Direct Assessment for Unpiggable Pipelines

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Agenda

✓ Presentation Content

• Background
• Direct Assessment History
• External Corrosion Direct Assessment (ECDA)
• Stress Corrosion Cracking Direct Assessment (SCCDA)
• Internal Corrosion Direct Assessment (ICDA)
• Q&A
Corrosion is a natural process, which converts a refined metal to a more chemically-stable form, such as its oxide, hydroxide, or sulfide.
Pipeline Integrity

“Pipeline integrity is the ability of the pipeline system to operate safely and withstand the loads imposed during the pipeline lifecycle”

DNV-OS-F101

**Corrpro definition:**
Total integrity of a system exists when, under the operating conditions it was designed for, and taking into account the current condition of the pipeline, the predictable risk of its failure (endangering the public, property and the environment) is acceptable.
Direct Assessment History

... where it all began:

- Battelle expert team
- Formed in 2000, operational through early 2002
- Sponsored by INGAA
- Led by Dr. Brian Leis
- Worked closely with US Department of Transportation
- Tasked to develop integrity assessment strategy as an alternative to ILI and hydrotesting
Pipeline Regulations in USA

- Regulations were initiated in 2001 for US pipeline operating companies to develop Integrity Management Programs (IMP’s)
- NACE published RP 0502-2002 “Pipeline External Corrosion Direct Assessment Methodology” in 2002
- NACE and US regulations are now being adopted around the world
What is External Corrosion Direct Assessment (ECDA)?

- A structured process to improve safety and reduce the impact of external corrosion on buried pipelines
- Anticipates future pipeline defects, as well as detecting existing defects
NACE Standard Practice SP0502 provides a methodology for applying the ECDA process to buried onshore piping systems

ECDA is a four-step process:

- Pre-assessment
- Indirect Inspection
- Direct examination
- Post Assessment
The ECDA process may not be applicable on pipelines:

- With disbonded coating
- Ground surfaces such as pavement, frozen ground, and reinforced concrete
- Where measurements cannot be done in a reasonable time frame
- Congested locations with adjacent buried metallic structures
ECDA Data Presentation
ECDA Direct Examination

[Image of a damaged area with a ruler for scale]
Stress Corrosion Cracking Direct Assessment (SCCDA)

SCCDA Indirect Inspection Tools

- Pipe locate and depth-of-cover – AC Current Attenuation (PCM)
- Pipe elevation (sub-meter or sub-foot GPS) for slope magnitude (steep, gentle, flat) and locations on slopes (bottom or top)
- Environment – soil characteristics, drainage and soil resistivity
- Coating defects (DCVG) and cathodic protection deficiencies (CIS)
- In-line inspection information for stress risers (mechanical damage) and appurtenances (bends, river weights, attachments) – ILI may also provide much of above information (GPS, elevation and defects associated with SCC)
What is Internal Corrosion Direct Assessment (ICDA)?

- A structured process to improve safety and reduce the impact of internal corrosion on buried pipelines
- Anticipates future pipeline defects, as well as detecting existing defects
Internal Corrosion Direct Assessment (ICDA)

ICDA Indirect Tools

- NACE SP0110-2010 (WG-ICDA)
  Wet Gas Internal Corrosion Direct Assessment Methodology for Pipelines

- NACE SP0116-2016 (MP-ICDA)
  Multiphase Flow Internal Corrosion Direct Assessment Methodology for Pipelines

- NACE SP0206-2016 (DG-ICDA)
  Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas

- NACE SP0208-2006
  Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines
Internal Corrosion Direct Assessment (ICDA) (§192.927)

- Identify Areas Where Water or Other Electrolyte may Accumulate Inside Pipeline
- Focuses Direct Examination Where Internal Corrosion Most Likely
- Four Step Process
  - Pre-Assessment
  - ICDA Region Identification
  - Identify Excavation Locations and Perform Direct Examinations
  - Post Assessment
- In Addition, Rule Requires ICDA Plan to Include:
  - Criteria for Making Key Decisions for Each Step of Process
  - Provisions for More Restrictive Criteria for First Use
  - Provision for Analysis of Entire Pipeline, Except Remediation Limited to Covered Segments
ICDA Step 1 – Pre-Assessment

- Gather and Integrate Data and Information to:
  - Evaluate Feasibility of ICDA for Covered Segment
  - Support Use of Model to Determine Where Electrolyte may Accumulate
  - Identify ICDA Regions
  - Identify Areas Where Liquids may be Entrained

- Data and Information to Include:
  - All Data Elements of B31.8S Appendix A2 (physical and historical operating data)
  - Information for Model (gas input and withdrawal points, low points, elevation profile, etc.)
  - Operating Data Regarding Historic Upsets
  - Scraper or ILI Use
ICDA Step 2 – Region Identification

- Region Extends From Where Liquid May Enter and Encompasses Area Along Pipeline Where Internal Corrosion May Occur
- Region May Encompass More Than One Covered Segment
- Must Use GRI 02/0057 Model to Identify Regions (unless operator demonstrates another model equivalent)
ICDA Step 3 – Flow Simulations

- Develop Digital Elevation Model
- Assess Inclination Angle and Identify Critical Elevation Changes
- Identify Areas with Water Hold-Up
- Evaluate Water Residence Times
ICDA Step 3 – Dynamic Analysis
ICDA Step 3 – Identify Transit Profile
ICDA Step 3 – Identify Excavation Locations

- Identify Two Locations Within Each ICDA Region
  - One at Low Point Nearest Beginning
  - A Second Location Further Downstream Near the End of ICDA Region
ICDA Step 3 – Perform Direct Examinations

- Dig All Locations Identified and Perform Direct Examination (ultrasonic, radiography or other)
- If Corrosion is Found, Must:
  - Evaluate Severity and Remediate
  - Either Perform Additional Digs or Use Another Assessment Method in Region
  - Evaluate Potential for Internal Corrosion in Covered and Non-Covered Segments with Similar Characteristics and Remediate as Needed
ICDA Step 4 – Post-Assessment

- Evaluate Effectiveness of ICDA Method
- Detailed Route Cause Analysis
- Update Pipeline Risk Assessment
- Adjust Inspection Strategy
- Continue to Monitor Each Segment Where Internal Corrosion Identified
  - UT Sensors or Electronic Probes
  - Analysis of Liquids
- Determine Reinspection Interval
ICDA Step 4 – Post-Assessment

Pipeline Jct. 20A
In-Line Inspection Results vs. Predicted Internal Corrosion Locations

Predicted ICDA Corrosion Sites

50% Wall Loss

Critical Inclination Angle

ILI Defect Depth - %

Pipeline Inclination Profile

Pipeline Elevation Profile

Distance - feet

ILI Defect

Depth - %

50% Wall Loss

Critical Inclination Angle

Distance - feet
Thank you for your participation!