Readout Report: Working Group #5 Anomaly Detection, Repair, and Rehabilitiation

Working Group Leaders

Joshua Johnson: Metallurgist, PHMSA
Tom Bubenik: Vice President, DNV

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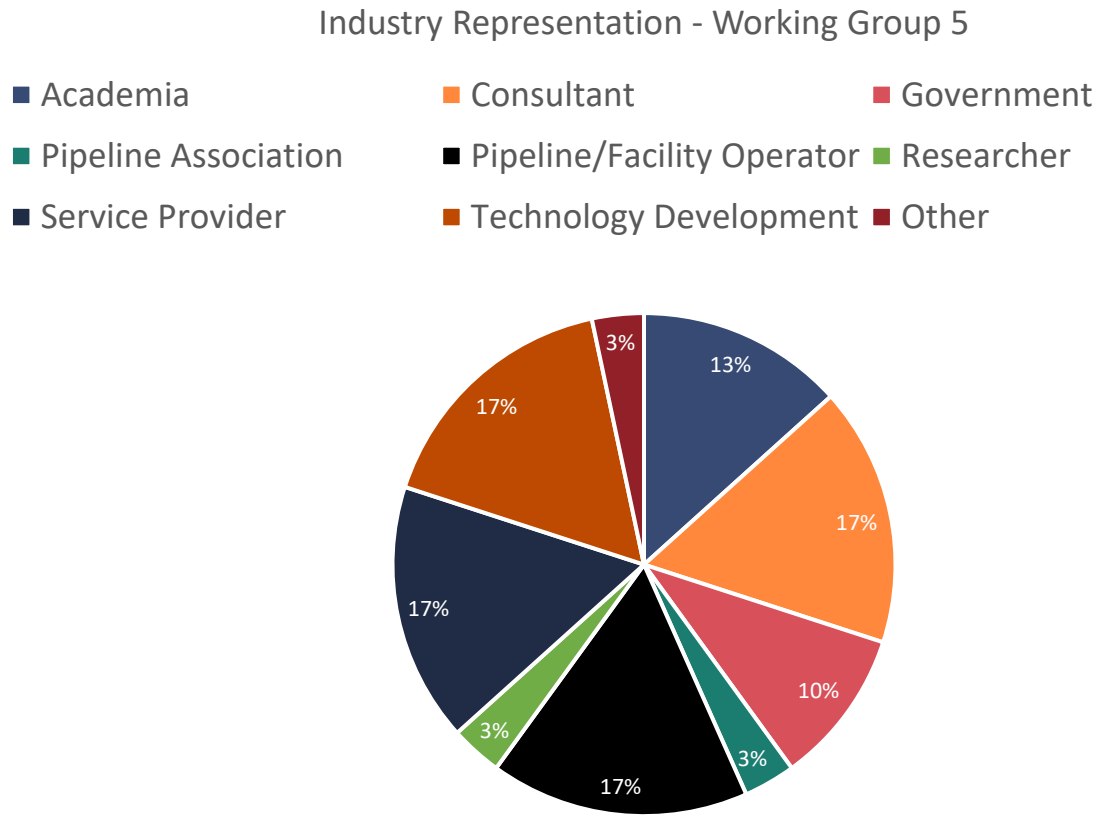
Working Group Participation by Industry



Top Identified R&D Gaps

NOTE: Red text indicates gaps with a possible academic focus.

Gap #1 – Non-destructive means to determine pipe body and weld fracture toughness via ILI or In-ditch methods (Output type: Technology Development)(Infrastructure type: Liquid Transmission/Gas Transmission)

Gap #2 – Update the "History of Line Pipe Manufacturing in North America" to include more detail of mill processes, evolution of steel making, add HSLA materials, fittings, history of coating types, and foreign manufacturers. (Output type: General Knowledge)(Infrastructure type: Liquid Transmission/Gas Transmission)

Gap #3 – Further development of inline non-metallic pipe inspection technology to detect anomalies, map service tees, characterize ovality and any material degradation (Output type: Technology Development)(Infrastructure type: Gas Distribution Non-Metallic)

Top Identified R&D Gaps

NOTE: Red text indicates gaps with a possible academic focus.

