NiSource and Willbros Engineering: GIS and the Direct Assessment Process

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NiSource Gas Transmission and Storage

- Serve 16 states
- Over 15,000 miles of natural gas pipeline from the Gulf Coast to New York
- One of the largest underground storage systems in North America
- Headquarters in Houston
- Significant presence in Charleston WV, including engineering and GIS personnel
Willbros Capabilities

• Provide clients with a single source integrated, technical and remediation/construction solution from concept to completion
• We are a full service provider of Engineering, Procurement, Construction and O&M services
• Project management excellence

- Engineering
- Project Management
- Pipeline Integrity Management
- EPC or Discrete Services
- Pipeline GIS Services
- Operations / Maintenance
- Commissioning & Startup
- Construction Management
- Pipeline Integrity Construction Services
- Logistics
- Due Diligence / Feasibility Studies
- Financing Assistance
- ROW / Permitting
- Procurement
Reasons for Selection of Direct Assessment

- Numerous single feeds to towns and small cities
- Unique characteristics and threats (e.g., age, material, coating)
- Many lines not piggable
- High cost to retrofit for smart pigging
- Low flow and pressure pipelines
Pre-Assessment – Step 1

Data Analysis

• Utilize historic and recent data to determine if ECDA/SCCDA is feasible

• Data analyses
  a) ECDA-Identify appropriate Indirect Inspection tools/methods
  b) SCCDA-Prioritize segments for potential susceptibility to SCC

• Required data typically found in GIS database
Pre-Assessment – Step 1

GIS Support

- Create KMZ files of HCA areas for site visits.

- Overlay GIS data to Populate Pre-Assessment Data.

- Combine GIS and SME reports where necessary to complete Pre-Assessments
Indirect Inspection – Step 2

Indirect Inspection. The Indirect Inspection Step covers aboveground inspections and/or inspections from the ground surface to identify and define the severity of coating faults, other anomalies, and areas where corrosion activity may have occurred or may be occurring. Two or more indirect inspection tools are used over the entire pipeline segment to provide improved detection reliability under the wide variety of conditions that may be encountered along a pipeline right-of-way.

- SCC data includes terrain conditions: Soil type, topography, drainage
Indirect Inspection – Step 2

- Close Interval Survey (CIS) was chosen as 1 of the Indirect Inspection tools
  1. -0.850mV (Cu/CuSO4) polarized potential criteria was utilized as the industry standard to evaluate Cathodic Protection (CP) Performance
  2. An Impressed Current Cathodic Protection (ICCP) Interrupted (On/Off) CIS was conducted to evaluate the pipe to soil potentials along the HCA extents
    a) On/off surveys measure the potential difference between the pipe and the ground surface as the CP current is switched on and off.
Indirect Inspection – Step 2

GIS Support

- Data Alignment
- Pre-Processing and QC of field data prior to GIS processing
  - Data Missing/Bad from vendor.
  - Special characters.
  - Multiple header rows.
  - Abbreviate comments.
- ModelBuilder Toolsets and Models created to perform simple ordered tasks.
  - Centerline from Data.
  - Format data for GIS
  - Calculate reading severity.
  - Load Data to GIS.
Indirect Inspection – Step 2

What to do with the results?

• Report out to engineer to choose dig locations.

• Create Integrity Sheets to include in reporting.
Direct Inspection – Step 3

Direct Examination. The Direct Examination step includes analyses of indirect inspection data to select sites for excavations and pipe surface evaluations. The data from the direct examinations are combined with prior data to identify and assess the impact of external corrosion on the pipeline. In addition, evaluation of pipeline coating performance, corrosion defect repairs, and mitigation of corrosion protection faults are included in this step.

One benefit of performing any of the DA methods is that other pipeline integrity issues may be detected and additional inspections or assessments can be performed with data that has been field-verified.
Data Workflow

Direct Assessment Data Workflow  ECDA/SCCDA

Step 1
- Receive Data from District Survey Data
- Pre-Prove ex Collector

Step 2
- Excavation
  - Pressure Pre-Interval Repair
  - Import Data Into Permanent Geo Database Tables
  - Create Calculated Compartments from Lift Line and Station Data
  - QC Engineer and Geotechnical Engineering/QC
  - Check that all Survey Data can be referenced in Centerline

Step 3
- Creation
  - Create ECDA or SCCDA Sheets for Engineer and Recording-Viewer Initial Dips
  - QC Sheets
  - Send Survey Sheets for Engineer for Review

Step 4
- ECDA Algorithm
  - Add Algorithms Attributes to Tabular
  - Calculate ACV 5 Slope
  - Calculate Slope Stability
  - Calculate PSM Stability
  - Calculate GIS Stability
  - Export Data to FormC3.xls

SCC Algorithm
- FormC3.xls
  - Searc Section Data to create table segments
  - Extract Elevation and Landuse Data from Survey File to create Elevation
  - Calculate Percent Slope
  - Run Pitrun overlays
  - Q&C Overlay results
  - Add Form C, SMR results where needed
  - Calculate Bump between Lift Line to segments
  - Run SCC analysis report on data
  - Highlight Highest scores and send to Engineer
Stress Corrosion Cracking – SCC

SCC- A form of Environmentally Assisted Cracking (EAC) - Occurs below tensile strength due to a combination of stress, corrosive environment, and properties of the material.

