

# DIRECT ASSESSMENT ON DIFFICULT TO ASSESS PIPING SEGMENTS

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Direct Assessment (DA) techniques are PHMSA approved methodologies for assessing the condition of buried pipelines. DA methods rely on a programmatic assessment approach based on fundamental engineering practices involving a four step process specific to each type of major corrosion threat (External, Internal, and Stress Corrosion Cracking):

- (1) Pre-Assessment: Collecting and assessing information about the design factors, construction, operation, and maintenance of the pipeline.
- (2) Indirect Inspection: Collecting data and performing analysis of the data to supplement the pre-assessment data and prioritize areas likely to exhibit the identified corrosion threat.
- (3) Direct Examination: Excavating and examining the pipeline at those identified areas as prioritized in Step 2.
- (4) Post Assessment: Analyzing the results, assessing whether additional repairs or excavations are required, determining the effectiveness of the approach, and identifying future mitigation and remediation actions as well as a re-assessment interval.

Since the implementation of the Pipeline Safety Act of 2002 and subsequent Integrity Management Regulations by the Department of Transportation, difficult-to-assess pipeline segments such as cased segments and station piping have posed significant challenges to operators relying on External Corrosion Direct Assessment (ECDA) and Internal Corrosion Direct Assessment (ICDA) as integrity assessment methods.

## STATION PIPING

Terminal, compressor, fabricated gate and generating stations pose some significant challenges to the use of traditional Direct Assessment. The data collection and analysis process is typically much more challenging as stations can have multiple pipelines varying in design characteristics, operating parameters, and varying degrees of corrosion susceptibility throughout the facility. Drawings may not be accurate and data, if documented, is likely to be spread across multiple and disparate sources. Additionally, traditional indirect inspection tools may have limited effectiveness and excavations can be complicated by unusual depth and multiple pipelines in the dig region.

Structural Integrity has designed and implemented a specific program incorporating unique tools to overcome some of these challenges. As a first step, we perform a site walk-down to validate drawings and collect missing data elements. All data and drawings are then consolidated into a Geodatabase and incorporated into 3-Dimensional GIS and CAD drawings for a complete relational mapping and orientation of the piping and attributes throughout the facility. Using these modeling tools, we can better organize, analyze, and manage

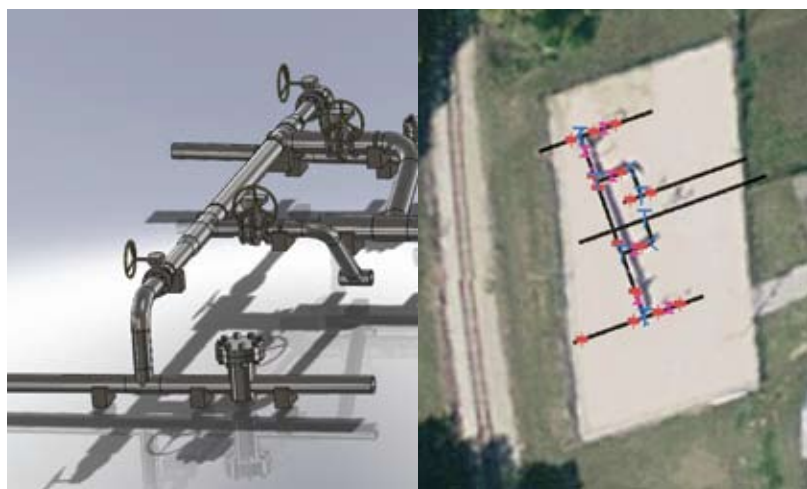


Figure 1. 3-Dimensional GIS Illustration

the pipeline data and facilitate the completion of pre-assessment forms as well as identify the proper indirect inspection tools. In addition to assisting in the analysis, the database output also results in more organized and auditable data records.

Traditional ECDA indirect inspection tools such as Close Interval Survey (CIS), Direct Current Voltage Gradient (DCVG), and Alternating Current Voltage Gradient (ACVG) techniques collect potential values that are a measurement of an area associated with the location of the reference cell placement. Figure 1 depicts the relationship of a reference cell and the area of potential measurement as a function of the pipe depth.

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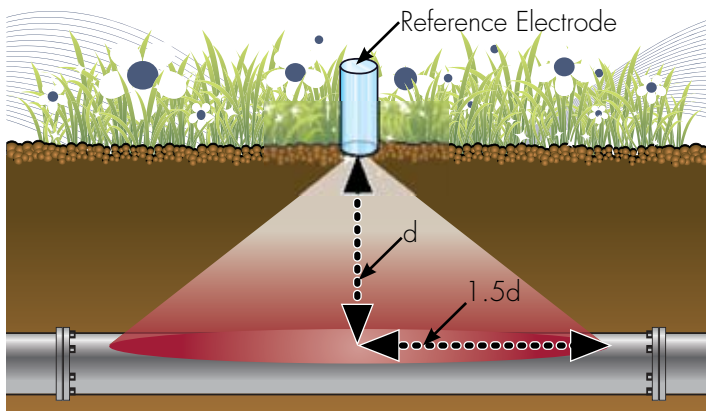


Figure 2: Area Potential as a Function of Pipe Depth

Note in Figure 2, that the area potential measured by the reference cell is a cone with a radius of 1.5 times the depth of the pipe. In a congested area of piping such as a station or plant, many additional structures may exist within this conical area, constructed from various materials (copper, zinc, steel, stainless steel, etc.), sometimes drastically influencing the potential measurements of the intended structure to be assessed. Low potential indications may be a factor of adjacent structures, not a lack of coating or cathodic protection.