Gap #4 – Improved coating/liners for pipeline repair considering materials/cost/continued inspection and maintenance
(Output type: Technology Development)(Infrastructure type: Liquid Transmission/Gas Transmission/Gas Distribution Metallic/Gas Gathering/Carbon Dioxide/Hydrogen)

Gap #5 – Artificial Intelligence or Machine Learning improvements in inspection technologies (standardization, data sharing, validation)
(Output type: Technology Development/General Knowledge)(Infrastructure type: Liquid Transmission/Gas Transmission/Gas Distribution Metallic/Gas Distribution Non-Metallic/Gas Gathering/Carbon Dioxide/Hydrogen)

Gap #1 Associated Details

Title: **Non-destructive means to determine pipe body and weld fracture toughness via ILI or In-ditch methods**

Main Objective: To develop a method to capture fracture toughness measurements appropriate to line pipe to improve fracture mechanics analyses (fitness for purpose).

a. What pipeline or facility type(s), or LNG/UGS operations, does the technology target? **Pipe body and seams**
b. What operating environment(s) must the technology operate in? **In-line or In-ditch**
c. Are there any functionality and/or performance requirements? **Accuracy relative to destructive testing**
d. Does the gap address any regulatory, congressional, or NTSB drivers? **49 CFR: 192.607, 192.712e, 192.624, 195.452**
e. Does the gap address related consensus standards? **API RP 1160, 1176, 579; ASME B31.8s**
f. What technical or regulatory roadblocks or barriers prevent the technology deployment? **High-risk of no outcome (low TRL); Funding similar projects**
g. What are anticipated targets or timeframes to complete this research? **3 Years**

Gap #2 Associated Details

Title: **Develop a digital catalogue including updated information and interpretive narrative from the "History of Line Pipe Manufacturing in North America."**

Main Objective: To catalogue the information included in "History of Line Pipe Manufacturing in North America" in a digital format. Additionally, to update the information and include more detail of mill processes, evolution of steel making, add HSLA materials, fittings, history of coating types, and foreign manufacturers.

a. What pipeline type(s) does the general knowledge target? **All steel pipelines**
b. Does the gap address any regulatory, congressional, or NTSB drivers? **49 CFR 192.60, 192 subpart o , 195.452, 192.712**
c. Does the gap address related consensus standards? **ASME B31.8s, API 1160, etc.**
d. What technical details or scope items are necessary and recommended?
    - **Must include narrative information and interpretation**
    - **Deliverable can include multiple formats (including but not limited to a database)**
    - **Should include interviews with relevant industry experts**
e. What are anticipated targets or timeframes to complete this research? **2 years**

Note: May consider AI implications in future

Gap #3 Associated Details

Title: **Further development of inline non-metallic pipe inspection technology to detect anomalies, map service tees, characterize ovality and any material degradation**

Main Objective: To develop technology solutions or a product that could be used for inline non-metallic pipe inspection to detect anomalies, map service tees, characterize ovality, any material degradation, and find unlocatable plastic pipe.

a. What pipeline or facility type(s) does the technology target? **Non-metallic distribution and gathering systems**
b. What operating environment(s) must the technology operate in (inside/outside-pipe)? **Inside pipe**
c. Are there any functionality and/or performance requirements?
   - **Max pressure 125psig**
   - **Live operation**
   - **No digging except at launch point; No damage to pipe**
   - **>2" diameter**
   - **>1000 ft range**
d. Does the gap address any regulatory, congressional, or NTSB drivers? **PHMSA ADB March 2012, DIMP**
e. Does the gap address related consensus standards? **ASTM D2513, ASME B31.8**
f. What technical or regulatory roadblocks or barriers prevent the technology deployment? **Tech Transfer, Industry Adoption**
g. What are anticipated targets or timeframes to complete this research? **2 years**

