Adding Value to CPM Testing

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Overview

• Introduction to the Norman Wells Pipeline

• CPM Testing Introduction

• CPM Testing Methods:
  • API 1149 Assessment
  • API 1130 Testing
  • Simulated Leaks
  • Fluid Withdrawals

• Adding Value to Testing:
  • Cost-Benefit Planning
  • Evaluation of new CPM Systems
Norman Wells Pipeline

- Operational in 1985
- First pipeline in permafrost
- Chilled injections
- Length = 869 km (540 mi)
- NPS 12 inch
- Pump stations = 3
- Two Injections, One Delivery

Map showing the pipeline route from Norman Wells to Zama, Wrigley, and Mackenzie in Alaska.
What is a Computational Pipeline Monitoring System?
• Computer software that uses pipeline data to infer leaks.
• Alarms upon anomalies that have the characteristics of a leak.

Why do pipeline operators need to test the performance their CPM systems?
• Due diligence
• Standards best practice in API 1130 (U.S.) & CSA Z662 Annex E (Canada)
• System Development
• Final Testing
• Re-Testing

What are the methods to test CPM systems?
• API 1149 Assessment
• Parameter Manipulation
• Software-based Simulated Leaks
• Fluid Withdrawal
API 1149 Assessment

• Based on API publication: Pipeline Variable Uncertainties and Their Effects on Leak Detection
• Used to estimate theoretical leak detectability of a pipeline with a specified configuration and instrumentation.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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</thead>
<tbody>
<tr>
<td>• Can perform programmatically</td>
<td>• Highly theoretical</td>
</tr>
<tr>
<td>• System independent</td>
<td>• Valid for steady state conditions only</td>
</tr>
<tr>
<td>• Capable of predicting future detectability for instrumentation improvements and additions</td>
<td>• Does not reflect state estimation</td>
</tr>
<tr>
<td></td>
<td>• Valid for mass balance systems only</td>
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API 1149 Assessment

Example:
Parameter Manipulation

- Alter an input parameter, such as a flow reading, to create a process measurement anomaly for the CPM system.
- Parameter can be changed in SCADA or in the CPM settings.
- Recognized as a testing method in API 1130

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<th>Pros</th>
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<tbody>
<tr>
<td>Can perform programmatically</td>
<td>Not hydraulically accurate</td>
</tr>
<tr>
<td>API recognized testing practice</td>
<td>Leak locations are limited to instrument locations</td>
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<tr>
<td>More reflective of the tested CPM system</td>
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Simulated Leaks

- Uses an accurately tuned offline simulation model (Simulator) to create leak data that is used as input for the CPM model
- Various leak sites and leak sizes can be created to test MBS leak sensitivity. Recognized as a testing method in API 1130

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<tr>
<td>• Hydraulically complete</td>
<td>• Time-intensive and costly to develop</td>
</tr>
<tr>
<td>• Applicable to any size pipeline</td>
<td>• On going maintenance costs involved with keeping the simulator up-to-date</td>
</tr>
<tr>
<td>• Applicable to all operational scenarios</td>
<td></td>
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<tr>
<td>• Leak sites can be anywhere along the pipeline</td>
<td></td>
</tr>
<tr>
<td>• Capable of predicting future detectability for instrumentation improvements and additions</td>
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Simulated Leaks

Output of Simulator Model

- **XX INJECTION FLOW**
  - Field: 1561.9
  - Model: 116433
  - Time: 10/10/24 06:00:00

- **XX STN PRESSURE**
  - Field
  - Model: 1S
  - Time: 10/10/24 06:00:00
Fluid Withdrawal

- Removal of commodity from the pipeline into trucks or tanks.
- The preferred method of testing a CPM system.

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</table>
| • Direct test of the CPM system  
• API recognized testing practice  
• Real operational and leak data  
• Validates operational leak response procedures | • Costly to perform  
• Limited by operational constraints  
• Storage limitations prevent tests that require large amounts of commodity to be removed |
Fluid Withdrawal

November Arctic Fluid Withdrawal
Application of API 1149 assessment for doing a cost-benefit analysis on the addition or upgrade of instrumentation and improvement in leak detectability.
Cost-Benefit Analysis

Example: Improvement in leak detectability after instrumentation upgrades
Evaluation of New CPMs

- Performance of CPM systems is largely dependent on the configuration of the pipeline and its instrumentation.
- Difficult for pipeline operators to make an informed decision on which CPM system to purchase without a trial run.
- Trial runs are not feasible because of the high costs of configuring and installing the trial systems.
- Data produced from simulated and withdrawal leak tests can offer a cost effective way of evaluating several CPM systems at once.
Evaluation of Multiple CPM Systems for the Norman Wells Pipeline

• Enbridge gave 4 vendors pipeline configuration information and a set of operational pipeline data for “typical” operation.
• Two sets of operational data, extracted from withdrawal and simulated leak tests, were provided with leak information embedded.
• Vendors ran the scenario data through their offline systems and reported on their output:
  • time of leak
  • location of leak
  • size of leak
Evaluation of New CPMs

Time to detect leak

Location of leak

Size of leak
Thank You

Questions?