pipeline operator based on successful, industry-proven practices in ILI.

1.4 This standard is specific to the inspection of line pipe installed along a right-of-way, but the general process and approach may be applied to other pipeline facilities such as hydrocarbon distribution and gathering systems, water injection systems, station piping, and isolated crossings of railroads, highways, or waterways.

1.5 ANSI[(1)]/ASNT[(2)] ILI-PQ[2] establishes minimum requirements for the qualification and certification of ILI personnel whose jobs require specific knowledge of the technical principles of ILI technologies, operations, regulatory requirements, and industry standards as applicable to pipeline systems.

1.6 API[(3)] 1163[3] provides requirements for qualification of ILI systems used in onshore and offshore gas and hazardous liquid pipelines. This includes, but is not limited to, tethered or free-flowing systems for detecting metal loss, cracks, mechanical damage, pipeline geometries, and pipeline location or mapping. This standard is an umbrella document covering all aspects of ILI systems, including procedures, personnel, equipment, and associated software. It is performance-based, but it does not define how to meet qualification requirements.

Section 2: Definitions

Aboveground Marker (AGM): A portable or permanently installed device placed on the surface above a pipeline that both detects and records the passage of an ILI tool or transmits a signal that is detected and recorded by the tool.

Anomaly: An unexamined deviation from the norm in pipe material, coatings, or welds. See *imperfection* and *defect.*

Appurtenance: A component that is attached to the pipeline, e.g., valve, tee, casing, instrument connection, etc.

Batch, Batching: Separated volume of liquid within a liquids pipeline or of liquid within a gas pipeline. Sealing (batching) pigs are typically used for separation.

Bellhole: An excavation to permit a survey, inspection, maintenance, repair, or replacement of pipe sections.

Bend: A physical configuration that changes pipeline direction. A bend can be classified according to the centerline radius of the bend as a ratio to the nominal pipe diameter. A 1.5 diameter (D) bend would have a centerline radius of 1.5 times the nominal pipe diameter. A 3 D bend would have a centerline radius of three times the nominal pipe diameter.

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(1) American National Standards Institute (ANSI), 25 West 43rd St., 4th floor, New York, NY 10036.
(2) American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518.
(3) American Petroleum Institute, (API) 1220 L Street NW, Washington, DC 20005-4070.

Buckle: A condition in which the pipeline has undergone sufficient plastic deformation to cause permanent wrinkling or deformation of the pipe wall or the pipe's cross-section.

Calibration Dig: An exploratory excavation to compare findings of an ILI system to actual conditions with the purpose of improving data analysis. See *verification dig.*

Caliper Pig: A configuration pig designed to record conditions such as buckles, dents, wrinkles, ovality, bend radius and angle, and occasionally, indications of significant internal corrosion by sensing the shape of the internal surface of the pipe (also referred to as a geometry pig).

Cathodic Protection (CP): A technique to reduce the corrosion rate of a metal surface by making that surface the cathode of an electrochemical cell.

Chainage: Cumulative pipeline distance usually measured on the surface from a specific point of origin.

Characterize: To assign characteristics to a pipeline anomaly or feature, based on its classification.

Check Valve: Valve that prevents reverse flow. (Can cause damage to ILI tools if not fully opened.)

Classify: To identify the cause of an inspection indication (e.g., anomaly, irrelevant indication, feature, component, or type of imperfection/defect).

Cleaning Pig: A utility pig that uses cups, discs, scrapers, or brushes to remove dirt, rust, mill scale, corrosion products, and other debris from the pipeline. Cleaning pigs are used to increase the operating efficiency of a pipeline or to facilitate inspection of the pipeline.

Combination Tool: An instrumented ILI tool designed to perform both geometry (deformation) inspections, as well as metal loss inspections with a single tool chassis.

Component: Any physical part of the pipeline, other than line pipe, including but not limited to: valves, welds, tees, flanges, fittings, taps, branch connections, outlets, supports, and anchors.

Corrosion: The deterioration of a material, usually a metal, that results from a chemical or electrochemical reaction with its environment.

Crack: (1) A partial split or break. (2) A split or break in a coating that penetrates to the substrate.

Data Analysis: The evaluation process through which indications are classified and characterized.

Defect: A physically examined anomaly with dimensions or characteristics that exceed acceptable limits. See imperfection.

Deformation: A change in shape, such as a bend, buckle, dent, ovality, ripple, wrinkle, or any other change that affects the roundness of the pipe's cross-section or straightness of the pipe.

Deformation Tool: An instrumented ILI tool designed to record geometric conditions such as buckles, dents, wrinkles, ovality, and bend radius and angles. See *caliper pig* and *geometry tool.*

Dent: A local change in piping surface contour caused by an external force such as mechanical impact or rock impingement.

Detect: To sense or obtain a measurable indication from a feature.

Electric Resistance Weld (ERW): A weld seam formed by resistance heating of the two edges of a pipe and then forcing them together.

Electromagnetic Acoustic Transducer (EMAT): A transducer for non-contact sound generation and reception directly generated within the material adjacent to the transducer.

Evaluation: A review following the characterization and examination of an anomaly to determine whether the anomaly meets specified acceptance or rejection criteria.

Examination: A direct physical inspection of a pipeline or anomaly by a person, which may include the use of nondestructive examination (NDE) techniques.

Fatigue: The process of progressive localized permanent structural change occurring in a material subjected to fluctuating stresses less than the ultimate tensile strength of the material that may culminate in cracks or complete fracture after a sufficient number of fluctuations.

Feature: Any physical object detected by an ILI system. (Features may be anomalies, components, nearby metallic objects, welds, appurtenances, or some other item.)

Gauging Pig: A utility pig mounted with a flexible metal plate or plates to gauge the internal diameter of the pipeline. Pipe bore restrictions less than the plate diameter or short radius bends permanently deflect the plate material.

Geographical Information System (GIS): A computer system capable of assembling, storing, manipulating, and displaying geographically-referenced information.

Geometry Tool: An instrumented ILI tool that records data about the geometric condition of the pipeline or pipe wall. Caliper tools and deformation tools are examples of geometry tools.

Girth Weld (GW): A complete circumferential butt weld joining pipe or components.

Global Positioning System (GPS): The navigational system utilizing satellite technology to provide a user an exact position on the earth's surface.

Gouge: Elongated grooves or cavities usually caused by mechanical removal of metal.

Hydrostatic Test (hydrotest): A pressure test of a pipeline by completely filling with water and pressurized to ensure it meets the design conditions and is free of leaks.

Imperfection: An anomaly with characteristics that do not exceed acceptable limits. See *defect.*

Indication: A signal from an ILI system. An indication may be further classified or characterized as an anomaly, imperfection, or component.

Induction Coil: A type of sensor that measures the time rate of change in magnetic flux density. Induction coils do not require power to operate, but have a minimum inspection speed requirement (also see MFL and MPI.)

In-Line Inspection (ILI): An inspection of a pipeline from the interior of the pipe using an ILI tool. Also called *intelligent* or *smart pigging.*