#### STRUCTURAL INTEGRITY'S APEC INDIRECT SURVEY TECHNIQUE

To overcome the misinterpretation of indirect inspection measurements, we've designed the APEC indirect survey

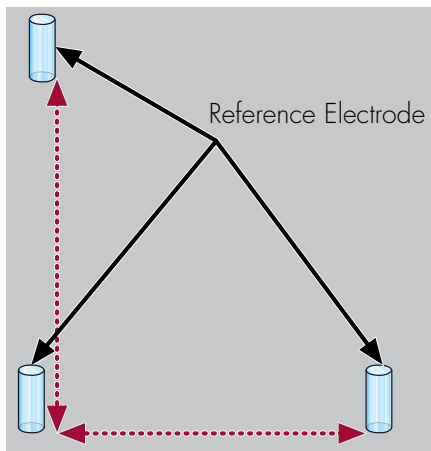


Figure 3: APEC Reference Electrodes and Picture of Example Survey

technique. APEC is a combined CP survey technique that collects area potential measurements based on a modified CIS approach in combination with an evaluation of the earth current movement using an enhanced 3-half cell DCVG methodology (see Figure 3). In a terminal or station environment, it is important to know where any corrosion

cell is operating and where CP currents are flowing. When CP system rectifiers are cycled "ON" and "OFF", the migration of CP current around the plant can be understood and used to adjust and balance the overall performance of a CP system.

Determining ICDA excavation locations can also be a difficult process as the piping is likely to be routed throughout the facility having several inclination changes and changes in dimension. Using 3D GIS and CAD based models, flow variation among different segments can be bracketed and an analysis can be performed so that excavation selection can be optimized to areas most likely to accumulate liquid.

#### CASED SEGMENTS

Similar to station piping, cased segments present a significant challenge to ECDA Indirect Inspection. As illustrated in Figure 4, casings shield the carrier pipe from CP current. As such, traditional Indirect Inspection methods (CIS, DCVG, ACVG, etc.) are ineffective at determining the level of polarization or measuring potential within the casing – measurements typically used as an indication of corrosion control. Another inspection method, Guided Wave Testing, can be a useful tool and is deemed an acceptable assessment approach as long as the prescriptive PHMSA 18-point requirements are followed. However, compliance with these requirements is difficult for longer cased segments and segments with non-favorable coating conditions (such as thick Coal-Tar and Bitumen).

We've also developed a unique program that is not only aligned with recent PHMSA guidelines for performing ECDA on cased segments, but have further developed integrated indirect inspection tools and protocols to more closely follow NACE practices in determining areas of active corrosion. In addition to polarization levels and other commonly used tools and protocols to determine electrolytic or metallic shorts, our program also takes into account actual Cathodic Protection (CP) current density at each end of the cased segment and trends this data to determine if there is adequate CP on the carrier pipeline.

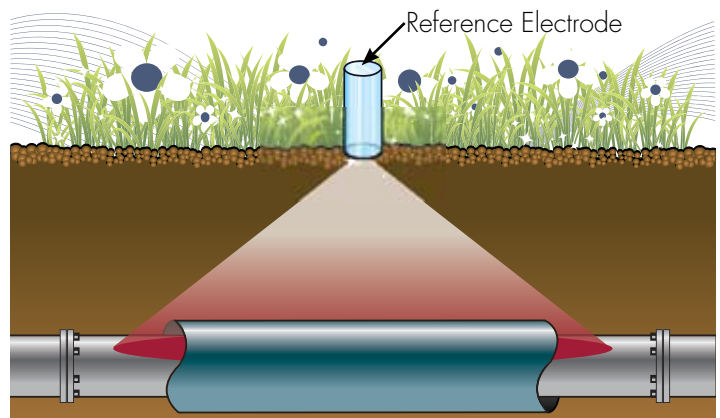


Figure 4: Pipeline Potential - Shielding from the Casing

As a result, a more robust program that prioritizes further examination of cased segments based on susceptibility to corrosion that is aligned with NACE practices can be implemented. In addition, as we are directly involved at each step of the project, we can utilize our engineering knowledge captured during pre-assessment combined with our NDE expertise to apply additional assessment tools when appropriate.