R&D in DA Assessment and Unpiggable Pipelines Robotic Platforms

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NYSEARCH – Northeast Gas Association

Northeast Gas Association

- NGA: New York State and New England natural gas trade association
- NGA: Merger of New York Gas Group and New England Gas Association 1/1/03
- NYSEARCH: R&D Committee of NGA
  - 10 Members and 5 Associate Members

Pipeline Integrity R&D Focus

- Efforts focused in two fronts
  - Risk Assessment
    - Develop needed tools for risk assessment of pipelines
  - Direct Assessment
    - Establish our ability to use DA as an alternative to ILI and hydrotesting
  - Robotic Platforms for unpiggable pipelines
    - Develop the necessary platforms for the deployment of sensory devices for the in-line inspection of unpiggable pipelines

Direct Assessment

- Objectives
  - Prove to NGA members and PSC Staff that DA applied according to the NACE standard can be used to assess pipeline integrity with respect to external corrosion, coating flaws and third party damage.
  - Demonstrate that DA is a valid pipeline integrity alternative to in-line inspection and pressure testing.

Direct Assessment (continued)

- Two phase effort
- Phase I: Study ability of ECDA (applied consistent with the NACE Standard Recommended Practice) to serve as an integrity verification tool
  - 9 month effort; completed April ’03
- Phase II: Extend study to add to the DA database created in Phase I and develop approaches for pipe in special areas (cased pipe, crossings, bare pipe), test survey tools for inaccessible pipe, and perform ICDA according to the NACE Standard
  - 12 month effort; to be completed in March ’04

Phase I DA Process Validation

- First comprehensive and systematic study of ECDA consistent with the NACE Standard Recommended Practice as an integrity verification tool
  - 9 month effort; completed April ’03
  - 9 companies participated
  - ~20 miles of pipeline assessed

Key Elements of Phase I Project

- PSC staff as a project partner
- Adherence to NACE ECDA TG041 Standard to validate DA
- DA process applied in a uniform and structured manner across NYS by the operators
- Industry expert, CC Technologies, compiled and analyzed results – objective third party

Technical Basis

- Utilized indirect survey tools to identify locations on pipe predicted to have indications and non-indications (ie, controls)
- Excavated and assessed ECDA indications and non-indications
- Compared predictions to excavation results
- Performed statistical analysis

Results of Phase I ECDA

66 excavations

- 43 indications
  - 40 locations with coating flaws
    - 11 corrosion damage
    - 2 third party damage
  - 3 no damage
- 23 controls
  - 22 no damage
  - 1 coating flaw

Binary Logistic Regression

- 98% probability of finding an anomaly at indication
- 88% probability of finding no anomaly at control
- Odds ratio of finding an anomaly at indication vs. control is 293 to 1

*Consider 95% confidence interval

Conclusions of Phase I ECDA

The DA process was validated by:

- Demonstrating that ECDA as performed by NYSEARCH companies (and in compliance with the NACE TG041 standard) discriminates between pipeline locations in good and poor conditions with respect to corrosion and/or coating damage.

Lessons Learned about DA Implementation

Overall:

- ***DA requires a high attention to detail***
- ***DA requires a thorough engineering analysis and approach***
- ***Communication essential!***

Phase II DA Process Validation

- Enhance existing database from Phase 1
- Develop improved DA approaches for pipe in special areas: cased pipe, crossings, bare pipe.
- Test survey tools for inaccessible pipe (cased, crossings):electromagnetic wave inspection; long range ultrasonic inspection
- Perform ICDA according to the NACE Standard

Phase II DA Process Validation

(continued)

- Effort initiated 4/03; to be completed 4/04
- Additional ECDA to support validation
  - Expecting ~60 of pipeline miles to be assessed
  - 12 companies participating (in and out of NYS)
- Develop ECDA methods for special areas
  - Cased and uncased crossings
  - Bare pipe
- ICDA demonstration

Robotic Platforms for Unpiggable Pipelines - Objectives

- Conduct research and development in support of new technologies that will allow the internal inspection of presently unpiggable LDC-owned transmission pipelines
  - Identify and evaluate critical technologies
  - Build prototype platform systems
  - Not sensor focused

Robotic Platforms for Unpiggable Pipelines (continued)

- Three phase effort
- Phase I: Conduct feasibility study to determine our ability to develop integrated locomotor/sensor robotic systems for the inspection of presently unpiggable LDC-owned pipelines
- Phase II: Study/test technologies identified as critical
- Phase III: Build prototype systems

Background

- Based on member/funders survey developed system requirements:
  - 12” to 24” pipe sizes; up to 0.5” wall thickness
  - About five (5) miles run length
  - Typical flow velocities of 25 ft/s, maximum 150 ft/sec.
  - Able to negotiate plug valves, mitered bends, compound 90–deg bends, diameter reductions of two pipe sizes
  - Detect defects due to internal and external corrosion
  - Modularity for detecting gouges, ovality, and weld failures
  - Minimize number of hot-taps
  - Minimize extent of excavations needed for launching

Phase I- Feasibility Study

- Two parallel efforts carried out
  - Foster-Miller/GE Power Systems (PII)
  - Automatika Inc./Maurer Engineering
- Carried out feasibility study based on system requirements developed
  - 7 month efforts
  - Funded by NGA and SoCalGas
  - Different approaches reached similar results

Outcome of Phase I- Feasibility Study

- Robotic platforms for ILI are possible; commercial success depends on performance of critical technologies
- Four Critical Technologies were identified
  - Locomotor
  - Mode of operator-robot communication
  - Sensor
  - Battery-life extension

Phase II- Evaluation of Critical Technologies

- NYSEARCH is continuing with the two parallel efforts through this Phase
  - Automatika (funded by NGA, OTD, SoCalGas)
  - Foster-Miller/PII (funded by NGA, DoE)
- Similarities
  - battery powered - modular
  - semi-autonomous - able to negotiate all obstacles
- Differences
  - locomotors
  - mode of communication-robot control

Phase II- Evaluation of Critical Technologies (continued)

- Automatika
  - locomotor based on EXPLORER
  - wireless communication for live data transmission and control
  - battery recharge system

Phase II- Evaluation of Critical Technologies

- Foster-Miller
  - locomotor based on Pipe Mouse
  - fiber optic tether for live data transmission and control
  - Segmented MFL sensor able to pass through plug valves

Phase-II Efforts - Ongoing

- F-M/GE(PII)
  - Locomotor seems to be meeting requirements
  - Tether option seems to be viable under certain conditions
  - Segmented MFL sensor seems to be able to provide needed accuracy
- Automatika
  - Wireless option seems to be viable under certain conditions
  - Locomotor and battery recharge system work just initiated

Summary

- Multifaceted approach to Pipeline Integrity a clear necessity given complexity of problem
- NYSEARCH/NGA members are actively validating Direct Assessment on approx 80 miles of qualifying transmission lines
- NYSEARCH/NGA and partners have identified the challenges presented by unpiggable lines and are addressing them

Summary (continued)

- Need for LDC and government role clear; manufacturers/service providers are interested but not as proactive as the utilities who face implementation of new rule
- Collaborative cofunding is key to keeping gas industry needs at the forefront

More Information

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