Factors Necessary for SCC (High pH SCC only)
• Operating stress >60% SMYS
• Operating Temperature exceeds 100°F
• Segment Less than 20mi downstream of compressor station
• Pipeline Age >10 years
• Coating is other than FBE

(Near neutral SCC excludes temperature factor)
SCC Algorithm

1. Incorporates NACE and CEPA criteria
   a) Client specific criteria & weightings for each situation

2. USGS soils and drainage data
   b) Client data from previous excavation activities

3. Relative risk ranking of all different segments along a single pipeline
   c) Refined as much as data allows- foot by foot segments if needed.

SCC History?  Coating Type & Condition?  Soils & Drainage?  CP -850mV instant off?  Pipe Stresses?
SCC Algorithm

Combination of Python scripts and Visual Basic used to Calculate SCC scores.
Direct Inspection – Case Study

SCCDA : Line 10240 HCA No. 10:100514

- SCC Modeling correlated with Indirect surveys & ILI data over 557 segments
  - 34 segments identified susceptible to SCC
  - 3 excavation sites completed covering all 34 segments
  - Exposing the pipe revealed FBE which eliminated the threat of SCC
    a) SME data and GIS records indicated Coal Tar Enamel
    b) Findings were corrected with NiSource’s GIS database
Direct Inspection – Step 3

Discovery of FBE Coating – Line 10240
Direct Inspection – Step 3

Girth Weld coated in FBE not shrink sleeve – Line 10240
**Direct Inspection – Case Study**

**ECDA : Line B111 HCA No. 1:27595**

- 487 indications identified
  - 2 “Severe” prioritized as “Scheduled”
  - 4 “Moderate” prioritized as “Scheduled”
  - 1 “Minor” prioritized as “Monitored”
  - 480 “NRI” (Non-relevant Indication) prioritized as “Monitored”

- 4 excavation sites completed
  - 3 Chosen Indications – worst case scenarios
  - 1 “Effectiveness/Control dig

- Results of the digs
  - Minor visual damage/coating flaws at all sites
  - Drainage box built on and around pipeline causing damage at one location which was not in the GIS database
Direct Inspection – Step 3

Drainage box built around pipeline!?
Direct Inspection – Step 3

Excavation of drainage box. Standard Engineering Practice??
Direct Inspection – Step 3

Removal of drainage box showing coating damage
Direct Inspection – Step 3

Drainage box removed showing mechanical damage.
Direct Inspection – Case Study

ECDA : Line 8000 HCA No. 45:578781

• 24 indications identified
  o 2 “Severe” prioritized as “Monitored”
  o 22 “Minor” prioritized as “Monitored”

• 4 excavation sites completed
  o 3 “Monitored” indications – worst case scenarios
  o 1 “Effectiveness/Control dig

Additional digs originally selected based off PCM survey indications- A problem with the weighting factors of the survey analysis caused coating discontinuities (patches, wrap type coatings over GW) to be more severe. Adjustments were made to correct this issue and new digs selected

• Results of the digs
  o Extruded polyethylene coating in excellent condition was found which NiSource wanted to confirm.
Direct Inspection – Step 3

Extruded polyethylene coating with patches and wrap over girth weld
Direct Inspection – Step 3

Extruded polyethylene coating with patch and wrap type coating over girth weld
Direct Inspection – Case Study

ECDA : Line UKY HCA No. 10:689001

- Casing excavation using Guided Wave
  - Hard short discovered during excavation
  - Guided Wave would fail due to shorted casing
  - The decision was made to open cut the road
  - Casing was cut off
  - Direct Inspection was performed on carrier pipe where it was cased

- Results
  - Carrier pipe was in good condition except for coating holidays caused by shorted casing
Direct Inspection – Step 3

Casing excavation
Direct Inspection – Step 3

Carrier pipe shorted to casing
Direct Inspection – Step 3

Casing pipe removal process
Direct Inspection – Step 3

Carrier pipe after casing removal—Coating damage from spacer
Direct Inspection – Step 3

Carrier pipe with new coating wrap
Post Assessment – Step 4

Post Assessment. The Post-Assessment Step covers analyses of data collected from the previous three steps to assess the effectiveness of the ECDA process and determine reassessment intervals.
Post Assessment – Step 4

Enterprise GIS data loading.

**DA Schema**
- Regions
- Inspections
- DigSite
- DAIndications
- CISReading
- Reading
- DigAnomaly
- Activity

**Other Schema**
- Coating
- Casing
- PipeSegment
Centerline adjustment – Case study:
Blue is where the centerline was moved based on Step 2 surveys and the Red line is where the original centerline existed from the digitization process from the maps. The largest adjust length was measured to be roughly 172 feet from the original centerline.
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Conclusion

Summary

1. Direct Assessment Starts and Ends with GIS
   - All Steps in the Direct Assessment Program Correct/Populate the GIS Data
     - SME input fills in Data and Operational Gaps
     - Record Research and Field Verification used to supplement GIS Data
     - GIS data improvement is never complete

2. Lessons Learned
   - Research and Validate Data early as possible in the process
   - Complete Interruption Plans Critical to continuing the Program
   - Alternative Assessment Methods Defined/Scoped