Pipeline Research Council International, Inc.

Technology Development for Pipeline Integrity

Current Features & Coming Attractions

API 2012 Pipeline Conference & Cybernetics Symposium
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Agenda for Briefing

- The S Curve and Technology Development – Linking the Flat Parts
- New Technologies and Processes
- Emerging Technologies to Monitor
- Role of R&D in Technology Development – Industry R&D Roadmap
Technology Development

- Industry slow to adapt/change – challenges to technology development and application
- Evolution and “step change”
- “move the needle quickly” - requires protein
- Balancing the R (or “r”) with the D&D
PRCI Integrated Program for Technology Development

**PRCI In-Line Inspection Projects**

- **EC-4 Program**
  - Mechanical Damage
    - Dual Field MFL (1-1)
    - Current Tool Performance (MD 1-2)
    - MFL Signal Analysis (MD1-3)
  - MFL-Vintage Welds (NDE 1-1)
  - Integrated Cleaning & Inspection Tool (NDE 1-3)
  - EMIT ILI (NDE 1-4)

- **Stress Corrosion Cracking**
  - SCC 3-4
  - SCC 3-7
  - SCC 3-12

- **Weld Fatigue Cracking**
  - Fatigue Cracks on Heavy Wall Gas Risers and Pipeline (SPIM 1-2)

- **ERW Pipe Program**

**Test Samples for Program**

- Create Dent + Gouge (MD 1-10, MD 1-11, MD 4-7)
- Create Cracks in Dents (MD 4-2)

**PRCI Sample Repository**

- Detection, Sizing and Characterization of SCC and Other Cracks in Dents in Liquid Pipelines (SCC 3-4)
- Technologies to Detect Fatigue Cracks in Heavy Wall SCRs (SPIM 1-2)

**PRCI related in-ditch projects**

- **EC-4 Program**
- **ERW Pipe Program**
- SCC 2-8/3-6
- SCC 3-5
- SCC 3-10
- JENTEK MWM NDE 2-1
- JENTEK MWM MD 1-4
- MD 1-5
- MD 1-6
- MD 1-8
- IOS SBIR

**Key:**

- SCC/cracking
- Mechanical Damage
- General NDE
- Corrosion

**Input to Models**

**Improved Repair and Decision Making**
Building Solutions Through Technology

- Mechanical Damage Program - Inspection technologies challenges
  - Complexity of issues
  - Secondary features
  - Experimental vs. actual field sites

- Recent advances in program – using tools to manage MD (and other) threats - ILI with in-ditch NDE

Identical depths; very different equivalent strain - need tools to quantify accurately

Depth alone is insufficient – need to move to dent profile + strain and stress distributions, cracking, other features
Dual-field MFL ILI Tool

- Tool Setup for both gas and liquid lines – runs completed in each
- Results provided for:
  - Metal loss
  - Hard spots
  - XYZ mapping
  - ID anomalies
  - Mechanical damage
1. Dents<6% with high strain
2. Dents>6% with low strain
Signal Decoupling analysis – 500+ dents on two pipelines – inspection set selected

Detailed technology applied for NDE in-ditch inspection for second tool run in gas line – 3D laser scan (from MD 1-4) and MWM-array

Dual Field Tool and in the ditch measurement methods provided important anomaly information for dents perimeter shoulder

- Magnetic permeability fields – residual stresses
- Cracking in dented region
Development of NDE Reference Standard & Procedure Qualification – External Corrosion

- **Calibration Standards for procedure qualification**
  - 51 Distinct Calibration Features on 3 Different Diameter Pipes
  - Determine actual ML depth w/ surface replicas measured by white light interferometry, +/- 5 μm

- **Replication Process**
  - Meets ASTM E1351 for field metallographic replicas
  - Resolution down to 0.1 micron
  - Negligible shrinkage
  - Replicas are being stored - provide reference std

- **Develop Correction Factors – ILI Performance**

- **Other features**

<table>
<thead>
<tr>
<th>NDE Technology</th>
<th>Depth Error %wt</th>
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<tbody>
<tr>
<td>Digital Pit Gauge</td>
<td>+/- 1.09%</td>
</tr>
<tr>
<td>Ultrasonic Pen Probe</td>
<td>+/- 1.39%</td>
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<tr>
<td>3D Laser</td>
<td>+/- 1.96%</td>
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Applying the Data – True ILI Performance

- **Application Error: Correlating ILI with Actual Measurements**
  - Effects of different in-ditch measurement techniques on ILI data
  - 20” and 36” diameter pipe – numerous features; depth and length, unity plots

- **True ILI performance – corrected for NDE error**
  - Length (not shown; challenging)
  - Depth

**Consolidated Guidance Document**
Methods for determining ILI accuracy
Validation sample selection
Process and recommendations for systemic bias measurement and correction
Recognition and response to random and systemic error

- **Reliability-Based Integrity Management Program**
- **PRCI NDE Repository**
Integrated Cleaning & Inspection Tool

• “Semi-smart” pig - the opportunity - make enhanced use of cleaning runs – e.g., ILI interval - 120 Months vs. cleaning interval – monthly
  • Trending Δ on wall thickness using low resolution data, enhance integrity planning & the deployment of high resolution ILI tools
• Development of two systems
  • Electromagnetic Impedance (EMIT)
  • Meandering Winding Magnetometer (MWM)
Proposed tool does not need to achieve same level of resolution as current ILI tools:

- Sensitivity may be insufficient to get accurate estimates of wall loss but error is reduced through repeated measurements (i.e., more data sets)
- By overlaying more frequent results, we can achieve improved ILI planning
- See if there is overall growth in anomaly size from intermediate results.
- Wall thickness alone does not explain what is happening in terms of degradation.
Recent pipeline incidents have raised interest in confirming records for pre-1970’s “grandfathered” pipes

Many of the systems will be challenged to provide data and records that are “traceable, verifiable, and complete”

- POs, MTRs, and construction records not always available for pre-1970’s vintage pipelines
- Basis for MAOP
- Add “as built” ILI data to supplement available records to meet the requirements for records due diligence and confidence in MAOP

ILI technologies are improving and many of the sensors could provide data to support the determination of conditions where records are limited or absent – combo tools/sensors
Technical Approach

- **6 Tasks – focus is on confirming ILI capabilities**
  - Material properties
  - Manufacturing features/imperfections
  - Weld types and inconsistencies
  - Large anomalies in welds
  - Coatings condition assessment

- **Initial background work and framing the issue**
  - Manufacturing history and associated metallurgy
  - Assessment of ILI relative to challenge of grandfathered pipe

- **New look at data processing and algorithms**

- **Testing and verification**

- **Reporting and verification of ILI as alternative to overly conservative use of hydrotest in all cases**
Developing the Industry R&D Roadmap

PRCI is Conduit for Industry
- Gas, liquid, industry associations
Owner of R&D Roadmap
Continuous Feedback Loop

Identify R&D Partnerships
Monitor PHMSA R&D Program
Information Sharing & Repository
Communication & Deployment
R&D Roadmap & Industry Focus

Top R&D Needs

- Unpiggable Pipelines
- ERW/Longitudinal Seam Welds
- Leak Detection
- Data Integration & Decision-making Processes/Tools
- SCC & Cracking – welds and pipe body
- Anomaly Assessment
- Mechanical Damage
- Damage Prevention
- Improvements in ILI capabilities
- Facility Integrity
- Risk Assessment

Consistent with PRCI Programs and Roadmaps
Closing Slide
Thank you for your attention
Questions?

Follow-up questions or information needed:
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