Regulatory Next Steps in Addressing Pipeline Seam Weld Challenges

2014 KCC Kansas Pipeline Safety Seminar
October 28th & 29th
Regulatory Next Steps in Addressing Pipeline Seam Weld Challenges

- Introduction and History
- Regulatory Mandate and Recommendations
- Seam Study – Phase 1
- Seam Study – Phase 2
- Integrity Verification Process – Overview
- Regulatory Action – Status Update
Introduction and History

- **U.S. PHMSA - Advisory Bulletins on ERW Seam Failures**
  - Alert Notice – ALN-88-01 and ALN-89-01
    - Advised operators and the public on factors contributing to operational failures of pipelines constructed prior to 1970 with Electric Resistance Weld (ERW) seams

- **Liquid Propane Pipeline Rupture – Carmichael, MS**
  - November 1, 2007
  - Fracture along LF-ERW seam
  - 2 fatalities and 7 injuries

Incident #1 - Carmichael, MS
Introduction and History

- **Natural Gas Transmission Rupture – San Bruno, CA**
  - September 9, 2010
  - Failure of 30-inch diameter weld seams
  - Fracture along partial welded seam – 6 short pipe joints
  - 5 pups fabricated in 1956, did not meet pipe quality standards
  - 8 fatalities, many injured, 38 homes destroyed, 70 homes damaged

Incident #2
San Bruno, CA

Photograph of the 28-foot-long ruptured section of pipeline
U.S. Regulatory Mandate and Recommendations: *Pipeline Safety Act of 2011*

- **Pipeline Safety Act of 2011 - Section 23**
- **Verification of Records and Reporting**
  - Identify pipe segments with no records to verify Maximum Allowable Operating Pressure (MAOP) for all Gas Transmission steel pipe [Class 3, 4 and all High Consequence Areas (HCAs)]
- **Determination of MAOP**
  - Reconfirm MAOP for pipeline segments with insufficient records
- **Testing Regulations**
  - Requires conducting tests to confirm material strength of previously untested gas transmission steel pipelines in HCAs and operating pressure of +30% Specified Minimum Yield Strength (SMYS) that were not previously pressure tested
U. S. Regulatory Mandate and Recommendations: NTSB Recommendations

- **NTSB P-09-01 “Comprehensive Study”** – to identify actions that can be implemented to eliminate catastrophic longitudinal seam failures in ERW pipe
- **NTSB P-09-02 “Implement Actions from Study Findings”**
- **NTSB P-11-14 “Delete Grandfather Clause”** – recommends all grandfathered pipe be pressured tested, including a “spike” test
- **NTSB P-11-15 “Seam Stability”** – recommends pressure test to 1.25 x MAOP before treating latent manufacturing and construction defects as “stable”
- **NTSB P-11-17 “Piggable Lines”** – Configure all lines to accommodate smart pigs, with priority given to older lines
U. S. Regulatory Mandate and Recommendations

- How much pipeline mileage will these mandates and recommendations effect?
## Piggability: ILI Able vs Not Able

<table>
<thead>
<tr>
<th>Part R</th>
<th>Total Miles</th>
<th>ILI Able</th>
<th>ILI Not Able</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HCA</td>
<td>1,658</td>
<td>1,380</td>
<td>278</td>
</tr>
<tr>
<td>- non-HCA</td>
<td>234,851</td>
<td>146,035</td>
<td>88,816</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HCA</td>
<td>1,409</td>
<td>1,152</td>
<td>257</td>
</tr>
<tr>
<td>- non-HCA</td>
<td>28,978</td>
<td>15,073</td>
<td>13,905</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HCA</td>
<td>15,850</td>
<td>10,469</td>
<td>5,381</td>
</tr>
<tr>
<td>- non-HCA</td>
<td>16,751</td>
<td>6,924</td>
<td>9,827</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HCA</td>
<td>752</td>
<td>366</td>
<td>386</td>
</tr>
<tr>
<td>- non-HCA</td>
<td>209</td>
<td>112</td>
<td>97</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>300,458</strong></td>
<td><strong>181,511</strong></td>
<td><strong>118,947</strong></td>
</tr>
</tbody>
</table>

Gas Transmission 2012 Annual Report data as of 7-1-2013
## Summary of Gas Transmission (GT) Pipe

<table>
<thead>
<tr>
<th>Location</th>
<th>Total GT Miles</th>
<th>% in HCA</th>
<th>GT HCA Miles</th>
<th>Non-HCA Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>237,756</td>
<td>0.7</td>
<td>1,660</td>
<td>236,096</td>
</tr>
<tr>
<td>Class 2</td>
<td>30,210</td>
<td>4.7</td>
<td>1,412</td>
<td>28,798</td>
</tr>
<tr>
<td>Class 3</td>
<td>32,613</td>
<td>48.6</td>
<td>15,854</td>
<td>16,759</td>
</tr>
<tr>
<td>Class 4</td>
<td>962</td>
<td>78.2</td>
<td>752</td>
<td>209</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>301,540</strong></td>
<td></td>
<td><strong>19,678</strong></td>
<td><strong>281,862</strong></td>
</tr>
</tbody>
</table>

