STRESS-CORROSION CRACKING
DIRECT ASSESSMENT
Current Research and Future Needs

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SCC DA

- Identifying locations of highest probability of SCC is critical to success
- NACE RP 0204 provides general guidance on factors to consider but little specific guidance
- Some companies have developed useful correlations from extensive dig programs or ILI runs
J. A. Beavers and W. V. Harper,

“SCC Prediction Model” NACEExpo 2004

• Gas transmission pipeline, primarily asphalt enamel coating, DSAW
• Near-neutral-pH SCC
• Conclusions
  – 18 times more likely to find SCC with one manufacturer than with other manufacturers A
  – 3 times more likely to find SCC with asphalt than with other coatings (coal tar, epoxy urethane, FBE and wax) (No tape coating on the line)
  – 4 times more likely to find SCC with glaciofuvial soil than with lacustrine soil
Near-neutral pH SCC on a gas pipeline

Verified model with 6 digs
- 5 true positives
- 1 true negative
- No false positives or negatives

Three important parameters
- **Mild corrosion** (<10% w.t.) determined with high-res. MFL tool
- **Intact (but disbonded) asphalt coating** as determined from close-interval on/off P/S survey (No SCC under coal tar)
- **Alluvial deltaic modified sands** where drainage was influenced by topography
IPC04-0267: A Statistical Model for the Prediction of SCC Formation Along a Pipeline, O. Youzwishen, et. al.

- Tape coated, ERW, liquid pipeline
- Near-neutral-pH SCC
- Model based on ~120 digs, confirmation based on 11 digs
  - 7 true positive, 1 true negative, 3 false positives
  - 48% of “corrosion” digs found SCC
- Most important parameters: Proximity to mild corrosion and CP level
- Other relevant parameters: CP shift, ground depression, bend angle of the pipe, direction of the bend
- More confirming activities are planned
• Near-neutral-pH SCC on liquid line
• Developing correlation with pressure cycles and soil/terrain
The Enbridge 15-5-1 Approach - Loading Rate Analysis

Data can be analyzed for different operating pressure ranges

USCD ILI tool:
- Stations 1, 2, 3, and 4 – shallow SCC (metal loss -ML)
- Stations 5 and 6 – shallow (ML) + significant SCC
Factors Correlating with SCC Sites from Past Field Studies

<table>
<thead>
<tr>
<th>Factor</th>
<th>High pH Gas P/Ls</th>
<th>NN pH Gas P/Ls</th>
<th>NN pH Liquid P/Ls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proximity to other SCC failures</strong></td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Discharge of compressor station</strong></td>
<td>Strong</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Suction of compressor station</strong></td>
<td>Negative</td>
<td>1 case</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Strong</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Class I location</strong></td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Age (&gt; 15 years)</strong></td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Coating type (tape, coal tar, asphalt)</strong></td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Coating condition (disbonded)</strong></td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Soil moisture level</strong></td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Mild corrosion</strong></td>
<td>None</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Stress cycles (R &amp; frequency)</strong></td>
<td>??</td>
<td>??</td>
<td>Strong</td>
</tr>
<tr>
<td><strong>Soil type</strong></td>
<td>None</td>
<td>Area specific</td>
<td>Area specific</td>
</tr>
<tr>
<td><strong>Terrain</strong></td>
<td>Weak</td>
<td>Area specific</td>
<td>Area specific</td>
</tr>
</tbody>
</table>
SCC DA -- Current Research

• Guidelines for the Identification of SCC Sites and the Estimation of Intervals for SCC DA
  – NRTC plus various subcontractors
  – Funding from PHMSA and PRCI
  – Initial approach: Mechanistic model based upon information from literature
  – Added approach: Validate model with field experience from industry survey
SCC DA -- Current Research

- SCC Data Mining
  - BIZTEK Consulting plus subcontractors
  - Funding from PRCI
  - Approach: Correlate severity of SCC as determined from ILI, hydrotesting, or extensive dig programs with operational and environmental factors
    - Gas and liquid pipelines
    - High-pH and NN-pH SCC
SCC DA -- Current Research

- JIP on Management of SCC in HCAs on Gas Pipelines
  - BIZTEK Consulting and Macaw Engineering
  - Funding from El Paso, Great Lakes, Panhandle, Spectra, and TransCanada
  - Approach: Develop more specific guidelines based upon industry experience
SCC DA -- Current Research

- Field Studies to Inspect for SCC
  - Various pipeline companies
  - Self funded
  - Approach: Develop algorithms for locating SCC based upon ILI, hydrotest, or dig programs
SCC DA -- Remaining Gaps

• Crack growth rate models based on measurable parameters, with emphasis on the effects of pressure fluctuations
  – Useful for selecting sites, determining intervals, and possibly prevention or mitigation
  – Parameters
    • High pH and NN pH
    • High and low amplitudes, high and low frequencies
    • Differentiate between corrosion fatigue and SCC

• More field correlations