Direct Assessment
Activities by NYSEARCH/NGA & NGA

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DOT R & D Forum
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NYSEARCH/NGA Initiatives for Direct Assessment (DA)

- Phase 1 ECDA Validation Project
  - March 2002 – April 2003

- Phase 2 DA Project
  - April 2003 – September 2004

- ECDA Criteria Project
  - June 2004 – mid-2006

- RFP related to Difficult Applications of DA
  - Projects initiated December 2004

- NGA activity related to evolving Industry Standards
Phase I and Phase II Participants

♦ Nine NYS LDC NGA members participated in Ph I DA Validation Project:
  - KeySpan
  - National Fuel
  - NYS Electric & Gas
  - Niagara Mohawk
  - Rochester Gas & Electric

♦ Twelve LDCs participating in Ph II DA Project:
  - KeySpan
  - National Fuel
  - NYS Electric & Gas
  - Niagara Mohawk
  - Rochester Gas & Electric
  - Questar

♦ NY PSC involved from start as active participant
Phase I NYS DA Process Validation

Project Objectives

♦ Demonstrate that ECDA is a valid alternative to ILI and pressure testing
♦ Prove to NGA-NY members, NYS PSC Staff, and federal regulators that ECDA can be used to assess pipeline integrity with respect to external corrosion, coating flaws and third party damage
♦ Fill an industry gap for quantitative validation
Key Project Elements

♦ Consistent with RP0502
♦ Process applied in a consistent and structured manner across NYS allowing pooling of data
♦ Industry expert, CC Technologies – objective third party
Phase I DA Process Validation Project

The DA process was validated by:

- Demonstrating that ECDA as performed by NGA -NY companies (and in compliance with the NACE RP0502) discriminates between pipeline locations in good and poor conditions with respect to corrosion and/or coating damage.
Phase I Technical Approach

- Nine NGA members performed ECDA on ~ 2 mile segments (total 20 miles)
- Utilized indirect survey tools and selected locations on the pipe predicted to have indications and predicted to have non-indications (controls).
- Excavate ECDA indications and controls and assess condition using 3 separate metrics
  1. Coating damage
  2. Corrosion damage (i.e., metal loss)
  3. Corrosivity (e.g., soil chemistry at pipe surface)
- Compare predictions to actual results
- Perform statistical analysis
Phase II Technical Approach

• Phase II included adding to Phase I validation (total ~60 miles)

• Redo analysis to decrease statistical uncertainties
  • Interpretation of probabilities require consideration of confidence intervals

• Develop understanding and approach for addressing challenging or difficult environments with DA
Project Definitions

- **Indications:** Locations on pipe predicted to have anomalies. (Anomalies=coating flaws, external corrosion, metal loss, third party damage)

- **Controls (non-indications):** Locations on pipe predicted to be in good condition.

*Indications and controls selected based on survey data, pre-assessment information and operator knowledge of system*

Controls required to conduct statistical analysis
ECDA Validation

- ~60 miles of pipe
- 113 excavations
  - 84 indications
    - 81 locations with coating flaws
      - 18 corrosion damage
      - 3 mechanical damage
    - 29 controls
      - 25 no damage
      - 4 coating flaw

<table>
<thead>
<tr>
<th>Indication Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Metal Coating Flaw Only</td>
</tr>
<tr>
<td>Disbonded Coating Only*</td>
</tr>
<tr>
<td>Exposed Metal &amp; Disbonded*</td>
</tr>
<tr>
<td>No Coating Damage</td>
</tr>
<tr>
<td>Total Excavations</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Indication</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Corrosion Damage Only</td>
</tr>
<tr>
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</tr>
<tr>
<td>Total Excavations</td>
</tr>
</tbody>
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Binary Logistic Regression

- \( P(\text{defect}) \) at indication is 96%
  - \( P(\text{no defect}) \) is 4%
  - Odds of finding a defect at indication 27 to 1

- \( P(\text{defect}) \) at control is 14
  - \( P(\text{no defect}) \) is 86%
  - Odds of finding a defect at a control 1 in 6

- Odds ratio of finding a defect at indication vs. control is 169 to 1
Examples of Validated Data

Mechanical damage detected by ECDA and apparently caused during installation of fiber optic cable.

