Peer-review Report

Pipeline and Hazardous Materials Safety Administration

Pipeline Safety Research & Development Program

Peer-reviews Conducted
May 1, 2019, & May 8, 2019

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EXECUTIVE SUMMARY

Since 2006, in accordance with mandates from the Office of Management and Budget (OMB) and the Office of the Secretary of Transportation, the Pipeline and Hazardous Materials Safety Administration's (PHMSA) Pipeline Safety Research and Development (R&D) Program has held annual peer reviews of active Core Program research projects that are designed to maintain research data quality. PHMSA holds these reviews virtually via teleconference and the internet, saving both time and resources by foregoing physical meeting spaces. Virtual teleconferences facilitate attendance from Canada, Europe, and all U.S. time zones, making it easier for panelists, researchers, project cosponsors, and Agreement Officer Representatives (AORs) to participate.

The annual peer review continues to build on a strong, systematic evaluation process that was developed by PHMSA's Pipeline Safety R&D Program and certified by the Government Accountability Office. The 2019 peer-review panel, which was made up of 6 academic representatives, reviewed 17 projects using the following 6 evaluation criteria:

1. Is progress being made towards project objectives and project management for both the budget and the schedule?
2. Is there a plan for technology transfer or the dissemination of results, including publications, reporting, and/or patents?
3. How much end-user involvement is incorporated into the scope of work?
4. Is the project work being communicated to other related research efforts?
5. Are the intended results consistent with scientific knowledge and/or engineering principles?
6. Are the intended results presented in such a manner as to be useful for identified end users?

The rating categories assigned by the peer-review panel are "Ineffective", "Effective", "More Than Effective", and "Very Effective." The average score for the 17 projects assessed during the May 2019 review was "More Than Effective".

The greatest project strengths that were identified were in the areas of technology transfer, end-user involvement, and project communication, while maintaining project schedule was indicated as the area needing the most improvement. An outline of overall program performance that is based on the summary of the reviewed projects may be found in Table 4. Table 5 itemizes the order of project rankings for projects with the same score that have equal rankings. Additional details are available in Tables 4 and 5, Section 7, and Appendix C.

PHMSA is pleased with the process used to conduct these reviews, as well as the Calendar Year (CY) 2019 findings and recommendations that were provided by the panelists. PHMSA accepts the findings and recommendations that were summarized in the report, as shown in the official PHMSA response memorandum in Appendix A.

1.0 Introduction

The purpose of this document is to report findings from the peer reviews that were held by PHMSA's Pipeline Safety R&D Program on May 1, 2019, and May 8, 2019. The findings and recommendations in this report were derived from scoring and comments provided by the peer-review panelists. Department of Transportation (DOT) Operating Administrations (OA) are required to develop and execute a systematic process for peer reviews and all influential or highly influential information that is intended for dissemination in the foreseeable future.

Through the Information Quality Act, Congress directed the OMB to "provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by Federal agencies."[1] The resulting OMB Bulletin, Final Information Quality Bulletin for Peer Review, prescribes the required procedures for federal programs.

The purpose of the DOT's peer reviews is to uncover technical problems, keep projects on target to achieve their original objectives, ensure projects remain aligned with stakeholder needs, and provide technical guidance using experts who are objective, independent, and technically competent. These reviews are held annually for active Core Program research projects and usually occur during the second quarter of each CY.

2.0 Research Program Background

PHMSA regulates safety of the design, construction, operation, maintenance, and spill response planning for more than 2.7 million miles of pipelines that transport natural gas and hazardous materials. PHMSA is focused on the continual reduction of natural gas and hazardous liquid pipeline incidents that result in death, injury, significant property damage, or environmental harm.

The vision of the PHMSA Pipeline Safety R&D Program is to support PHMSA's mission to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. The mission of the PHMSA Pipeline Safety R&D Program is to sponsor research and development projects focused on providing near-term solutions that will improve the safety, reduce the environmental impact, and enhance the reliability of the Nation's pipeline transportation system.

PHMSA has regulatory responsibility regarding the safety of natural gas and hazardous liquid pipelines. Beginning in 2001 and as a response to several nationally recognized pipeline failures, PHMSA strengthened its role in the safety of the Nation's pipeline system in numerous ways,

[1] 106th Congress. *Treasury and General Government Appropriations Act for Fiscal Year 2001* (Public Law No. 106-554-515(a)). U.S. Government Printing Office. Retrieved from: https://www.gpo.gov/fdsys/pkg/PLAW-106publ554/html/PLAW-106publ554.htm.

including promulgating new integrity management regulations.[2,3,4] Both these regulations and the new inspection processes used by regulators to evaluate operator compliance rely on operator access to technologies that support improved safety and integrity performance, as well as on regulator access to information on the appropriate use and limitations of these technologies. Congress expanded support for the PHMSA Pipeline Safety R&D Program in 2002 to address the need for new technologies related to integrity and data on the validity of these technologies.[5] As authorized by Congress, PHMSA sponsors R&D projects that are focused on providing near-term solutions to increase the safe, reliable, and environmentally sound operation of the United States' energy transmission and distribution pipelines.

The Pipeline Safety R&D Program contributes directly to PHMSA's mission by focusing on three objectives:

1. Fostering the development of new technologies that can be used by operators to improve safety performance and more effectively address regulatory requirements;
2. Strengthening regulatory requirements and related national consensus standards; and,
3. Educating pipeline safety officials so industry managers, regulatory managers, and PHMSA pipeline safety field inspectors can make better decisions regarding safety issues and resource allocation.

The Pipeline Safety R&D Program is organized around eight program elements that reflect PHMSA's statutory responsibilities and guidance from both pipeline experts and stakeholder groups regarding the many challenges associated with pipeline safety and facility management. All ongoing and future projects are linked to at least one of these program elements, each of which has associated safety issues, technology needs or gaps, and R&D opportunities. Program goals define the desired outcomes for R&D projects and are associated with each R&D Program element. Additionally, each program goal bears a direct relationship to the longer-term enhancement of pipeline safety. Table 1 identifies these program elements and the desired improvements.