Data as of 7-1-2013 from Part Q of Operator Annual Reports
## Aging Infrastructure: % by Decade in USA

<table>
<thead>
<tr>
<th>Decade</th>
<th>Hazardous Liquid</th>
<th>Gas Transmission</th>
<th>Gas Distribution Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown &amp; &lt;1920</td>
<td>2%</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1920s</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>1930s</td>
<td>3%</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>1940s</td>
<td>8%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>1950s</td>
<td>20%</td>
<td>22%</td>
<td>10%</td>
</tr>
<tr>
<td>1960s</td>
<td>21%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>1970s</td>
<td>16%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>1980s</td>
<td>9%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>1990s</td>
<td>11%</td>
<td>11%</td>
<td>21%</td>
</tr>
<tr>
<td>2000s</td>
<td>8%</td>
<td>10%</td>
<td>18%</td>
</tr>
</tbody>
</table>

Notes:
- Hazardous Liquid: Data for 1920s-1990s
- Gas Transmission: Data for 1920s-1990s
- Gas Distribution Service: Data for 1970s-2000s
Nominal Pipe Size

- Intrastate: about 106.2 thousand miles - 35%
- Interstate: about 196.2 thousand miles - 65%

<table>
<thead>
<tr>
<th>Inches</th>
<th>Intrastate</th>
<th>Interstate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4</td>
<td>10,584</td>
<td>11,454</td>
</tr>
<tr>
<td>6-8</td>
<td>26,149</td>
<td>21,392</td>
</tr>
<tr>
<td>10-16</td>
<td>35,080</td>
<td>36,641</td>
</tr>
<tr>
<td>18-26</td>
<td>19,454</td>
<td>60,409</td>
</tr>
<tr>
<td>28-36</td>
<td>11,991</td>
<td>59,348</td>
</tr>
<tr>
<td>&gt;36</td>
<td>8,229</td>
<td>1,179</td>
</tr>
<tr>
<td>Other</td>
<td>317</td>
<td>159</td>
</tr>
</tbody>
</table>
### Pressure Test Range

<table>
<thead>
<tr>
<th>Pressure Test Range</th>
<th>Total Miles</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT &lt; 1.1 MAOP or no PT</td>
<td>93,817</td>
<td>31%</td>
</tr>
<tr>
<td>1.25 MAOP &gt; PT ≥ 1.1 MAOP</td>
<td>19,131</td>
<td>6%</td>
</tr>
<tr>
<td>PT ≥ 1.25 MAOP</td>
<td>187,628</td>
<td>62%</td>
</tr>
</tbody>
</table>

Gas Transmission 2012 Operator Annual Report data as-of 7-1-2013
Seam Study
Comprehensive Study to Understand Longitudinal ERW Seam Failures

- **Research Contractor:** Phase 1
  - Battelle

- **Subcontractors:** Phase 1
  - Det Norske Veritas (DNV) & Kiefner and Associates (KAI)

- **Principle Investigators:** Phase 1
  - Bruce Young – Battelle
  - Brian Leis & Bruce Nestleroth, in conjunction with
    - John Kiefner (KAI) & John Beavers (DNV)

- **Phase 1 Completed – Jan. 2014; Phase 2 underway**
Phase 1 — Findings

- **ILI Detection & Sizing:**
  - ILI results show inconsistencies with digs & hydro test results
  - May be due to either ILI tool findings or interpretation
  - ILI tools are useful for finding & eliminating some seam defects

- **In-the-Ditch Assessment Methods**
  - No consistent standard practice
  - Can be inspector dependent

- **In-the-Ditch / ILI Improvements required for:**
  - More specific identification of anomaly type
  - Reduction of false calls
  - Improved sizing of defect depth and length for effective assessment and evaluation results
Phase 1 – Findings

- **Failure Pressure Models**
  - Should use a more representative Charpy impact toughness position relative to the bond line
  - Toughness values when unknown, need to be conservative
- **Predictive Model for Assessing Failure Stress Levels**
  - Must be based upon whether the failure is brittle or ductile, if unknown evaluate for both
  - Must use lower-bound failure stress levels based upon defect type (cold weld, hook cracks, stress corrosion cracking, etc.)
Phase 1 – Findings

- **Hydrostatic test pressures**
  - Need to be higher to be effective based upon a review of over 600 seam failures
  - Time to failure increases at an exponential rate to increased test pressure
  - Higher test pressures should mean longer interval before a retest
Phase 2 – Overview

