Perspective on Energy Pipelines

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Setting the Stage

The role of Energy Pipelines

- Essential and necessary links between production/delivery and consumption
- Different pipes serve different functions in the supply chain and face different challenges
- Disruptions/lack of capacity constrain supply
- More capacity needed!
Setting the Stage: Frequency

Pipeline Incidents Involving Death or Major Injury (1988-2009)

PHMSA Incident data, as of Aug. 28, 2008

Trendline: 10% every 3 years

Targets: 43 42 40 38
### Setting the Stage: Consequence


<table>
<thead>
<tr>
<th>Year</th>
<th>Public Fatalities</th>
<th>Industry Fatalities</th>
<th>Public Injuries</th>
<th>Industry Injuries</th>
<th>Total Property Damage (b) (c)</th>
<th>Damage to Public Property (d) (b)</th>
<th>Damage to Industry Property (d) (b)</th>
<th>Value of Product Lost (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>13 100%</td>
<td>0 0%</td>
<td>22 66%</td>
<td>11 33%</td>
<td>$3,040,760</td>
<td>$24,222,505 74%</td>
<td>$6,983,318 21%</td>
<td>$1,201,776 3%</td>
</tr>
<tr>
<td>2005</td>
<td>11 70%</td>
<td>3 21%</td>
<td>31 79%</td>
<td>3 20%</td>
<td>$536,255,450</td>
<td>$27,200,095 5%</td>
<td>$504,200,125 20%</td>
<td>$5,472,230 1%</td>
</tr>
<tr>
<td>2006</td>
<td>10 62%</td>
<td>6 37%</td>
<td>11 42%</td>
<td>13 58%</td>
<td>$20,066,461</td>
<td>$17,860,192 89%</td>
<td>$1,892,237 9%</td>
<td>$314,032 1%</td>
</tr>
<tr>
<td>2007</td>
<td>7 77%</td>
<td>2 22%</td>
<td>23 63%</td>
<td>13 36%</td>
<td>$23,434,500</td>
<td>$20,643,622 85%</td>
<td>$3,114,135 13%</td>
<td>$275,746 1%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>41 78%</td>
<td>11 21%</td>
<td>87 64%</td>
<td>45 33%</td>
<td><strong>$612,864,023</strong></td>
<td><strong>$89,326,415 14%</strong></td>
<td><strong>$516,272,815 84%</strong></td>
<td><strong>$7,264,793 1%</strong></td>
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<tr>
<td>2003</td>
<td>0 0%</td>
<td>1 100%</td>
<td>3 37%</td>
<td>5 62%</td>
<td>$55,232,363</td>
<td>$11,407,440 20%</td>
<td>$27,054,985 48%</td>
<td>$17,770,337 31%</td>
</tr>
<tr>
<td>2004</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>2 100%</td>
<td>$39,242,623</td>
<td>$17,417 0%</td>
<td>$26,571,401 74%</td>
<td>$9,516,922 24%</td>
</tr>
<tr>
<td>2005</td>
<td>0 0%</td>
<td>0 0%</td>
<td>2 40%</td>
<td>3 60%</td>
<td>$237,225,169</td>
<td>$92,511,087 39%</td>
<td>$120,326,393 50%</td>
<td>$24,385,687 10%</td>
</tr>
<tr>
<td>2006</td>
<td>1 33%</td>
<td>2 66%</td>
<td>1 25%</td>
<td>3 75%</td>
<td>$33,827,402</td>
<td>$2,706,730 7%</td>
<td>$26,660,670 74%</td>
<td>$7,263,002 12%</td>
</tr>
<tr>
<td>2007</td>
<td>1 50%</td>
<td>1 50%</td>
<td>1 14%</td>
<td>6 85%</td>
<td>$54,452,580</td>
<td>$1,538,500 2%</td>
<td>$34,894,884 64%</td>
<td>$18,019,196 33%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>2 33%</td>
<td>4 66%</td>
<td>7 26%</td>
<td>15 73%</td>
<td><strong>$424,998,338</strong></td>
<td><strong>$108,338,176 25%</strong></td>
<td><strong>$235,703,015 56%</strong></td>
<td><strong>$76,952,147 18%</strong></td>
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<tbody>
<tr>
<td>2003</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>5 100%</td>
<td>$94,938,762</td>
<td>$31,011,307 56%</td>
<td>$22,034,644 40%</td>
<td>$1,492,811 2%</td>
</tr>
<tr>
<td>2004</td>
<td>5 100%</td>
<td>0 0%</td>
<td>15 93%</td>
<td>1 7%</td>
<td>$159,374,542</td>
<td>$92,755,694 21%</td>
<td>$122,941,426 77%</td>
<td>$2,777,421 1%</td>
</tr>
<tr>
<td>2005</td>
<td>0 0%</td>
<td>2 100%</td>
<td>2 100%</td>
<td>0 0%</td>
<td>$165,426,524</td>
<td>$84,036,478 50%</td>
<td>$77,911,540 47%</td>
<td>$3,478,235 2%</td>
</tr>
<tr>
<td>2006</td>
<td>0 0%</td>
<td>0 0%</td>
<td>2 100%</td>
<td>0 0%</td>
<td>$62,150,107</td>
<td>$19,055,720 31%</td>
<td>$35,032,107 61%</td>
<td>$4,252,271 6%</td>
</tr>
<tr>
<td>2007</td>
<td>2 50%</td>
<td>2 50%</td>
<td>9 30%</td>
<td>1 10%</td>
<td>$50,502,629</td>
<td>$18,982,971 37%</td>
<td>$27,980,501 55%</td>
<td>$3,539,157 7%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>7 63%</td>
<td>4 36%</td>
<td>28 80%</td>
<td>7 20%</td>
<td><strong>$491,992,646</strong></td>
<td><strong>$187,642,449 38%</strong></td>
<td><strong>$288,800,299 58%</strong></td>
<td><strong>$15,549,856 3%</strong></td>
</tr>
</tbody>
</table>
Pipeline Threats