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[2] Code of Federal Regulations. (Rules effective May 29, 2001, and February 15, 2002). *Pipeline Integrity Management in High Consequence Areas for Hazardous Liquid Operators* (49 Code of Federal Regulations Part 195). U.S. Government Publishing Office.

[3] The Federal Register. (December 15, 2003.) *Pipeline Safety: Pipeline Integrity Management in High Consequence Areas (Gas Transmission Pipelines)* (68 FR 69777). Final Rule. Retrieved from: https://www.federalregister.gov/documents/2003/12/15/03-30280/pipeline-safety-pipeline-integrity-management-in-high-consequence-areas-gas-transmission-pipelines.

[4] The Federal Register. (May 26, 2004). *Pipeline Integrity Management in High Consequence Areas (Gas Transmission Pipelines)* (69 FR 29903). Final Rule, as amended. Retrieved from: https://www.federalregister.gov/documents/2004/05/26/04-11789/pipeline-safety-pipeline-integrity-management-in-high-consequence-areas-gas-transmission-pipelines.

[5] 107th Congress. (December 17, 2002). *Pipeline Safety Improvement Act of 2002* (Public Law No. 107-355). U.S. Government Printing Office. Retrieved from: https://www.congress.gov/107/plaws/publ355/PLAW-107publ355.pdf.

Table 1: Program Elements of the PHMSA Pipeline Safety R&D Program		
	Program Element	**Program Element Goal**
1.	Threat Prevention	Develop new or improved tools, technology, or practices to reduce damage to pipelines, thereby preventing releases.
2.	Leak Detection	Develop new or improved tools and technology solutions to reduce the volume of product released.
3.	Anomaly Detection and Characterization	Develop new or improved tools, technology, and assessment processes to identify and locate critical defects in pipeline systems, improving the capability to characterize the severity of such pipeline defects.
4.	Anomaly Repair and Remediation	Enhance repair materials, techniques, processes, tools, and technologies that are designed to quickly bring pipeline systems back online after an outage.
5.	Design, Materials, and Welding/Joining	Improve the industry's ability to design and construct safe, long-lasting pipelines using the most appropriate materials and welding/joining procedures for specific operating environments.
6.	Alternative Fuels, Climate Change, and Other	Identify and resolve technical challenges that prevent both the safe transportation of alternative fuels via pipeline and resolution of the problems that have a national impact on other emerging technological or policy issues.
7.	Liquefied Natural Gas (LNG) Facilities	Examine standards incorporated into the Code of Federal Regulations for LNG, analyze performance gaps, and examine methodologies based on performance and Quantitative Risk Assessments to keep pace with the growing demand for the United States to export LNG.
8.	Underground Gas Storage (UGS) Facilities	Refine integrity requirements for UGS to prevent incidents such as the 2015 Aliso Canyon gas storage well release. Develop new procedures for the safe operation of UGS facilities and the reduction of the environmental impacts caused by uncontrolled releases.

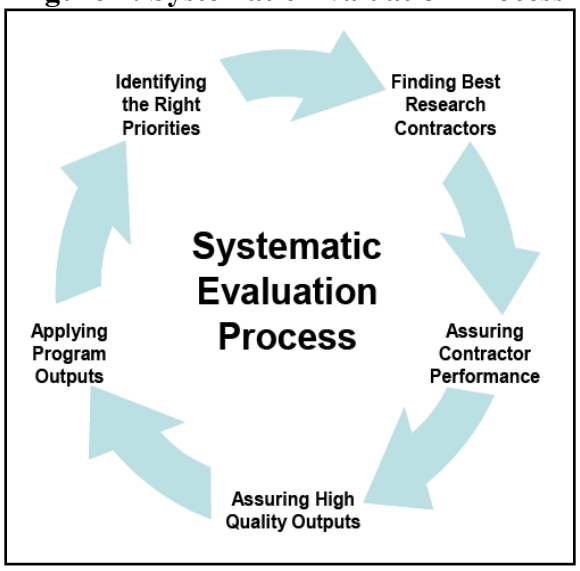
More information on the Pipeline Safety R&D Program strategy is outlined on the program website: https://www.phmsa.dot.gov/research-and-development/pipeline/about-pipeline-research-development.

Research Program Quality

To improve the quality of the Pipeline Safety R&D Program, PHMSA designed and implemented a systematic evaluation process that follows research projects from inception to implementation. This evaluation process contains five steps, each of which helps ensure that project outcomes will be high quality, relevant to PHMSA's mission, and applied to the appropriate end users.

Figure 1 identifies the steps in the systematic evaluation process and how it follows the lifecycle of research projects.

Figure 1: Systematic Evaluation Process



Ensuring the quality of research projects begins with establishing the right priorities for these projects. This preparatory work, which takes place at joint government-industry R&D forums and other meetings, identifies the priorities and structures necessary for projects to meet end users' technical needs. Additionally, this work minimizes duplication of programs, leverages funds, broadens synergies, accounts for ongoing research efforts with other agencies and private organizations, and allows government and industry pipeline stakeholders to agree on the technical gaps and challenges facing future R&D.

Next, the priorities and project design are refined and a search is conducted to onboard the best researchers. PHMSA then gathers representatives from federal and state agencies, industry, and trade organizations to form a merit review panel that is designed to use strong evaluation criteria to review research submissions.

PHMSA uses trained project managers and its Management Information System to ensure awarded projects are performing well. The Management Information System electronically monitors and tracks contractor performance as projects move toward completion, providing the necessary oversight to ensure that contract accounting and specific contractual milestones prescribed by the award documents are systematically followed. Additionally, system design maintains and improves program quality, efficiency, accounting, and accountability. Further oversight is provided by AORs, who are trained, certified, and assigned to each project in accordance with federal acquisition regulations.