1. Improve hydrotesting protocols for ERW/FW Seams

2. Enhance Defect Detection and Sizing via Inspection

3. Defect Characterization: Types, Sizes, & Shapes

4. Develop & Refine Predictive Models & Quantify Growth Mechanisms

5. Develop Management Tools

6. Public Meeting/Forum

Completed reports for Phase 1 available at:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=390
Integrity Verification Process (IVP)

Overview of Basic Principles
Principle #1
Apply to Higher Risk Locations

- High Consequence Areas (HCAs)
- Moderate Consequence Area (MCA):
  - Onshore area within a potential impact circle
  - Containing one or more buildings intended for human occupancy
  - Occupied site or designated Federal interstate, expressway, or 4-lane highway right-of-way
  - Does not meet definition of high consequence area, as defined in § 192.903.

- PHMSA Estimates
  - \( \sim \) 76,000 miles HCA/MCA (out of \( \sim \) 301,000 miles)
Principle #2
Screen for Categories of Concern

- Apply process to pipeline segments with:
  - Grandfathered Pipe
  - Lack of Records to Substantiate MAOP
  - Lack of Adequate Pressure Test
  - Operating pressures over 72% SMYS (pre-Code)
  - History of Failures Attributable to Manufacturing & Construction Defects
Principle #3
Know & Document Pipe Material

- Inadequate Validated, Non-traceable Material Documentation, Establish Material Properties by an approved process:
  - Cut out and Test Pipe Samples (Code approved process)
  - *In Situ* Non-Destructive Testing (if validated and if Code approved)
  - Field verification of code stamp for components such as valves, flanges, and fabrications
  - Other verifications
Principle #4
Assessments to Establish MAOP

- Allow Operator to Select Best Option to Establish MAOP
- **Candidate IVP Options for Establishing MAOP**
  - Subpart J Pressure Test with Spike Test
  - Derate Operating Pressure
  - Engineering Critical Assessment
  - Replace Pipe Segment
  - Alternative Technology or Technical Options
  - Other options PHMSA should consider?
Integrity Verification Process (IVP) Chart

- **Applicable Segments**
  - (Steps 1, 2, 3 and 4)
- **MAOP Determination**
  - Methods (Steps 5 – 10)
    - Pressure Test
    - Pressure Reduction
    - Engineering Critical Assessment (ECA)
    - Pipe Replacement
    - Pressure Reduction for Segments w/Small PIR
    - Alternative Technology
- **Materials Documentation**
  - (11)
    - Destructive
    - Non-destructive
- **Continue Operations**
  - (12)

http://primis.phmsa.dot.gov/meetings/MtgHome.mtg?mtg=91
Why are pipeline material records needed?

- To establish design and MAOP
- For integrity management (IM)
- Anomaly evaluations for safe operating pressure
- Record Types:
  - Materials
  - Design
  - Construction
  - Pressure Testing
  - Corrosion Control
  - O & M –
    - IM, Surveys, Patrols, Manuals, Procedures
Material Documentation Plan

- **Procedures**
  - Tests for:
    - Yield strength, ultimate tensile strength, seam type, coating type and chemistry
  - Destructive Tests
    - Pipe removed from replacements and relocations
  - Destructive and/or Non-Destructive Tests
    - Direct examinations, repairs, remediation & maintenance
  - Tests used only to verify and document material grade
MAOP Determination

**Applicable Locations**
- Located in HCA, MCA, and meets *any of the following*:
  - Experienced reportable in-service incident since last pressure test due...
  - Legacy pipe or constructed with legacy construction techniques and has not had a Pressure Test (PT) of the greater of
    - 1.25 times MAOP or applicable Class location PT requirement
  - No PT records
  - MAOP established per Grandfather Clause
MAOP Determination

- **Pressure Test**
  - 1.25 or class location test factor times MAOP
  - **Spike test segments** w/ reportable in-service incident due to legacy pipe/construction and cracking
  - Estimate remaining life, segments w/crack defects

- **Pressure Reduction**
  - Reduce pressure by MAOP divided by class location test factor
  - Estimate remaining life, segments w/crack defects

- **Pipe Replacement**
  - Install new pipe that meets Code requirements
MAOP Determination

- **Engineering Critical Assessment (ECA)**
  - ECA analysis – for MAOP
    - Segment specific technical and material documentation issues
    - Analyze crack, metal loss, and interacting defects remaining in pipe, or could remain in the pipe, to determine MAOP
  - MAOP established

- **Alternative Technology**
  - Alternative technical evaluation process that provides a sound engineering basis for establishing MAOP
Regulatory Action – Status Update

- **Notice of Proposed Rulemaking (NPRM)**
  - Regulation drafted
  - Being routed for approval to notice to Public
- **Applicable to Gas Transmission Pipelines**
  - 49 Code of Federal Regulations Part 192
Regulatory Next Steps in Addressing Pipeline Seam Weld Challenges

Stay Tuned