Track #3
Anomaly Detection/Characterization

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Attendance Breakdown

Approximate total attendance	49 persons
Federal Regulators	2 persons
State Regulators	1 persons
International Regulators	1 persons
Pipeline Industry	17 persons
Standard Organizations	2 persons
Researchers/Vendors	24 persons
Academics	2 persons

"Buckets" of Identified R&D Gaps

1. Unpiggable Pipeline Inspection Tools
2. Outside-the-Pipe Inspection Tools
3. Low Frequency ERW Pipeline Failures
4. Cased Crossing Assessment Methods
5. Inspection Data Evaluation & Risk Assessment/Qualification Testing
6. Advanced Development of ILI Technologies/Tools
7. Technology Transfer
8. Inspection of Plastic/Composites Pipes & Fittings
9. Data Collection, Sharing/Linking & Analysis (including samples)

Top 4 Identified R&D Gaps

Gap #1 – Outside-the-Pipe Inspection Tools - Detection and Characterization of Anomalies from Outside the Pipe (Technology)

Gap #2 –Unpiggable Pipeline Inspection Tools - Platform Improvements for Operational Efficiency (Technology)

Gap #3 –Cased Crossing Assessment Methods - Correlation of Parameters for Assessing Middle of Casing (General Knowledge)

Gap #4 – (Low Frequency) ERW Pipeline Failures – Fracture (Damage) Mechanics (General Knowledge)

Track 3 – Anomaly Detection/Characterization

Gap #1 Detection and Characterization of Anomalies from Outside the Pipe

Pre-amble: Metal loss, planar and distortional anomalies, and poor fusion joints all threaten the performance of energy pipelines. The ability to detect and characterize these to a higher performance level than inside or above ground pipeline inspections is paramount for pipelines. The closing of this gap would contributes to improved reliability. It requires linking all pipe inspections (outside, inside, and above) and material properties and integrating with Reliability Based Integrity Management.

New or Improved Technology

a.What pipeline type(s) does the technology target?

Pipelines of all material types including carbon steel, cast iron, polymer and composite without limitation on wall thickness or diameter.

b. What operating environment(s) would the technology operate?

Access to the outer surface of the pipeline is key to the technologies for responding to this gap.

c. What are any functionality and or performance requirements?

These have a unique criteria;

An order of magnitude more precise than technologies used from inside of the pipe, and

Can provide information not currently attainable.

d. What road blocks or barriers prevent the technology deployment?

Appropriate funding levels and resources to close these gaps.

e. What are anticipated targets or timeframes to complete this research?

1-5 years can close these gaps.

Additional Identified Gaps –

Detection and Characterization of Anomalies from Outside the Pipe

- Anomaly Detection Gaps:
  - Measurement of pipe grade,
  - Measurement of anomalies under supports,
  - Cast iron cracking and graphitic corrosion,
  - Guided wave range and access through key holes,
  - Polymer joint integrity, and
  - Improved crack detection.
- Anomaly Characterization Gaps:
  - Strain and load measurements,
  - Accuracy, Tolerance and Reliability capability (performance) for each anomaly type,
  - 3D imaging,
  - Differentiate mechanical damage from corrosion,
  - Criteria and limits for anomalies in composite materials and
  - Classification of anomalies and their characteristics for linking and integrating with other inspections.

Gap #2 Unpiggable Pipeline Inspection Tools

Platform Improvements for Operational Efficiency

1. Locomotion Methods (wheels/tractor/floaters)
2. Extended Range and Power Issues
3. Communication and Controls

New or Improved Technology

a. What pipeline type(s) does the technology target? HL/Gas Trmn/Gas Dist

b. What operating environment(s) would the technology operate? Unpiggable pipelines

c. What are any functionality and or performance requirements? Locomotion, must be able to get in/out of the pipelines and around obstacles.

d. What road blocks or barriers prevent the technology deployment? Technology Development

e. What are anticipated targets or timeframes to complete this research? 1-5 Years

Additional Identified Gaps – Unpiggable Pipeline Inspection Tools

•Improved non-traditional sensors for defect detection. Unique opportunities to look for different types of defects due to technology (welds, material properties, mechanical damage, coating disbondment)

•Sensors for unpiggable features (mitered elbows, plug valves, tees, diameter changes)

Gap #3 Cased Crossing Assessment Methods

Correlation of Parameters for Assessing Middle of Casing

Determine how data collected from the assessment of end sections of a casing can be correlated to accurately model and predict the condition of the middle section of the casing.

