

Pipeline Research and Development (R&D) Forum



Event Summary Report

**Hyatt Regency Inner Harbor
Baltimore, MD**

September 11-12, 2018

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Event Forward

The Pipeline Research and Development (R&D) Forum was held in Baltimore, Maryland on September 11-12, 2018. This 2-day event is held periodically to generate a National research agenda that fosters solutions for the many challenges with pipeline safety and with protecting the environment. The forum allows public, government and industry pipeline stakeholders to develop recommendations on the technical gaps and challenges for future research. It also reduces duplication of programs, factors ongoing research efforts, leverages resources and broadens synergies. The national research agenda coming out of these events is aligned with the needs of the pipeline safety mission, makes use of the best available knowledge and expertise, and considers stakeholder perspectives. Specifically, the forum:

1. Identifies key pipeline technical challenges facing industry and government;
2. Disseminates information on current research efforts; and
3. Identifies new research that can help to meet known challenges.





Key Challenges Executive Summary

The Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) led a steering committee of ten government and industry organizations that organized, planned and executed this forum. The forum brought together approximately 200 representatives from Federal, State and foreign government offices along with domestic and foreign natural gas and hazardous liquid pipeline operators. The forum's goals included identifying key challenges facing industry and government, sharing information on current research efforts, and identifying research that can help solve known challenges.

Within the Panel addressing National Perspectives on Key Pipeline Challenges, we first heard a perspective from PHMSA that the research program has remained very competitive and able to narrow down multiple dozens of research submissions to select the best researchers to address R&D forum topics. We also heard the progress is being made with active work and solutions of various types have made it to the market. However, many challenges remain as reported from various incidents corresponding to the subjects of the working groups managed at the 2018 forum. This means in many cases that PHMSA will continue to invest in our core areas and expand in new ones such as for LNG.

The perspective from the National Association of Pipeline Safety Representatives (NAPSR) reminded the audience that they support any research efforts that provide a way for pipeline operators to promote public/pipeline safety or to increase efficiency in operating their pipeline systems. Several areas of research were recommended as ongoing good example or current needs that should be sought such as addressing tools or processes for identifying plastic pipe degradation/failures to supporting material tracking and traceability technology for improving technology to assess casings. Technology for monitoring graphitization of cast iron pipelines and the development of in line inspection tools for small diameter gas pipelines were also mentioned as research NAPSR supports further work.

Next up was the hazardous liquid pipeline industry perspective which well highlighted recent advancement in inspection technologies and processes. Besides such advancements, there was still a clear call for the enhanced use of technology for complex integrity management threats as supported by future enhancements of ILI technology and enhancements of Non-Destructive Evaluation technology combined with advancements in the application of leak detection technologies. Finally, it was mentioned as recognized that investment in research today may only resolve integrity challenges in 3 to 5 years at best especially when you factor technology adoption and acceptance of new methods.

The perspective from the natural gas transmission pipeline industry noted that natural gas to electric coordination depends highly on pipeline reliability. New infrastructure construction is experiencing delays/opposition making the continued operation of existing pipelines a long-term

priority. Avoiding/reducing natural gas releases is a growing environmental concern for transmission pipelines. Points were made that the industry must implement low-impact, highly-reliable integrity management solutions to leverage existing assets in the areas of increased tool/sensor capabilities, enhanced engineering processes, data management, analysis and integration and on pending regulations. Finally, it was conveyed that regardless of pipe vintage, it must function safely and reliably 100% of the time even though there is an increasing difficulty building new facilities, putting pressure on continued, long-term demands on existing assets.

The perspective from the natural gas distribution pipeline industry called for better tools and practices in employee safety (artificial intelligence/robotics), in leak identification and leak classification (methane volumes), in reducing methane emissions during purging operations, with better access to data and better data capture, customer safety and regulatory support. It was a stated goal that distribution companies strive for carbon neutral electrification, ultimate replacement or rehabilitation of cast iron systems and that collaborative research will play a strong in role in reaching such goals.

It should be noted that all presenters shared the goal of zero incidents and moving to safety management systems as the next safety frontier.

All presentation material from the forum is available for download from the following webpage: https://primis.phmsa.dot.gov/rd/mtg_091118.htm .

Introduction

Approximately 200 people attended the Pipeline R&D Forum held in Baltimore, Maryland on September 11-12, 2018. This 2-day event is held periodically to generate a National research agenda that fosters solutions for the many challenges with pipeline safety and with protecting the environment. The forum allows public, government and industry pipeline stakeholders to develop recommendations on the technical gaps and challenges for future research. It also reduces duplication of programs, factors ongoing research efforts, leverages resources and broadens synergies. The national research agenda coming out of these events is aligned with the needs of the pipeline safety mission, makes use of the best available knowledge and expertise, and considers stakeholder perspectives.

