Working Group #3
Anomaly Detection/Characterization

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Attendance Breakdown

Approximate total attendance	102
Federal Regulators	3
State Regulators	0
International Regulators	0
Pipeline Industry/Service Providers	45
Standard Developing Organizations	2
Researchers	31
Academics	17
Other	4

Summary of Process for WG #3

- Working Group "functioned as one"
  - No breakout group by sector (as was done with other WGs)
  - Challenges of the working group permeate all sectors; some have more specific issues and needs but as a general matter the challenge of one is the challenge of all
  - No one of us is as good as all of us mentality
- Working Group mandate was broad:
  - Anomaly detection and characterization - transmission & distribution piping
  - Full-scale testing to improve anomaly assessment methods
  - Difficult to inspect pipelines and facility piping (i.e., unpiggable)
  - Features on or near girth welds*
  - Non-line pipe challenges in gas and liquids stations/facilities
- Observation – the landscape hasn't changed much since R&D Forum in 2014

* This item was not a high priority for the industry based on the input from the WG participants

WG #3 - Top Identified R&D Gaps

Gap #1 – Validation of current methods for destructive and non-destructive methods for determining material properties (YS, hardness, toughness, etc. **(Technology)**

Gap #2* – Advanced data management and analytics for Asset Integrity data **(Technology)**

Gap #3 – Improving the performance and efficiencies of tools for difficult to inspect conditions **(Technology)**

Gap #4 – improvements to pipeline assessment methods and models to reduce conservatism **(Knowledge, Standards)**

* - identifies gaps that may be addressed with University Partnerships

WG #3 - Top Identified R&D Gaps (cont.)

Gap #5 – Improve POI for anomalies in longitudinal seams of energy pipelines

Gap #6 – Development of industry calibrations and reference standards for anomaly detection and characterization

Gap #7 – Develop and validate ILI technologies for circumferential anomalies and bending stresses **(Technology)**

Gap #8 – Establish and **MAINTAIN** relevant industry databases **(Knowledge)**

Gap #9* – Root Cause Failure Analysis of past pipeline incidents **(Knowledge)**

* - identify gaps that may be addressed with University Partnerships

WG #3 – Anomaly Detection & Characterization

Gap #1

Validation of Methods for Material Property Verification

Current and **new** methods for validation of current methods for destructive and non-destructive methods for determining material properties (YS, hardness, toughness)

- in-ditch and ILI
- Need PHMSA concurrence – alternatives for Gas MegaRule and Liquids IVP

All pipeline types (liquids, gas, distribution)

- Current projects in place and addressing "gap" – PRCI, DNV GL JIP, TDW method
- New methods considered as viable for R&D funding to drive innovation
- No roadblocks to success

Could lead to standards – modifications to existing, maybe new also

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Gap #2

Advanced Data Management and Analytics for Asset Integrity Data

R&D to develop advanced computational methods for data analysis & integration

- Significant opportunity
- Data completeness
- Quality standards - reporting protocols and deliverables
- Machine learning and computer vision techniques, advanced algorithms

Operators & regulators are getting inundated with data, need improved management systems and computational-based systems to manage the information

Rapidly changing environment – machine learning and BIG data, speed of improvements

- Start now – don't wait for the perfect opportunity (it doesn't exist)
- User is in the driver's seat, define how data will be used

While a gap, this will be a difficult topic to address in an R&D arena – was identified as a project that would be well suited for a University/Academic approach (current CAAP projects)

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Gap #3

Improving the Performance and Efficiencies of Tools for Difficult to Inspect (DTI) Conditions

Square peg, round hole approach – current ILI technologies have been applied to DTI conditions with limited success – change needed
Each DTI conditions has its own unique set of challenges – a "challenge to the challenge" is the incentive to develop technology for a "unique" condition, but …
… there are some common issues associate with improving the technology development and deployment pathways

- Longer battery life
- Longer inspection distance
- Broader range of sensor systems on the DTI platforms

These items should be considered as prime targets for PHMSA R&D funding to provide some answers to the fundamental issues that are consistent for the industry for DTI conditions

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Gap #4

Improvements to Pipeline Assessment Methods and Models to Reduce Conservatism

Applies to corrosion, construction, manufacturing, dent fatigue, etc..