- There is no one-size, fits all solution to this wide ranging set of failure causes

Source: PHMSA Significant Incidents Files April 15, 2009
Steps Taken to Improve Performance

• Fortified Regulatory Standards – some of which aren’t yet in effect
  – e.g., reporting, IMP, CRM, damage prevention
• Increased and Improved Regulatory Oversight/Enforcement
  – Both at the national and State levels
• Increased (though still underinvested) investments in R&D
  – Improved technology, better standards, and foundation knowledge improvements
• Improved understanding of risks and risk controls
  – e.g., SCC, excavation damage, casings, etc.
• Expanded public participation and transparency
Current Challenges

- Connecting new sources of supply with demand
  - Driving down project economics
  - While shoring up lifecycle management quality control
    - Confidence most recently shaken with construction
      - Problems encountered in materials procurement, welding, coatings, lay techniques, precommission test failures, etc.
- Economically and rigorously shoring up fitness for purpose of existing infrastructure
- Properly incentivizing all companies to “do the right thing”
  - Pipelines, utilities, excavators, locators, vendors, etc.
- Persuading communities to make smarter land use decisions near pipelines
Steps Needed to Further Improve Pipeline Transportation Performance

- Better data – improve risk-informed decisions and choices
- Better risk models – helping companies and regulators alike
  - To prioritize assessments, repairs, and maintenance alike
- Better assessment/characterization technologies
  - Especially for long seams, casings, and unpiggable pipe
- More rapid commercialization of new technologies
- Expanded/improved maintenance – especially in facilities
- Improved confidence in science underpinning repair algorithms
- Collaboration in understanding risks on new products
  - e.g., biofuels joint project
- Increased investment in R&D – both short to mid-, as well as long-term research
Learning Much from Canada!

- Arctic Pipeline Experience
- New technology deployment
- Welding high strength steels
- Strain Based Design
- Reliability Based Design Assessments
- Alternative Integrity Verification
Technical Challenges Remain

• Gas Integrity Management
  - Baseline Assessments 2012
  - Lack of technology for unpiggable systems
  - Long-term cased crossing

Failure of Cased Crossing Under Highway
Technical Challenges Remain

• Corrosion
  – External
  – Internal
  – Stress Corrosion Cracking
  – Microbial Induced

External Corrosion
Technical Challenges Remain

- New Construction
  - Materials
  - Welding
  - Coatings
  - Installation
  - Applying lessons learned:
    - Preventing Damage
    - Protecting Communities
Technical Challenges Remain

• Safely Transporting Alternative Fuels
  – Ethanol – SCC, elastomers, oxygen monitoring
  – Biodiesel – Inhibitor performance
  – Biogas – MIC and Internal corrosion
  – Hydrogen Economy – Materials and cracking

• Climate Change Issues
  – CO2 Pipelines – Corrosion, safe blow down, protecting communities
Future is Bright!

- Strong coalitions/partnerships formed
- Data and science are driving more decisions – politics are driving fewer
- Many new or improved standards/best practices now available
- Infrastructure making adjustments to handle alternative fuels
- Research facilitating the desired impacts we are striving for!
Thank You!