The forum was structured so attendees would hear national perspectives on key challenges from federal and state regulators and the entire pipeline industry. The forum factored other panel discussions about current industry research roadmaps and the challenges with transferring

solutions into the marketplace. Finally, the forum provided public roadmapping sessions in the following five subject working groups:

1. Improving Assessment Methods for Dents & Cracks
2. Remote Sensing/Leak Detection-Mitigation
3. Locating & Preventing Damage to Distribution Pipelines
4. Expanding In-Line Inspection Capabilities & Application
5. Liquefied Natural Gas

These five groups were charged with identifying technical gaps and challenges for future research that do not duplicate existing efforts. The output must identify both short and long term research objectives for hazardous liquid/natural gas and transmission and distribution pipelines as well as for LNG. Basic roadmapping was conducted on identified technical gaps so identified research is addressing the need effectively. Details were then provided of the ultimate research goals so appropriate end users are factored into project scopes.

The forum was successful in identifying key pipeline technical challenges facing industry and government and disseminating information on current research efforts. It also did well in identifying new research that can help meet known challenges. See the working groups 1-5 report out file posted on the below webpage for much more information.

All presentation material from the forum is available for download from the following webpage: https://primis.phmsa.dot.gov/rd/mtg_091118.htm .

Competitive Academic Agreement Program

After the Panel on National Perspectives on Key Challenges, Joshua Arnold, PHMSA's CAAP Program Manager presented an overview of its research program with universities entitled the "Competitive Academic Agreement Program" (CAAP) launched in 2013. The CAAP is intended to spur innovation through enabling an academic research focus on high risk and high pay-off solutions for wide ranging pipeline safety challenges. The CAAP is different in focus, execution and reporting than PHMSA's core program on Pipeline Safety Research. It is intended to potentially deliver desired solutions that can be "handed-off" to further investigations in CAAP or in PHMSA's core research program that employs partnerships with a variety of public/private organizations. One goal in this strategy would be to validate proof of concept of a thesis or theory potentially all the way to commercial penetration into the market.

Another goal for CAAP is to expose undergraduate, graduate and PhD research students to subject matter common to pipeline safety challenges for illustrating how their engineering or technical discipline is highly desired and needed in the pipeline field. The pipeline industry and federal/state regulators are all experiencing low numbers of entry level applications to positions that are engineering or technically focused. Public conferences, meetings and journals have identified similar shortfalls.

PHMSA presented that this program is achieving its goals by involving 154 students total into the execution of the CAAP award work scopes from the 29 awards made since 2013. These projects

are addressing a wide variety of pipeline challenges including those for corrosion or preventing damage to pipelines.

CAAP Summary Totals

Annual Announcement	# Awards	PHMSA	Resource Sharing	# HS Students	# U-Grad Students	# Grad Students	# PhD Students	Total # Students	# Interns (a)	# Career Employed (b)
CAAP-1-13	8	\$814K	\$353K	1	23	19	16	59	3	4
CAAP-2-14	7	\$719K	\$391K		4	14	10	28	1	3
CAAP-3-15	11	\$2,968K	\$888K		16	22	19	57	2	
CAAP-4-16	3	\$909K	\$368K		2	7	1	10		
Grand Totals:	29	\$5,411K	\$2,002K	1	45	62	46	154	6	7

Footnotes:

(a) Denotes the number of internships offered by engineering firms, research organizations, government agencies or pipeline operators to students involved with CAAP research projects.

(b) Denotes the number of full time career employment/jobs offered by engineering firms, research organizations, government agencies or pipeline operators to students involved with CAAP research projects.

Nine schools participated at the forum with each given an opportunity for the principal investigator and the 13 accompanying students to summarize the project work scope and objectives.

The forum had a 13 poster Student Poster Session where the entire forum audience could meet the students and hear about the various technical aspects with their research project. Much more information on this program is available from the below website:

<https://primis.phmsa.dot.gov/rd/universitypartners.htm> .

Five Focused Working Groups

The working groups each addressed focused areas for research roadmapping. Some subject overlap is possible but was kept to a minimum. These groups were charged with three phases of operation in order to generate the desired output.

Phase 1 sets the stage and identifies the challenges for the working group subject matter via several short presentations and group discussion. This period of time is also used to identify the top priorities for new research and begins to review if any ongoing work will address the specifics of each challenge.

Phase 2 can continue Phase 1 activities but quickly transitions to road mapping the identified priorities. As part of the charge for this phase the specifics to the desired output from the research priorities will be determined including the output type. For instance, is the gap best addressed by a technology, an improvement to a consensus standard or a paper study to gather more information or create a new process with some goal? The suggested timeline to develop a solution as added to each gap is subjective and just a guide to assist researchers on the amount of effort that should be applied for proposed scopes to meet a desired delivery. These gathered details are critical here for soliciting for effective research projects.