This peer-review process is designed to improve research project quality by keeping projects on track to meet their ultimate goals. PHMSA defines a successful research project as one that results in a final product that is utilized by end users. PHMSA pipeline safety research projects have a higher probability of success if the first three steps of the systematic evaluation process are applied correctly and efficiently.

3.0 Peer-review Panelists

Peer-review panelists are chosen based on three criteria: expertise, balance, and independence. The specific panelist selection criteria were derived from the OMB Bulletin and secured from academia.

The 2019 peer-review panel consisted of academic representatives and one government employee (Table 2). Each panelist provided a short biography describing their work history and technical qualifications (Appendix B).

Table 2: Peer-review Panelists

	Name	Affiliation
1	R. Scott Lillard, Doctor of Philosophy (Ph.D.)	Professor & Carboline Endowed Chair, The Department of Chemical & Biomolecular Engineering, University of Akron
2	Anne Co, Ph.D.	Associate Professor, Chemistry and Biochemistry, The Ohio State University
3	Salvatore Salamone, Ph.D.	Associate Professor, Department of Civil, Architectural and Environmental Engineering, University of Texas at Austin
4	Laurence J. Jacobs, Ph.D.	Associate Dean, Academic Affairs School of Civil and Environmental Engineering, Georgia Institute of Technology
5	Ying Huang, Ph.D.	Associate Professor, Civil and Environmental Engineering Department, North Dakota State University
6	Yongming Liu, Ph.D.	Professor, Mechanical Engineering Program, Arizona State University

4.0 Panelist Charge

The peer-review panelist charge, which was initially developed in December 2005 and is revised annually, as needed, is provided to each panelist prior to the peer review. It contains specific instructions regarding what is expected from panelists in terms of review and is important for the following reasons:

1. It focuses the review by presenting specific questions and concerns that PHMSA expects the peer reviewers to address; and,
2. It invites general comments on the entire work product to date, which -- along with the specific comments -- should focus mostly on whether the scientific and technical studies were applied in a sound manner.

5.0 Scope of the Peer Review

During the annual peer review, the panel members review focused on high-level presentations from researchers that addressed the six evaluation criteria. Presentations were scheduled to take no more than 20 minutes and were followed by a 10-minute period in which panelist questions and possible written public questions could be asked. In its entirety, the review of each project took approximately two hours, which was sufficient time for a review of the background information for the project, including reporting, an advance copy of the review slides, and 30

minutes of review and questioning from the panel. This time included a post-review period that encompassed follow-up questioning, a consensus review meeting, and analysis of the peer-review report. The underlying objective of the Pipeline Safety R&D Program was to provide the best assessment of each project's performance, addressing specific criteria without comparing one project with another. PHMSA provided the panelists with scorecards that allowed them to rate a project's performance according to the following review criteria:

1. Is progress being made towards project objectives and project management for both the budget and the schedule?
2. Is there a plan for technology transfer or the dissemination of results, including publications, reporting, and/or patents?
3. How much end-user involvement is incorporated into the scope of work?
4. Is the project work being communicated to other related research efforts?
5. Are the intended results consistent with scientific knowledge and/or engineering principles?
6. Are the intended results presented in such a manner as to be useful for identified end users?

Essentially, projects that rated well on these criteria are expected to have a high likelihood of success. These criteria provide a numeric rating that is converted to a scale designed to illustrate how well a project addressed the goals of the peer review via ratings ranging from Very Effective to Ineffective. This conversion is illustrated in Table 3:

Table 3: Peer-review Rating Conversion	
Rating Scale	
Very Effective	4.5-5.0
More Than Effective	3.0-4.4
Effective	1.9-2.9
Ineffective	0.0-1.8

Very Effective
A project that receives this score provides the clearest method regarding how it will accomplish its purpose. Additionally, such a project will produce the intended or expected result in a superior manner.

More Than Effective
A project that receives this score is better, clearer, and more distinct than an Effective project in terms of how it will accomplish its purpose. Additionally, such a project will produce the intended or expected result in more than a satisfactory manner.

Effective
A project that receives this score is adequate to accomplish its purpose. Additionally, such a project will produce the intended or expected result in a satisfactory manner.

Ineffective
A project that receives this score will not be effective. Additionally, such a project will not produce desired results, will be ineffectual, and will lack the details to support a satisfactory desired outcome.

6.0 Associated Research

Specific research project subject matter will vary from one annual peer review to another; however, the subject matter generally falls within the eight program elements shown in Table 1. Technical issues usually address metallurgical, structural, technological, and risk-based subjects that are common in the pipeline industry.

The research assessed during the May 2019 review encompassed multiple technological solutions and projects, yet had a focus on general knowledge. A short description of each peer-reviewed project may be found in Appendix D.

7.0 Peer-review Findings

During the May 2019 review, the average program rating across all evaluation categories was "More Than Effective", and the average sub-criteria were also highly rated. Seventeen projects were reviewed this year, all of which were rated as "More Than Effective" or "Very Effective." Table 4 summarizes overall program performance based on the summary of reviewed projects, while Table 5 itemizes the ranking order for projects with the same score and equal rankings.

Most projects were approximately 30 to 50 percent complete at the time of review. During the course of the review, the panelists made several recommendations associated with each project that PHMSA categorized into strong and weak points. The greatest strengths were in the areas of technology transfer, end-user involvement, and project communication while maintaining project schedule was indicated as the area needing the most improvement. Slippage in project schedule can be partially attributed to the 2019 government shutdown since researchers could not address various project actions during this period. However, none of the comments identified the critical actions required to salvage a project from failure, but instead recommended actions to further improve performance.