Corrosion damage detected by ECDA.
Phase I Conclusions

- Data collected supports ECDA as a valid integrity management tool
- ECDA on par with ILI and pressure testing
- Improved technical capability by member companies to perform DA
- Elevated NYS PSC understanding of DA
Lessons Learned about DA Implementation

Overall:

♦ DA requires a high attention to detail

♦ DA requires a thorough engineering analysis and approach

♦ Communication essential!
Additional Activities in Phase II

♦ Develop consistent DA approaches and protocols for “special areas”
  – Cased pipe
  – Bare pipe
  – Inaccessible pipe
  – Stray current areas

♦ Test new long range guided wave inspection tools

♦ Develop DA Plans for NGA Integrity Management Program
Special Applications of DA

♦ Stray Current
  – Reduce measurement errors – guideline document

♦ Uncased crossings
  – Modify conventional ECDA tool application
    • P/S Potential (measurement or calculation)
    • Current Attenuation (macro)

♦ Cased pipe
  – Focus on mechanism for corrosion susceptibility
  – Prioritize casings likely to have corrosion

♦ Bare pipe
  – Prioritize corrosivity
  – Consider CIS accuracy
Field Tests and DA to Address Cased Crossings

- Focus on mechanism for corrosion susceptibility
  - Prioritize casings by likelihood of corrosion

Diagram:
- Electrically Isolated
- Electrolytic Short
- Metallic Short
- Electrolytic & Metallic Short
DA to Address Bare Pipe

- Coating flaw tools not relevant
- Potential measurement more accurate
- Other prioritization tools for corrosivity
  - Soil Properties (e.g., resistivity)
NGA Work to Finalize DA Plans

♦ Multiple constraints
  – Detailed specificity (including criteria)
  – Operator flexibility (for customizing)
  – Technical accuracy

♦ Plans for insertion to IMP*
  – ECDA
  – ICDA
  – SCCDA

*Overall plan developed by Gulf Interstate for NGA
Phase II Conclusions

♦ Validation further improved
♦ Protocols developed
  – Inaccessible
    • Straightforward but pipe-specific
  – Stray
    • Issues known
  – Cased
    • Approach good, direct examinations still issue
  – Bare
    • Some success, more to do, work ongoing in industry

♦ DA Plans developed
  – Living documents
NYSEARCH/NGA ECDA Criteria Development Project

♦ NYSEARCH/NGA teaming with CC Technologies & University of Florida

♦ Main objective: Develop an Excel spreadsheet tool which aids the operator in selecting and prioritizing indications (and digs)
Selecting Direct Examinations

How does the operator select where to excavate?

- Survey data (Indirect Inspections)
- Use of Preassessment data
- Operator knowledge of the system
- Expert opinion
- Sound engineering judgment

SUBJECTIVE PROCESS
Selection of Digs

♦ Subjectivity used to consider site specific parameters and pipeline conditions influence selection

♦ Problem – Gas Rule requires uniform criteria for prioritization
  – Industry response is to use company specific numerical criteria without consideration for pipeline conditions
    • Too many digs ($$), or the wrong digs (safety)

♦ Solution – develop objective pipeline-specific criteria to work *in conjunction* with the process used today
Benefits of ECDA Criteria Model

In summary, criteria could help operators:

♦ Prioritize indications and determine where to dig as this process is often challenging

♦ Satisfy Pipeline Integrity Rule requirements

♦ Better defend dig locations (e.g., to regulators)

♦ Provide increased consistency among the NGA/NYSEARCH members
Examples of ECDA Criteria

♦ CIS Criteria
  – CP effectiveness criteria (i.e., -850mV or 100mV)?
    • What change is significant?
    • Is on/off relevant?
    • What is proper survey spacing?

♦ DCVG (or ACVG) Criteria
  – %IR and/or mV drop
    • Depends on soil resistivity, pipe defect geometry/size, anode configuration, applied current

♦ Current Attenuation
  – % attenuation depends on resistivity, polarization level/character, galvanic anodes, etc.
Need Criteria Specific to Pipeline Region

♦ Most tools relate above ground measurement of current or potential to coating or corrosion condition
  – Based on E and I distribution around pipeline coating flaws and affected by
    • CP level, resistivity, coating condition (including defect interaction), polarizability, galvanic anodes, depth of cover, Pipe OD.
♦ Use CP predictive models
♦ A bonus: technical basis for survey spacing
Single Mg Anode
Off Potential with Coating Flaw
ECDA Criteria Modeling
Sample Output
NYSEARCH/NGA Projects to Address Special Applications of DA

- TWI/FBS Long Range Guided Ultrasonic Inspection Technology
- SwRI – Development of Long Term Monitor Using Magnetostrictive (MsS) Sensor
- FINO AG – NoPig Inspection Technology
- CCT – Enhanced Voltmeter to Address High Impedance Areas

  - Testing funded and new approaches
  - Using for DA training and new technology evaluation
Current Thinking on Potential Gaps & Challenges

- Need to further develop quantitative bases for ECDA decisions
- Need to customize ECDA for specific pipeline regions
- Need to study root causes of corrosion
- Need to improve interpretation of indirect inspection survey data
- Gaps exist for pieces of special ECDA areas: station piping, multiple pipes in ROW, etc.
Overall Summary

♦ ECDA process working well
  – Validated on pipes typical of most systems
♦ Procedures are necessary for special applications within a segment
♦ DA plans for IMPs are in place
♦ Custom ECDA criteria being developed
♦ Members stepping up activities on ICDA
♦ Technologies to address special applications are being developed but gaps still exist