New or Improved Technology

a. What pipeline type(s) does the technology target? Gas Trmn/Gas Dist
b. What operating environment(s) would the technology operate? Cased Pipe
c. What are any functionality and or performance requirements? Identify and assess anomalies.
d. What road blocks or barriers prevent the technology deployment? Regulatory acceptance, availability of data, and time.
e. What are anticipated targets or timeframes to complete this research? 12-15 Months

Additional Identified Gaps – Cased Crossing Assessment Methods

- Identify new indirect tools to assess casings.
- Demonstration and validation of tools in on-going R&D projects.
- Cleaning vent for inspection purposes
- Improving guided wave for limitations related to coatings and temperature
- Adapting Structural Liners to bring pipe below 20% SMYS
- Tools to Assess Full Wax Fill

Gap #4 Low Frequency ERW Pipeline Failures

Fracture (Damage) Mechanics

Study to understand damage mechanisms in ERW pipe.

- Must be statistical over representative sample size.

Comprehensive program to include real world samples

- Unflawed samples

- Notched samples

- Fatigue pre-cracked samples

Possible use of ASME B31.8S

Creation and Dissemination of General Knowledge

a. What pipeline type(s) does the new knowledge target? HL/Gas Trmn/Gas Dist

b. What operating environment(s) does the new knowledge target? ERW Pipe

c. What technical details are necessary and recommended? Material characterization.

d. Can any targets or timeframes be identified to complete this research? 2-3 Years

Additional Identified Gaps – Other

- Technology transfer – PHMSA to promote/host meeting and demonstrations to market promising technologies to venture capitalists, commercializers, operators (similar to Navy forum run by Dawnbreaker)
- Polymer/Plastic System Gaps
- Ability to monitor Cast Iron failure due to frost heave
- Strain measurement tools for bends, axial loading, dents and kinks
- Severity ranking and decision-making algorithms (risk assessment) enabling timely and proportionate responses when damage is discovered
- Reliability based Integrity Management
- Ability to predict future life of pipe materials
- Collection of benchmark defect samples for testing
- Sharing/publishing of known material property values
- Continuous feedback process from performance and uncertainty of the pipeline. Knowledge of materials properties (must deal with small defects), knowledge about dents, size of flaws.
- Integrating sensors of other tools
- Identifying cause of defect (corrosion, mechanical), does the cause of metal loss make a difference for the failure and thus the remediation/monitoring
- New Signal Calibration Methods Required
- New Signal Processing Methods Required to Compensate for Coatings

Additional Identified Gaps – Other

- •Advanced understanding of EMAT signals
- •Ability to monitor Cast Iron failure due to frost heave
- •Qualification process for new tools/procedures that is recognized by PHMSA
- •Re-inspection intervals that based on run results, # of inspection runs and interim monitoring
- •Modified B31G (and other remaining strength equations) for heavy wall pipe
- •Transportation of pipe by truck or rail standards
- •Address outside force threat with ILI data and how to monitor between runs
- •Understanding tool accuracy, tolerance and reliability for the defect type of mechanism
- •Current State-of-the-Art and confidence of ILI usage on longitudinal seams and girth
- •Understanding of capabilities of computational ILI models; capabilities and limitations Improved tools for crack/crack detection

Additional Identified Gaps – Other

•Development of multi-purpose ILI tools
•Quantitative understanding of the performance of existing ILI for discriminating between significant and benign anomalies
•Understanding of capabilities of computational ILI models; capabilities and limitations Improved tools for crack/crack detection
•Advanced understanding of EMAT signals
•Advantages/potential for combining MFL and Eddy Current sensors
Improve on ILI tolerances of +/-10% or 15% with 80% confidence
Improve methods for correlating in-the-ditch assessment to ILI signals
•Advantages/potential for combining MFL and Eddy Current sensors
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•Improve methods for correlating in-the-ditch assessment to ILI signals
•Additional field experience to validate dual-field MFL and other emerging ILI technologies
•Assessing pipe in vault walls or other supports/bridge hangers
•Advanced MFL and non-MFL sensors for increased inspection capability
•Ability to interpret MFL signals for accurate characterization of defect features
•Alternatives for inspection of heavy walled pipe
•Increase availability of 'Other technology' for inspecting transmission lines in HCAs