Table 6 in Appendix C itemizes the Strong and Weak points of the 17 panelist-reviewed projects. These points were consistently raised by the panelists and are reflected in the scoring of multiple evaluation categories. Any specific recommendations will be disseminated to researchers and AORs, as necessary, so that individual decisions regarding changes in scope can be determined.

Table 4: Summary of Total Average Score & Rating for the Review Categories and Sub-criteria		
Review Categories and Sub-criteria	**Score**	**Rating**
1. Is progress being made towards project objectives and project management for both the budget and the schedule?	3.9	More Than Effective
2. Is there a plan for technology transfer or the dissemination of results, including publications, reporting, and/or patents?	4.1	More Than Effective
3. How much end-user involvement is incorporated into the scope of work?	4.2	More Than Effective
4. Is the project work being communicated to other related research efforts?	4.0	More Than Effective
5. Are the intended results consistent with scientific knowledge and/or engineering principles?	4.1	More Than Effective
6. Are the intended results presented in such a manner as to be useful for identified end users?	4.1	More Than Effective
Program Summary	**4.1**	**More Than Effective**

Table 5: Summary Ranking & Rating of Individually Reviewed Research Projects					
Rank	**Project ID**	**Project Title**	**Contractor**	**Rating**	**Score**
1	693JK31810003	Validating Nondestructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry	Operations Technology Development	Very Effective	4.8
2	693JK31810011	River Scour Monitoring System for Pipeline Threat Prevention	Arizona State University	Very Effective	4.6
3	693JK31810001	Improvements to Pipeline Assessment Methods and Models to Reduce Variance	Gas Technology Institute	More Than Effective	4.4
3	693JK31810014	Evaluation of Well Casing Integrity Management for Underground Storage Wells	Pipeline Research Council International	More Than Effective	4.4
4	693JK31810013	Tools for Predicting Gas Migration and Mitigating its Occurrence/Consequence	Colorado School of Mines	More Than Effective	4.3
5	693JK31810002	On-board Power and Thrust Generation for the Explorer Family of Robots for the Inspection of Unpiggable Natural Gas Pipelines	Northeast Gas Association/NYSEARCH	More Than Effective	4.2
5	693JK31810005	External Leak Detection Body of Knowledge	Gas Technology Institute	More Than Effective	4.2
5	693JK31810009	Improved Tools to Locate Buried Pipelines in a Congested Underground	Gas Technology Institute	More Than Effective	4.2

Rank	Project ID	Project Title	Contractor	Rating	Score
5	693JK31810010	ORFEUS Obstacle Detection for Horizontal Directional Drilling	Operations Technology Development	More Than Effective	4.2
6	693JK31810012	Modernize the Assessment of River Crossings	Pipeline Research Council International	More Than Effective	4.1
7	693JK31810006	Consistency Review of Methodologies for Quantitative Risk Assessment	Gas Technology Institute	More Than Effective	3.9
7	693JK31810007	Performance Gap Comparison of Process Safety Management Consensus Standards and Regulatory Requirements for LNG Facilities	Gas Technology Institute	More Than Effective	3.9
7	693JK31810008	Review of Control System Testing Frequency	CH-IV International	More Than Effective	3.9
8	693JK31810017	Risk Assessment and Treatment of Wells	C-FER Technologies	More Than Effective	3.8
8	693JK31810004	Cost-benefit Analysis of Deploying or Retrofitting Externally Based Leak-detection Sensors	C-FER Technologies	More Than Effective	3.8
9	693JK31810015	Tubing and Packers Life-cycle Analysis for UGS Applications	Battelle Memorial Institute	More Than Effective	3.3
10	693JK31810016	Reliability of Subsurface Safety Valves	Battelle Memorial Institute	More Than Effective	3.2

8.0 PHMSA's Response to Panelists' Findings and Recommendations

The CY 2019 reviews were the PHMSA Pipeline Safety R&D Program's 14th structured peer review. PHMSA is pleased with these reviews, findings and recommendations provided by the peer-review panelists.

The panel indicated that some immediate actions can be taken to further enable research projects to achieve their contractual milestones (Table 6, Appendix C). PHMSA issued a response memorandum detailing PHMSA's plan to improve the likelihood that projects can achieve their proposed goals by addressing specific recommendations with project cosponsors and researchers (Appendix A).

PHMSA will continue refining the annual peer-review process, as needed, by incorporating feedback submitted by the researchers and peer-review panelists. PHMSA will also disseminate other specific panelist recommendations to both researchers and AORs. PHMSA has planned several initiatives to provide further guidance on the commercialization of technology projects and better coordination with strengthened project standards, thereby bringing transparency to the panel's recommendations. PHMSA views the comments received during the course of these reviews as an opportunity to continually improve.

APPENDIX B

Peer-review Panelist Biographies

MEMORANDUM FOR THE RECORD

From: ALAN KRAMER MAYBERRY
Alan K. Mayberry
Associate Administrator for Pipeline Safety, PHP-1
x6-4595

Subject: Pipeline Safety Research Program Peer-reviews, May 1 and 8, 2019

SUMMARY

The Pipeline and Hazardous Materials Safety Administration's (PHMSA) Pipeline Safety Research and Development (R&D) Program holds annual structured peer-reviews of active research projects to maintain research data quality, in accordance with mandates from the Office of Management and Budget and the Office of the Secretary of Transportation. PHMSA is pleased with the process used to conduct these reviews, as well as the findings and recommendations provided by the peer-review panelists. In calendar year (CY) 2019, most projects and the overall program retained a rating of "More than Effective," the same rating received in 2018. Further, the panelists identified a number of suggestions aimed at maintaining or improving research quality in years to come.

