Standard Practice

Guided Wave Technology for Piping Applications

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Foreword

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 on 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, codes, and standards have 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 regulatory 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 1998, pipeline operators began to use a form of instrumented inspection technology that has evolved into what is known at present as guided wave testing (GWT), which detects changes in the cross-sectional area of the pipe wall. Test equipment software provides a percent estimate of the change (gain or loss) and is often expressed as percent estimated cross-sectional loss. Note that some features (such as welds) represent gains in cross-sectional area. These changes include metal loss indications, anomalies, or defects such as corrosion, gouges, etc., or metal pickup such as welds, valves, flanges, etc. The technology is now in many operators' integrity management programs. However, there has been a lack of industry-recognized standards that specify and govern GWT and as a result there has been variability in the expectations and results. When properly applied, GWT can monitor cross-sectional loss over time, and provide economic benefits and efficiencies in integrity assessments.

This standard practice outlines a process of related activities that a pipeline operator should use to plan, organize, and execute a GWT project. Guidelines pertaining to GWT are included (e.g., site setup, people and equipment qualifications, performance expectations, accessible and inaccessible facilities, and pipe). Key NACE companion standards include NACE SP0502,[1] SP0206,[2] and SP0210.[3]

This standard is intended for use by qualified individuals and teams planning, implementing, and managing GWT 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 standard was prepared by Task Group (TG) 410, "Long-Range Guided Wave Ultrasonic Testing." TG 410 is administered by Specific Technology Group (STG) 35, "Pipelines, Tanks, and Well Casings," and it is sponsored by STG 05, "Cathodic/Anodic Protection." This standard is issued by NACE International under the auspices of STG 35.

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.

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Contents

1. General 1
2. Definitions 3
3. Preassessment 8
4. Conducting Guided Wave Testing 12
5. Post-Assessment Step 13
6. GWT Service Provider Quality Management System Perspective 17
7. Guided Wave Testing Records 18
References 19
Appendix A: Guided Wave Testing Background, Technical Explanation, and Field Implementation Protocol to Assist Operators 21
Appendix B: Commonly Used GWT Terminology 40
Appendix C: Sample Preinspection Questionnaire 41
Appendix D: GWT Inspector Certification Levels 43
FIGURES
Figure 1: Typical volumetric coverage of a guided wave examination 2
Figure 2: Examples of different 10% cross-sectional areas flaws 7
Figure 3: Schematic diagram of pulse echo, through transmission, and pitch catch configurations 12
TABLES
Table 1: Typical Values of Relative Signal Amplitude 2
Table 2: General Effects of Appurtenances on GWT 9
Table 3: Example of Acceptance Criteria and Response Plan 16
Table D1: Descriptions of Responsibilities of Guided Wave Testing Inspector Levels 43
Table D2: Training Criteria for Guided Wave Testing 45

Section 1: General

1.1 This standard is primarily applicable to GWT tools that are designed to be coupled to the external surface of the pipe. However, this standard can be adapted to GWT technology that couples to the interior of the pipe using deployment tools such as tethered, remotely controlled, internal free-swimming, or permanently installed inspection devices.

1.2 This standard is applicable to a variety of industries that use metallic pipelines and piping systems to transport natural gas and hazardous liquids, including those containing anhydrous ammonia, carbon dioxide, water (including brine), liquid petroleum gases (LPG), isotopes, and other services that are not detrimental to the function and stability of GWT tools.

1.3 This standard provides specific guidance based on successful, industry-proven GWT practices.

1.4 This standard requires the service provider to determine the attenuation levels for GWT examinations for each pipe. In practice, GWT attenuation levels should not be greater than 1 dB/m (0.4 dB/ft) during testing. When attenuation levels are greater than 1 dB/m (0.4 dB/ft), the service provider must have an equipment-specific procedure tailored to the piping configuration and target corrosion mechanism of the pipe to be tested. As such, use of this standard as a stand-alone practice on such piping should only be used as a guideline.

1.5 This standard is primarily intended for use on above- and/or below-ground pipelines installed along a right-of-way, plants, pump/compressor station piping, and for subsea pipelines and flow lines. The general process and approach may be applied to other facilities such as hydrocarbon distribution and gathering systems, water injection systems, station piping, and isolated crossings of railroads, highways, or waterways.

1.6 GWT is a nondestructive testing technique that provides for the rapid screening of lengths of pipe from each test location in order to achieve inspection coverage of a pipe in a cost-effective manner and to target suspect areas for closer examination by local nondestructive testing (NDT) techniques. With this process, the reduction of access costs is a significant positive factor. This method also has the ability to examine pipe lengths that are inaccessible for more conventional NDT methods, such as road or rail crossings, by testing from the nearest accessible location, thereby increasing the proportion of any pipe system that can be inspected.

1.7 GWT is similar to the use of Lamb waves in conventional Lamb wave testing, which may be generated in plates and in common pipe thicknesses. Currently, piezoelectric and magnetostrictive transducers are used to generate and receive ultrasonic signals that travel through the pipeline wall, and changes in time of flight can be used to detect imperfections, features, and defects in the short segments of the pipeline system under inspection. To generate the appropriate wave modes, guided waves are several orders of magnitude lower in frequency than that which is used for normal ultrasonic tests. Typically, frequencies of approximately 50 kHz are used in GWT, compared to approximately 5 MHz for conventional thickness testing. These waves can travel many meters with minimal attenuation and offer the potential to test large areas from a single point using a pulse-echo transducer bracelet wrapped around the pipe. This principle is shown in Figure.1. The transducer transmits a controlled pulse GWT along the pipe. Any changes in the thickness of the pipe, either on the inside or the outside, cause reflections, which are detected by the transducer. Hence, metal loss indications from corrosion/erosion inside the pipe or corrosion on the outside of the pipe may be detected. The detection of additional mode converted signals from defects aids discrimination between pipe features and metal loss. Knowledge of the speed of the guided waves as they travel along the pipe allows the distance from the transducer tool to the corrosion to be measured so that its position can be determined.