FACILITY PIPING, A RISK ASSESSMENT APPROACH

Matt Crist
Equipment & Inspection SME
Phillips 66 Pipeline LLC
Houston, TX
UNKNOWN WHICH NEED TO BE ANSWERED

- Where to start?
- What type of risk assessment would fit the facility setting?
- What tools are there to reduce risk?
- What inspection scope of work would provide the best evaluation of facility condition?
- What frequency would be needed to sustain facility integrity?
AGENDA

- Risk Reduction Process
- Risk Assessment Tool
- Consequence of Failure
- Likelihood of Failure
- Mitigation
- Success Stories
- Summary
Risk Reduction Process

1. FIRA (Facility Integrity Risk Assessment)
2. SOW (Scope of Work)
3. NDE Execution & Operations Mitigation
4. FIRA Re-evaluation

The process is cyclical, with each step leading to the next and back to the first step.
RISK ASSESSMENT TOOL

- Establish a Risk Assessment Procedure
- Use of Corporate Risk Matrix
- Establish Consequences of Failure
  - HCAs
  - Business Impact
- Establish Likelihoods of Failure
  - External Corrosion
  - Internal Corrosion
CONSEQUENCES OF FAILURE

- High Consequence Areas
  - Drinking Water
  - Sole Source Aquifers
  - High Population Areas
  - Ecological Areas
- Product Type
- Manned / Unmanned Sites
- Business Impact
LIKELIHOOD OF FAILURE
MODEL STRUCTURE

2 Threats
• Internal Corrosion
• External Corrosion

4 Sub-Threats
• Aboveground Internal Corrosion
• Aboveground External Corrosion
• Buried Internal Corrosion
• Buried External Corrosion

5 Likelihood Categories
• Facility Location
• Design and Piping Configuration
• Operations
• Current Mitigation Practices
• Failure Data

11 Likelihood Elements
1. Environment & Conditions
2. Piping Supports
3. Soil to Air Interfaces
4. CUI
5. Coating Buried Piping
6. Product Corrosiveness
7. Flow Type
8. Monitoring & Protection Programs
9. Inspection & Testing
10. Piping Work Process
11. Corrosion Incidents History
# LIKELIHOOD OF FAILURE

## WEIGHTS

<table>
<thead>
<tr>
<th>Elements</th>
<th>15% Above Ground-External</th>
<th>20% Above Ground-Internal</th>
<th>43% Buried-Internal</th>
<th>22% Buried-External</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Environment &amp; General Facility Conditions</td>
<td>29%</td>
<td>18%</td>
<td>18%</td>
<td>27%</td>
</tr>
<tr>
<td>2. Piping Supports (External Corrosion)</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3. Soil to Air Interface (External Corrosion)</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>4. Corrosion Under Insulation (CUI)</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>5. Buried Coating</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>6. Product Corrosivity</td>
<td>0%</td>
<td>13%</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>7. Flow Type</td>
<td>0%</td>
<td>9%</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>8. Monitoring &amp; Protection Program</td>
<td>0%</td>
<td>20%</td>
<td>20%</td>
<td>17%</td>
</tr>
<tr>
<td>9. Inspection and Testing</td>
<td>23%</td>
<td>22%</td>
<td>21%</td>
<td>25%</td>
</tr>
<tr>
<td>10. Facility Piping Work Processes</td>
<td>8%</td>
<td>6%</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>11. Corrosion Incident History</td>
<td>17%</td>
<td>13%</td>
<td>13%</td>
<td>16%</td>
</tr>
</tbody>
</table>
MITIGATION OF INTERNAL CORROSION

DEAD LEGS AND UNDERUTILIZE PIPING FOCUS

- Design
- Removal
- Purge & Isolation
- Operational
  - Flushing
- Chemical Treatment
- Inspection
  - Increased Inspection Cycles
  - Specific High Effectiveness NDE
MITIGATION OF EXTERNAL CORROSION

- Piping Supports Design
- Maintain Good Thermal Insulation
- Coatings & Thermal Insulation Specs
- Cathodic Protection (CP)
- Inspection
  - CP Surveys
  - Increased Inspection Cycles
  - Specific High Effectiveness NDE
HIGH EFFECTIVENESS NDE & SURVEYS TO REDUCE RISK

- Profile Radiography
- GWUT (Guided-Wave)
- Phased Array
- Long or Short Wave UT
- EMAT
- ILI – MFL / UT Tools
- NDE Robots / Crawlers
- Tracer Gas Leak Detection
- P/S Potential Surveys
- ACVG / DCVG
NDE SCOPE OF WORK TO REDUCE RISK

<table>
<thead>
<tr>
<th>CML</th>
<th>COVERAGE [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HCA</td>
</tr>
<tr>
<td></td>
<td>Crude</td>
</tr>
<tr>
<td></td>
<td>Manned</td>
</tr>
<tr>
<td>Buried Deadleg</td>
<td>100</td>
</tr>
<tr>
<td>Above Ground Deadleg</td>
<td>100</td>
</tr>
<tr>
<td>Buried Low Flow</td>
<td>100</td>
</tr>
<tr>
<td>Above Ground Low Flow</td>
<td>100</td>
</tr>
<tr>
<td>Soil to Air Interfaces</td>
<td>10</td>
</tr>
<tr>
<td>Low Point Bleeds / Drains</td>
<td>20</td>
</tr>
<tr>
<td>Over Water Piping</td>
<td>100</td>
</tr>
</tbody>
</table>
NDE SUCCESS STORIES

- **GUL Indication**
  - 3 Medium (Cat 2) Indications 30% to 49% Wall Loss
- **Profile RT**
  - Drain was at 50% wall loss
- **Tracer Gas**
  - Leaking Sample Shack drain piping
SUMMARY

- Start evaluating likelihood of failure in facilities in HCA, then calculate relative risk and prioritize risk mitigations.

- Use a scalable simplified risk assessment model based on threats that cause the majority and most severe failures in facilities.

- Use a combination of tools making sure that the effectiveness of the mitigations are confirmed including high effective NDE methods.

- The NDE scope of work targets high likelihood of failure configurations / locations generating a CML coverage based on the consequence of failure.

- A risk based frequency from 3 to 10 years corrected with corrosion based frequency, whichever is shorter.
Questions