PHMSA will use feedback submitted by researchers and panelists to refine the process for holding annual peer reviews. Since none of the reviewed projects were rated "Ineffective", no immediate project modifications are warranted. The panelists specific recommendations will be disseminated to researchers and Agreement Officer's Representatives, who will decide if these recommendations warrant any process changes. PHMSA will continue refining the process, the criteria, and the guidance of our peer reviews to ensure future outcomes better support our goals.

RECOMMENDATION

The PHMSA Pipeline Safety Program accepts the findings and recommendations summarized in the CY 2019 Peer-review Report.

The Associate Administrator for Pipeline Safety

APPROVED: ALAN KRAMER MAYBERRY _____

DISAPPROVED: _____

COMMENTS: _____

DATE: _____

APPENDIX B

Peer-review Panelist Biographies

R. Scott Lillard

Dr. R. Scott Lillard is a professor and the Carboline Chair in Corrosion for the Department of Chemical and Biomolecular Engineering at the University of Akron. Prior to joining the University of Akron, Dr. Lillard worked for 16 years as a technical staff member for the Materials Science & Technology Division of the Los Alamos National Laboratory. He received his Ph.D. in Materials Science and Engineering in 1992 from the G.W. Whiting School of Engineering at the Johns Hopkins University and completed his postdoctoral work at the University of Virginia's Center for Electrochemical Sciences and Engineering in 1995. Dr. Lillard serves as an associate editor for the Journal of the Electrochemical Society, is the author of more than 90 technical publications, and is a NACE International fellow. His research is focused on environmental degradation, with an emphasis on crevice corrosion, pitting corrosion, galvanic corrosion, alternating current corrosion of buried pipelines, corrosion and environmental fracture in nuclear reactors, passivity and dielectric properties of oxide films, and hydrogen effects in metals.

Anne Co

Anne Co is an associate professor of Chemistry and Biochemistry and an associate fellow with the Center for Automotive Research at the Ohio State University. She received her Ph.D. in Chemistry from the University of Calgary, Canada. She then joined the National Research Council Canada's Institute for Chemical Process and Environmental Technology as a Natural Sciences and Engineering Research Council of Canada visiting fellow and was later promoted to the position of research associate. In 2008, she was awarded a Mary Fieser Fellowship Award to continue her postdoctoral studies with Professor Cynthia Friend at Harvard University. Professor Co's research interest is the development of next-generation battery materials, including ultra-fast charging materials, high-capacity materials, solid-state batteries, and flexible batteries for both mobile and stationary applications; she is also interested in corrosion and electrocatalysis. Professor Co's group has developed analytical tools designed to probe electrode and chemical processes in real time, allowing for understanding of mechanistic pathways of electrochemical reactions for applications. Professor Co received a National Science Foundation (NSF) Faculty Early Career Development Program (CAREER) award in 2014 and currently serves as an associate editor for ACS Applied Energy Materials. She is also on the editorial advisory board of the Journal of Applied Electrochemistry, the Education Committee of the Electrochemical Society, the board of directors for the Society for Electroanalytical Chemistry, and is the treasurer of the Physical and Analytical Electrochemistry Division of the Electrochemical Society. Dr. Co has an established record of recruiting and advising students, including 16 Ph.D. students (1 African-American, 3 Hispanic, and 6 female students), 5 Master of Science thesis students (1 African-American and 3 female students), 35 undergraduate students (4 African-American, 2 Hispanic, and 14 female students), and 4 postdoctoral fellows (1 Hispanic and 2 female students).

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Salvatore Salamone

Dr. Salvatore Salamone is an associate professor in the Department of Civil, Architectural and Environmental Engineering at the University of Texas at Austin. Before joining the University of Texas at Austin, Dr. Salamone was an assistant professor at the University at Buffalo and a postdoctoral fellow at the University of California: San Diego. He received his Ph.D. from the L'Università degli Studi di Palermo in Italy. Dr. Salamone's current research interests include structural health monitoring, nondestructive evaluation, the resilience of structural systems that are subject to earthquakes, ultrasonic sensing methods for smart structures, wave propagation in solids, digital signal processing and pattern recognition, the dynamics and vibrations of structural systems, piezoelectric energy harvesting, and nondestructive evaluation methods for additive manufacturing. His research is sponsored by the NSF, the Office of Naval Research (ONR), PHMSA, the Federal Rail Administration, ExxonMobil, the Texas Department of Transportation, the New York State Pollution Prevention Institute, the University Transportation Research Center 2, and the American Society of Nondestructive Testing (ASNT). Dr. Salamone has published more than 140 referred journal articles and conference publications, and his research contributions were recognized when he was awarded with the 2014 Achenbach Medal. He also received the 2018 Fellowship Research Award and the 2011 Faculty Grant Award, both from the ASNT. Dr. Salamone currently serves on several technical committees, including the American Society of Civil Engineers (ASCE) Structural Health Monitoring and Control Committee and the American Society of Mechanical Engineers (ASME) Ultrasonics for Mechanical Systems Committee.

Laurence J. Jacobs

Dr. Laurence J. Jacobs is a professor of civil, environmental, and mechanical engineering and is the associate dean for academic affairs for the College of Engineering at the Georgia Institute of Technology. Dr. Jacobs received his Ph.D. in Engineering Mechanics from Columbia University and, after a one-year postdoctoral position with the ONR, joined the faculty of Georgia Tech in 1988. Prior to receiving his Ph.D., he worked for two years in the aerospace industry and for one year as a structural engineer.

Dr. Jacobs' publications have been cited more than 6,600 times, with an *h*-index of 43 (Google Scholar), 34 (Scopus), or 35 (Web of Science), and he has published 123 peer-reviewed archival journal articles, 134 conference proceedings, and given 45 talks. In addition, he is a fellow with the ASME and is currently on the editorial board of NDT&E International. Dr. Jacobs' research has been funded by several federal agencies, the Georgia Department of Transportation, ExxonMobil, the Electric Power Research Institute, and General Electric. Further, he has been the Principal Investigator (PI) or Co-PI for $5 million in contracts since 1990. Dr. Jacobs has an established record of recruiting and advising students, including 20 Ph.D. students (2 African-American and 4 female students) and 68 M.S. thesis students.