- Provide guidelines for assessment methods to identify key input parameters
- Will likely require FEA (initially) with full-scale validation – real world feature testing vs fabricated/simulated anomalies
- New methods for mechanical damage with coincident features, interactive threats (cracks with corrosion)
- Seam anomalies assessment methods for Lack of Fusion, Selective Seam Weld Corrosion, hook cracks, cold welds – clear definition o what the features are, how to distinguish one from the other

Relative to the appropriate identification, assess the impact of proper identification relative to FFS assessment methods and practices

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Gap #5

Improve POI for Anomalies in Longitudinal Seams of Energy Pipelines

In-line inspection and NDE

PHMSA study was limited in this area of the ERW/longitudinal seam

IMP analysis and supplemental work is needed

- ILI pull tests
- NDE round robin studies
- Emerging technologies

Evaluate impacts of improved sizing on assessment methods

Closely linked to Gap #6 – consider as consolidated program

WG #3 – Anomaly Detection & Characterization

Gap #6

Development of Industry Calibrations and Reference Standards for Anomaly Detection and Characterization

Establish/improve industry calibration standards for NDE/ILI
Establish specifications for NDE technologies so that they can qualify ILI systems and reduce conservatism in assessment methods (crosses many of the identified Gaps)
Confirm processes/methods for fabricating calibration standards with a high degree of R&R

- All anomaly types
- Emphasis on cracks and seam anomalies
- Establish R&R through detailed destructive testing approach and statistical analysis

After confirming ability to produce calibration standards, the industry will have the ability to establish reference standards – fabricated and real-world samples can then be used for reference based on a well-established set of calibration standards

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Gap #7

Develop and Validate ILI Technologies for Circumferential Anomalies and Bending Stresses

Some limited and preliminary work on circumferential cracking detection and characterization
Circumferential cracking in dents (particularly bottom side) were specifically identified and a primary focus for any PHMSA R&D funding
Bending stresses also identified as needing additional focus – geotechnical and environmental conditions that could affect bending stresses on a pipeline

Some work being performed in this area of study, but no comprehensive approach that is known to date
Options and ideas:

- Industry data mining and compilation of current practice and performance
- ILI pull tests with NDE and destructive testing – Trifecta of integrity data
- Look at effects of temperature changes and thermal variability on pipelines with regard to stress added; climatic and operationally driven temperature variations
- Reference standards would be beneficial – tie to Gap #6

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Gap #8

Establish and MAINTAIN Relevant Industry Databases

A lot of discussion over the past decade of the benefits of industry databases
New rulemakings and TVC/IVP confirmation will benefit from having access to broad industry databases
materials properties
ILI vs in ditch
Repairs/remediation (mitigation of anomalies inspected)
Analysis of past incidents (see Gap #9)

PHMSA PIPES Act of 2016 – requires formation of an advisory group on data sharing; need to define what is RELEVANT

Material property databases currently exist and should be supplemented and leveraged

- pipe body
- girth welds
- Crack ILI data (use as a model for other anomalies)

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Gap #9

Root Cause Failure Analysis (RCFA) of Past Pipeline Incidents

- Comprehensive review of PHMSA incident database on past incidents
- Evaluate consistent with current practices for Incident Analysis and RCFA and use data available to better understand the root of the failure
- PHMSA Form 7000 has most emphasis on failure mode and the impacts of a release, not root cause and lessons learned
- Assess and identify lessons learned from this process that should be shared with the industry – publish Advisory Bulletins, other notices as appropriate
- Establish best practice for this process
- Apply process to all future release incidents (or at a minimum significant release incidents)
- Non-fatigue driven cracks and seam failures (role of HIC) were discussed as areas that would benefit from this analysis and developing a consistent, peer-reviewed process for RCFA and communicating outcomes and any significant findings