Phase 3 can continue Phase 2 activities but quickly transition to populating a provided template output presentation using audience participation. The template categories coincide with the data that the working group is gathering.

A PHMSA facilitator was assigned to each group to assist the working group leaders in executing these three phases and in capturing the necessary details that were reported out. The scope of and top gaps defined by each working group are provided below.

WG#1 – Improving Assessment Methods for Dents & Cracks

Leader: Munendra Tomar, Manager – Pipeline Integrity Process and Technology, Kinder Morgan Pipelines

Leader: Nick Homan, Integrity & Corrosion Engineering Manager, Marathon Pipe Line LLC

PHMSA Rep: Steve Nanney, Senior Engineer

Audience participants in this group discussed how to improve assessment methods determining the severity and fatigue life of dents in steel pipelines under hazardous liquid and natural gas service. The group also discussed improving assessment methods determining the severity and fatigue life of cracks near or in welds or crack in corrosion defects (CIC).

The group identified four gaps for future research depicted below. More details on the presentations given within the group and the identified gaps are available for download in the working group report-out file on the PHMSA research program webpage for this forum.

Gap #1 – (Technology) Validation of ILI capabilities with respect to the various types of mechanical damage (e.g. plain shallow dent, dent with gouge, plain dent with gouge etc.) and essential operating parameters.

Gap #2 – (General Knowledge) Bringing together various research performed related to mechanical damage along with a state of the art compendium of current ILI capabilities, risk prioritization processes and assessment methods. Deliverables would include: 1) Reporting specification for ILI, 2) Classification scheme for mechanical damage, 3) Tying the identified classifications to applicable screening/assessment models/processes, 4) Guidance on response criteria and appropriate response schedule.

Gap #3 – (Consensus Standard) Examine pipeline construction and materials standards and field practices with respect to impact on long term management of mechanical damage (API 5L, 1104; ASME B31.4, B31.8, CFR 192/195).

Gap #4 – (Consensus Standard) Comparison and validation of available assessment methods (critical strain (DFDI)/Fatigue based) and practical guidance for implementation.



Picture from Working Group #1

WG#2 – Remote Sensing/Leak Detection-Mitigation

Leader: Max Kieba, Engineer, DOT/PHMSA

Leader: Robert Smith, Senior Research Program Manager, DOT/PHMSA

Audience participants in this group discussed how remote sensing approaches (fixed sensors or via drones) can provide critical data to pipeline operators that quickly identify/prevent a wide range of integrity threats including leak detection.

The group identified three gaps for future research depicted below. More details on the presentations given within the group and the identified gaps are available for download in the working group report-out file on the PHMSA research program webpage for this forum.

Gap #1 – (Technology and General Knowledge) Develop Remote Sensing and Leak Detection Platforms that can deploy multiple sensor types.

Gap #2 – (Technology and General Knowledge) Further Validation of Remote Sensing and Leak Detection Technologies under realistic and differing operating conditions.

Gap #3 – (Technology and General Knowledge) Improving Data Collection, Normalization and Integration methods to enhance risk assessment tools for decision-making.



Picture from Working Group #2

WG#3 – Locating & Preventing Damage to Distribution Pipelines

Leader: Gordon King, Executive Vice President, Corporate Services, Okaloosa Gas District

Leader: Corinne D. Byrnes, Principal Program Manager, Federal Programs, National Grid US

PHMSA Rep: Annmarie Robertson, Program Manager

Audience participants in this group discussed how to improve locating distribution pipelines in a congested urban underground. The group also discussed approaches to prevent damage to distribution pipelines either in technology or in systematic protocols that factor tools, people and process.

The group identified four gaps for future research depicted below. More details on the presentations given within the group and the identified gaps are available for download in the working group report-out file on the PHMSA research program webpage for this forum.

Gap #1 – (Technology) Improved Pipe Locating Technology for Legacy/New Pipe.

Gap #2 – (Technology and General Knowledge) Improved Data Management.

Gap #3 – (New/Revised Consensus Standard and General Knowledge) Education and training of excavators to include general public – Development of Recommended Practices, to include details for all excavation technologies.

Gap #4 – (Technology) Trenchless Technology Challenges: HDD, Cross Bore, 3rd Party (non-operator) Locating.