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Ying Huang

Dr. Y. Huang currently is an associate professor and Welch faculty fellow with the Department of Civil and Environmental Engineering at North Dakota State University (NDSU). She obtained her Ph.D. from the Missouri University of Science and Technology in 2012 and has served as a faculty member with the NDSU since that time. Dr. Huang has taught nine civil engineering courses at the undergraduate and graduate level that received high student ratings. These courses included CE204: Surveying (fall semester), CE303: Materials (spring semester), and CE303L: Materials Laboratory (spring semester), and were attended by more than 100 enrolled students. Dr. Huang is also a major advisor for 18 graduate students (12 Ph.D. and 6 master's degree students) and 5 undergraduate research assistants, as well as the advisory committee member for 52 graduate students from fields including computer science, electrical engineering, construction engineering, and statistics. Dr. Huang's research background includes extensive experience in steel corrosion protection and mitigation, smart cities and autonomous systems, smart materials and structural health monitoring, intelligent transportation systems, pavement and traffic monitoring, railroad damage and defect assessments, big data for civil engineering applications, and emergency evacuation for multi-hazards. Dr. Huang obtained more than $2.5 million research grants from the NSF, the DOT, and the National Aeronautics and Space Administration (NASA), among others. She possesses two approved and pending patents and has published more than 85 high-quality, peer-reviewed publications, including a book chapter, 40 journals, and 45 conference papers. These publications were cited 620 times with an i10-index of 18. Dr. Huang has given more than 16 keynote and invited presentations, as well as 30 international and national presentations. In addition, she has received numerous awards, including the 2018 Welch Faculty Fellow, the 2018 NSF CAREER Award, the 2017 NDSU College of Engineering Researcher of the Year, the 2017 NDSU Centennial Award, the 2016 NDSU Forward Leap Research Award, and the 2015 NDSU Ozbun Economic Development Award.

Dr. Huang is an editor-in-chief for one international journal, the associate editor and editorial board member for five international journals, and a committee member for five distinguished professional societies, including the ASCE Structural Condition Assessment and Rehabilitation of Buildings Committee, the ASTM Fiber Optic Practices Committee, and the SPIE Sensors and Smart Structures Technologies Committee. She also organizes and modulates the following international conferences: the ASME International Mechanical Engineering Congress & Exposition, the International Workshop on Structural Health Monitoring, the Conference on Structural Health Monitoring of Intelligent Infrastructure, the SPIE Smart Structures & Nondestructive Evaluation Conference, and the ASCE Pipelines Conference. Dr. Huang is a grant reviewer for NSF Canada, the PHMSA Pipeline Safety R&D Program, the National Research Foundation of Singapore R&D, the Energy Market Authority of Singapore R&D, and the NSF Civil, Mechanical and Manufacturing Innovation Program. Dr. Huang is also a frequent peer reviewer for more than 50 leading international journals and conferences, serves on more than 40 of these journals as reviewer, and reviews more than 80 papers per year.

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Peer-review Panelist Biographies

Yongming Liu

Dr. Yongming Liu is a professor of mechanical and aerospace engineering at Arizona State University. He completed his Ph.D. at Vanderbilt University in 2006 and obtained his bachelor's and master's degrees from Tongji University in 1999 and 2002, respectively. Prior to joining Arizona State University in 2012, Dr. Liu served as an assistant professor/associate professor at Clarkson University from 2007 to 2012. Dr. Liu's research interests include prognostics, probabilistic methods, fatigue and fractures, imaging-based experiments, and Bayesian methods. He has published more than 100 journal articles and 100 conference papers/presentations, is an American Institute of Aeronautics and Astronautics associate fellow, and is a member of the ASCE, the ASME, and the Prognostics and Health Management Society. Dr. Liu is the recipient of the 2011 Air Force Young Investigator Award and has worked with a wide variety of governmental agencies and industrial partners during the course of his research, including NASA, the NSF, the Department of Energy, the DOT, and the Department of Defense. He has secured more than $17 million in research funding, $14 million of which he secured as a PI or institutional PI, and is currently leading a NASA University Leadership Initiative project on information fusion for system-level safety assurance.

APPENDIX C

Table 6 – Peer-reviewed Project Strong and Weak Points
(In order, as shown in Table 5)

The strong and weak points in Table 6 are shared with researchers and other project partners. An ongoing dialog between involved parries ensues and supports improvements so that projects increase their likelihood of success.

Project Title	Strong Points	Weak Points
Validating Nondestructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry	Very well organized and managed. The project is on schedule and making good progress towards achieving its objectives. There is very good end-user involvement.	There is the potential for schedule slippage due to the complexity of the project design. We suggest measures to better organize data sets as the project progresses. The project owners are encouraged to widen efforts to disseminate the results of the project.
River Scour Monitoring System for Pipeline Threat Prevention	Very well organized and managed. The project is on schedule and making good progress towards achieving its objectives. There is very good end-user involvement and the investigative team is very knowledgeable regarding policy and regulations.	There is some uncertainty regarding whether all variables for detecting scour events were considered.
Improvements to Pipeline Assessment Methods and Models to Reduce Variance	Presented a clear understanding of how the scope is utilizing scientific knowledge and/or engineering principles.	There is some uncertainty regarding how the project will address material intrinsic randomness, spatial variability, and defect location and geometry.
Evaluation of Well Casing Integrity Management for Underground Storage Wells	There is very good end-user involvement and communication with related efforts. Additionally, there is great use of prior related project results.	The project is slightly behind schedule. The project owners are encouraged to widen efforts to disseminate the results of the project.
Tools for Predicting Gas Migration and Mitigating its Occurrence/ Consequence	Presented a clear understanding of how the scope is utilizing scientific knowledge and/or engineering principles. The project remains on schedule.	It is suggested that this project widen input from end users. Additionally, communication between related efforts is encouraged. Significant challenges have been noted regarding variance in soil profiles.