Gap #4 Associated Details

Title: Improved coating/liners for pipeline repair considering materials/cost/continued inspection and maintenance

Main Objective: To rehabilitate or remediate pipelines in a minimally invasive manor inside the pipe (internal corrosion, defects, leakage, conversion to hydrogen, etc.). Structural or non-structural remediation methods.

a. What pipeline or facility type(s) does the technology target? **Primarily gas pipelines with potential for adaptation**
b. What operating environment(s) must the technology operate in (inside/outside-pipe, above/under-ground, hazardous liquid or natural gas service, etc.)? **Distribution and Transmission**
c. Are there any functionality and/or performance requirements?
   - **References ARPA-E repair program**
   - **Safety standards**
   - **Ongoing integrity evaluation**
   - **Structural requirements**
d. Does the gap address any regulatory, congressional, or NTSB drivers? **49CFR 192 and 195 maintenance subparts**

Gap #4 Associated Details - CONT

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e. Does the gap address any regulatory, congressional, or NTSB drivers? **49CFR 192 and 195 maintenance subparts**
f. Does the gap address related consensus standards? **ASME PCC-2, ASTM F1216, ASTM D2990, ASTM D638, ASTM D790, ASTM F3182, AMPP Coatings and Surface preparation standards, AWWA C305, ASTM F2207**
g. What technical or regulatory roadblocks or barriers prevent the technology deployment? **Must not impair future assessment; Must be equal or improve operation of pipeline**
h. What are anticipated targets or timeframes to complete this research? **3-5 years**

Gap #5 Associated Details

Title: Artificial Intelligence or Machine Learning improvements in inspection technologies (standardization, data sharing, validation)

Main Objective: To explore the applications of AI and ML in inspection and monitoring technologies for integrated asset management strategies.

a. What pipeline or facility type(s)does the technology target? **All**
b. What operating environment(s) must the technology operate in? **All**
c. Are there any functionality and/or performance requirements?
   - **Feature classification**
   - **Signal interpretation**
   - **Data accuracy**
   - **Information fusion**
d. Does the gap address any regulatory, congressional, or NTSB drivers? **Data integration requirements**
e. Does the gap address related consensus standards? **TBD**
f. What technical or regulatory roadblocks or barriers prevent the technology deployment? **Access to high-quality data, security, lack of governance, data accuracy, data reliability, proprietary data**
g. What are anticipated targets or timeframes to complete this research? **1-2 years**

Additional Identified Gaps

NOTE: RED text indicates gaps with a possible academic focus.

1. In-line or above ground technology for estimation of pipe strain including axial strain
2. Small diameter (<8") crack detection for gas pipelines
3. Impact of microbial corrosion on hydrogen production and hard spot corrosion
4. Non-Disruptive pipeline repair (trenchless, robotic, etc.)
5. Guidelines for accurate measurement and appropriate application of toughness data for use in failure pressure assessment of pipe body and seam weld cracks
6. Sensor implant for newly manufactured pipes
7. Depth sizing for defects with potential to leak
8. Detection, characterization, and sizing for circumfrential cracks in pipe body and girth welds for gas pipelines
9. Efficacy of recoat or composite repairs for SCC

Additional Identified Gaps

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10. Determine the different stress contributions in hardspots for evaluation of the critical flaw sizes from external hydrogen generation or internal hydrogen gas transportation, and determine changes in critical flaw sizes
11. Monitoring and mitigation of external microbial corrosion during cathodic protection and under disbonded coatings
12. Technology for differentiation of seams types and classification and sizing ILI for seam weld anomalies
13. Build large database for existing pipe failure of different stages for future AI use.
14. Enhanced hard spot measurement/detection by ILI and NDE (including seams)
15. Improvement to non-destructive technologies for mapping and sizing of stress corrosion cracking in the ditch (including failure pressure models for SCC colonies)

Thank You!/Questions?