Picture from Working Group #3

WG#4 – Expanding In-Line Inspection Capabilities and Application

Leader: Bruce Dupuis, Program Lead, Pipeline Integrity Liquids Pipelines System Engineering, TransCanada Pipelines

Leader: Craig Sisco, Director, Engineering Staff, Southwest Gas

PHMSA Rep: Joshua Johnson, Materials Engineer

Audience participants in this group discussed development of technology that can internally inspect natural gas and hazardous liquid pipelines. It covered both piggable and hard to inspect pipeline systems where robotic solutions are necessary. A primary focus of this group was to envision technology solutions that advance the state of the art beyond current abilities and push for technology to detect anomalies having complex features.

The group identified three gaps as depicted below. More details on the presentations given within the group and the identified gaps are available for download in the working group report-out file on the PHMSA research program webpage for this forum.

Gap #1 – (Technology) Adapting existing ILI sensor technology or expanding platform range would close the gaps for available sensor technology for “Unpiggable” pipelines and physical space challenges sometimes experienced in inline inspection.

Gap #2 – (Technology) Advance and evolve Computer Tomography for application on full joint spools in order to improve sample quality and preservation of the inventory for ILI and in-ditch validation through both open and blind qualification testing.

Gap #3 – (Technology) Currently no methodology to determine toughness in absence of destructive testing. Objective is to have a direct measurement applicable along entire pipeline, perhaps starting first with extrapolation from other attributes.



Picture from Working Group #4

WG#5 – Liquefied Natural Gas

Leader: Walter "Skip" Doucett, Director – LNG Operations Massachusetts North, National Grid

Leader: David Anderson, Manager, Asset Integrity Management & Reliability, Cheniere Energy, Inc.

PHMSA Rep: Senth White, Engineer

Audience participants in this group discussed various challenges for LNG facilities. Such challenges include identifying the areas of concern where the highest likelihood of LNG component failures or safety risks may occur for various Part 193 LNG facilities, including export, import, peakshaving, and small-scale. Areas of concern included component life expectancy, inadequate design, construction, or maintenance techniques, and potential hazards due to releases from component failures or due to natural catastrophes. Another challenge discussed was improving LNG facility inspections by developing best practices and enforcement strategies to achieve the highest possible levels of compliance, while keeping the costs and burden as low as possible. Selection and placement of the most optimal and reliable fire and gas detection technologies in LNG plants also presents challenges.

The group identified five gaps for future research depicted below. More details on the presentations given within the group and the identified gaps are available for download in the working group report-out file on the PHMSA research program webpage for this forum.

Gap #1 – (General Knowledge) Identify and evaluate, for technical relevance, inspection and maintenance frequencies required in CFR 49 Part 193.

Gap #2 – (Technology) Efficacy and treatment of hazard mitigation measures for siting (active – passive).

Gap #3 – (General Knowledge) Data collection of failures from LNG facilities.

Gap #4 – (General Knowledge) Develop a risk based approach and criteria for hazard detection layout.

Gap #5 – (Modeling – Standards) Developing an evaluation protocol for non-LNG release hazards.

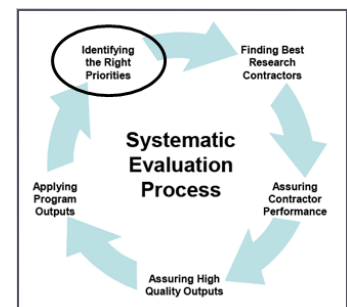


Picture from Working Group #5

Please see the report out file for each working group for much more details on these topics. Please also see the asterisk (*) that may be tagged to some of the main gaps and to some additional gaps if noted. These are suggested for university investigation and will be used by PHMSA as possible topics for the annual CAAP solicitations.

Next Steps

The forum is Step 1 in PHMSA's process for mustering successful research outcomes. It should be noted that identifying the right priorities in this manner is a form of peer review prior to soliciting for new research. Stakeholder driven input on what topics to solicit is key in leveraging resources, existing efforts and for removing duplication. PHMSA will now review the findings from the forum in preparation of its next research solicitation. The details illustrated in the working group report out files will drive the development of synergies necessary for comprehensive proposals and ultimately good research projects that align with the current needs for pipeline safety. When approved, the solicitation will be posted at <https://www.fbo.gov/> or <http://www.grants.gov/> with additional requirements posted therein.



Acknowledgments

The forum would not be possible without the volunteered time and efforts coming from the steering committee. The representation coming from these organizations were instrumental in advertising the forum, searching and securing speakers and working group leaders. PHMSA is grateful for this effort and comprehensive recommendations for the forum.

1. American Gas Association
2. American Petroleum Institute
3. American Public Gas Association
4. Interstate Natural Gas Association of America
5. National Association of Pipeline Safety Representatives
6. National Institute of Standards and Technology
7. Northeast Gas Association/NYSEARCH
8. Operations Technology Development
9. Pipeline Research Council International

Thank You to all who attended and participated!