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Project Title	Strong Points	Weak Points
On-board Power and Thrust Generation for the Explorer Family of Robots for the Inspection of Unpiggable Natural Gas Pipelines	The project seems well organized to achieve stated goals. There is a clear plan to address/resolve any delays.	There is some uncertainty regarding how much end-user involvement there is in the scope of this project, as well as what design role end users have played. The project was unclear about the battery types to be used, providing for the greatest inspection range.
External Leak Detection Body of Knowledge	Comprehensive data collection. This could be a highly impactful project, if successful.	It was unclear how the investigation into many technologies would be incorporated into the recommended practice. It is suggested that there should be some prioritization of tech types.
Improved Tools to Locate Buried Pipelines in a Congested Underground	The project scope seems well matched to the project goals. Additionally, the project includes a great field testing plan.	The project is slightly behind schedule. PHMSA encourages the project owners to widen efforts to disseminate the results of the project.
ORFEUS Obstacle Detection for Horizontal Directional Drilling	Great use of prior related project results. Additionally, there is very good end-user involvement.	This project is slightly behind schedule. Challenges remain regarding the use of ground-probing radar in this application.
Modernize the Assessment of River Crossings	Presented a clear understanding of how the scope is utilizing scientific knowledge and/or engineering principles. Additionally, there is very good end-user involvement.	The project is slightly behind schedule. The project owners are encouraged to widen efforts to disseminate the results of the project.
Consistency Review of Methodologies for Quantitative Risk Assessment	The project remains on schedule. Additionally, the investigating team is very knowledgeable.	It was unclear whether the project was truly on schedule after discussions regarding Task 3, a critical task that seemed unfulfilled. It was unclear how the QRA framework will be established.
Performance Gap Comparison of Process Safety Management Consensus Standards and Regulatory Requirements for LNG Facilities	The investigative team is very knowledgeable regarding policy and regulations.	It was unclear if the project was truly on schedule after discussions regarding Task 2, a critical task that seemed unfulfilled. It was unclear how the Performance Safety

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Table 6 – Peer-reviewed Project Strong and Weak Points
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Project Title	Strong Points	Weak Points
		Management framework will be established.
Review of Control System Testing Frequency	The project is structured to potentially support code change.	The success of this project is contingent on facility feedback. It is suggested that the project owners rescope the project to address potential impacts from any code change.
Risk Assessment and Treatment of Wells	Comprehensive data collection. This could be a highly impactful project, if successful.	The success of this project is contingent on facility feedback. The project owners are encouraged to widen efforts to disseminate the results of this project. It is suggested that project owners focus more on details that support model selection and that they fully populate the advisory panel.
Cost-benefit Analysis of Deploying or Retrofitting Externally Based Leak-detection Sensors	The project is structured to potentially support code change.	The project is slightly behind schedule. The project owners are encouraged to widen efforts to disseminate the results of this project. It is suggested that the project owners strengthen the focus on engineering justification for validation.
Tubing and Packers Life-cycle Analysis for UGS Applications	The project remains on schedule despite some stated subcontracting challenges.	The project should better convey how failure mechanisms are derived. Will there be enough data to generate a finding and support a model?
Reliability of Subsurface Safety Valves	The project remains on schedule despite some stated subcontracting challenges.	The project should better convey how failure mechanisms are derived given valve types/configurations, construction vintage, and testing frequency. Will there be enough data to generate a finding and support a model?

APPENDIX D

Peer-review Project Summaries
(In order, as shown in Tables 5-6)

Additional summaries and publicly available reports may be found at: http://primis.phmsa.dot.gov/matrix/.

Validating Nondestructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry

Operations Technology Development

This project will investigate nondestructive surface testing through micro-indentation and micro-machining methods for material property confirmation. Validation of testing technology provides benefits to pipeline safety, energy continuity, and integrity assessment programs because these techniques do not require a line to be taken out of service and do not destructively cut samples from in-service pipelines.

River Scour Monitoring System for Pipeline Threat Prevention

Arizona State University

This research will develop a river scour monitoring system that is capable of determining the degree of scour in a river bed, thereby alerting pipeline operators if and when the amount of cover over a pipeline is reduced. The proposed technology is based on a temperature gradient decay method that monitors subject pipeline river crossings for scour conditions. Field demonstrations of the proposed technology will provide a validation of the applicability of this technology for detecting depletion of cover above an installed pipeline.

Improvements to Pipeline Assessment Methods and Models to Reduce Variance

Gas Technology Institute

This project will develop, validate, and demonstrate improved assessment methods and models to lower the variance of model outputs when assessing the impact of interactive threats. This project will provide general knowledge, models, and methods pertaining to the assessment of overlapping defects in natural gas pipelines that are currently unavailable. The project deliverables will be directly applicable to fitness-for-service standards.

Evaluation of Well Casing Integrity Management for Underground Storage Wells

Pipeline Research Council International

This project will improve understanding of the current state of storage well-logging tool technologies and the performance of these technologies. The project will investigate factors that affect the tool response, as well as the suitability of available methods for calculating remaining casing strength. The information generated by this project will reduce uncertainty in the evaluation of storage well casing integrity through accurate assessment of reliability, leading to improved decisions regarding well interventions and allowable operating parameters.

APPENDIX D

Peer-review Project Summaries
(In order, as shown in Tables 5-6)

Tools for Predicting Gas Migration and Mitigating its Occurrence/Consequence
Colorado School of Mines

This project will develop an analytic method to predict the conditions needed for gas migration to occur and will establish a recommended practice to improve response to gas migration incidents. In addition, the project will gather broad stakeholder input to develop a clear understanding of current gas leak response protocols and will provide expertise/lessons learned regarding pipeline leakage scenarios while exploring ways to characterize gas migration.

On-board Power and Thrust Generation for the Explorer Family of Robots for the Inspection of Unpiggable Natural Gas Pipelines
Northeast Gas Association/NYSEARCH

This project will develop an on-board electric power generation and thrust generation system in order to extend battery life and increase the inspection distance for the family of Explorer robotic inspection tools. It will also develop, test, and commercialize this system of on-board generation of power and thrust for the in-line, live inspection of unpiggable natural gas pipelines.

External Leak Detection Body of Knowledge
Gas Technology Institute

This project will develop a recommended practice for externally based leak detection on natural gas transmission lines. The recommended practice will increase the safe operation of the United States natural gas transmission pipeline network by standardizing practices across operators and increasing the likelihood that a leak will be found before it becomes a safety hazard.

Improved Tools to Locate Buried Pipelines in a Congested Underground
Gas Technology Institute

This project will develop and commercialize a geospatial probe for mapping existing buried utilities via insertion of the probe into live natural gas pipelines. This probe will be capable of mapping live underground pipes three-dimensionally and will provide accurate utility locations. Additionally, this project will create a cloud-based data collection system in order to effortlessly collect and store data, thus making that data easily accessible to the utilities.

ORFEUS Obstacle Detection for Horizontal Directional Drilling
Operations Technology Development

This project will produce a field-proven, market-ready obstacle location technology for use in horizontal directional drilling (HDD) applications. ORFEUS is an effort aimed at developing a safe, cost-effective “look-ahead” obstacle detection system for HDD equipment. This project seeks to further develop the technology to bring forward a commercially viable product for

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Peer-review Project Summaries
(In order, as shown in Tables 5-6)

identifying obstacles in and around the path of a HDD rig, thereby reducing third-party damage to underground utilities.

Modernize the Assessment of River Crossings
Pipeline Research Council International

This project intends to supplement guidance from American Petroleum Institute Recommended Practice 1133: Guidance for Onshore Hydrocarbon Pipelines Affecting High Consequence Floodplains, and to expand and improve the capabilities of existing tools that are available for pipeline riverine crossing assessment and monitoring. Additionally, the project plans to develop and adapt risk-screening tools through field-validated advances in engineering analysis. This project will benefit from the broad participation of pipeline companies that are focused on enhancing the integrity of pipeline river crossings.

Consistency Review of Methodologies for Quantitative Risk Assessment
Gas Technology Institute

This project will develop a methodology and guidelines to establish consistency, guidance, background knowledge, and best practices when performing Quantitative Risk Assessments of LNG facilities. The project will demonstrate this on two representative LNG facilities (peak shaving and export).

Performance Gap Comparison of Process Safety Management Consensus Standards and Regulatory Requirements for LNG Facilities
Gas Technology Institute

The objective of this project is to evaluate consensus standards, best practices, and regulatory requirements for the process safety management of LNG facilities. Additionally, this project will identify and prioritize gaps between PHMSA requirements, National Fire Protection Association 59A: Standard for the Production, Storage, and Handling of Liquefied Natural Gas, and other codes regarding the desired process for safety management states. The project team will develop risk-mitigation strategies to address the key gaps that are identified.

Review of Control System Testing Frequency
CH-IV International

This project will provide PHMSA with a better understanding of the potential negative unintended consequences of overly conservative testing intervals. In addition, it will provide information on typical practices across other industries and include recommendations that are contained in other internationally recognized codes and standards.

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Peer-review Project Summaries
(In order, as shown in Tables 5-6)

Risk Assessment and Treatment of Wells
C-FER Technologies

This project will develop relative, quantitative, and probabilistic risk-assessment guidelines to assess the risks of well entry that are based on the type of entry. This will include a review of the methodologies used in the pipeline industry, the frameworks and models applied to wells, the relevant standards, and application of C-FER's existing quantitative framework for storage wells.

Cost-benefit Analysis of Deploying or Retrofitting Externally Based Leak-detection Sensors
C-FER Technologies

This project will deliver data that will outline a methodology for performing cost-benefit analyses on external leak-detection systems that are intended for use on hazardous liquid and natural gas transmission pipelines. The methodology will enable decision makers to objectively weigh the safety, environmental protection, and public perception enhancements that could be gained from system deployment against the associated costs for installation, maintenance, and operation. The output obtained from the application of this methodology will inform technology deployment decisions and enable operators to tailor system requirements and deployment configurations to their pipeline systems.

Tubing and Packers Life-cycle Analysis for UGS Applications
Battelle Memorial Institute

This project will develop a life-cycle analysis of tubing and packing well-entry impacts, as well as recommendations for improvements to both tubing and packing assembly designs and alternative coatings. As part of its results, this project will include a database and an analysis to provide a lifecycle assessment of wells that use tubing and packing assemblies, thereby allowing for better and safer operation of wells in the future.

Reliability of Subsurface Safety Valves
Battelle Memorial Institute

The project seeks to assess the role that subsurface safety valves can play in improving underground gas storage safety. This project will use relevant literature, interviews with subject matter experts, individual occurrence reports, and available databases to quantify the performance of subsurface safety valves across a range of deployments. This project is partnering with a leading oil and gas service company to evaluate specific valve designs that may be improved.

APPENDIX E

The peer-review coordinator (PRC) organizes, coordinates, monitors, and facilitates the annual peer review panel. The PRC is the main contact for panelists, the researchers involved in a peer review, and public inquiries. The PRC was Mr. Robert Smith of PHMSA.

Robert Smith
R&D Manager
Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety
Phone: (919) 238-4759
Email: robert.w.smith@dot.gov