# Peer-Review Report


**Pipeline and Hazardous Materials Safety Administration**

**Pipeline Safety Research & Development Program**

**Peer Reviews Conducted**
**May 3 and 10, 2017**

## Table of Contents

## EXECUTIVE SUMMARY

Since 2006, the Pipeline and Hazardous Materials Safety Administration's (PHMSA) Pipeline Safety Research and Development (R&D) Program has held annual structured peer reviews of active research projects to maintain research data quality, in accordance with mandates from the Office of Management and Budget (OMB) and the Office of the Secretary of Transportation (OST). PHMSA holds these reviews virtually via teleconference and the internet in order to save time and resources. Virtual teleconferences facilitate attendance from all U.S. time zones, Canada, and Europe, making it easier for panelists, researchers, project co-sponsors, and representatives of Agreement Officers to participate.

The annual peer review continues to build on an already strong, systematic evaluation process developed by PHMSA's Pipeline Safety R&D Program and certified by the Government Accountability Office. The 2017 peer-review panel, which consisted of six academic representatives, reviewed 18 projects using 11 evaluation criteria grouped into the following four categories:

1. Project management;
2. The method used to transfer results to end users;
3. Project coordination with other closely-related programs; and,
4. The quality of project results.

The potential ratings assigned by the peer-review panel are: Ineffective, Effective, More than Effective, and Very Effective. The average rating for the 18 projects assessed during the May 2017 review was More than Effective; the average sub-criteria were also rated highly, underpinning these findings. Five projects were rated Very Effective and 13 were rated More than Effective. Panelists made several recommendations associated with each project during the review that were categorized into Strong and Weak points. Recommendations focused on improving what was deemed to be overall good performance. Common project weaknesses identified for projects rated More than Effective were in the categories of scientific knowledge and/or engineering principles and/or communication. The majority of the projects were approximately 70 to 90 percent complete, which means only some projects will be further studied in future reviews.

Specific recommendations will be disseminated to researchers and Agreement Officers' Representatives (AORs), as necessary, so that individual decisions on changes in scope can be determined.

Additional information can be found in the following tables:

Table 4: Summarizes overall program performance based on the summary of reviewed projects.

Table 5: Itemizes the project ranking order for projects with the same score and equal rankings.

Table 6: Itemizes the Strong and Weak points collected from all 18 projects reviewed by the six panelists. These points were consistent among several panelists and are reflected in the scoring of multiple evaluation categories.

PHMSA supports the process performed to conduct these reviews, as well as the calendar year (CY) 2017 findings and recommendations provided by the panelists. PHMSA accepts the findings and recommendations summarized in the report; the official PHMSA response memorandum may be found in Appendix A.

## 1.0 Introduction

This document reports findings and recommendations from PHMSA's Pipeline Safety R&D Program research peer reviews held May 3 and 10, 2017. The findings and recommendations are derived from the scoring and comments collected from the peer-review panelists.

The Department of Transportation (DOT) Operating Agencies (OAs) are required to develop and execute a systematic process for peer reviews, as well as all influential/highly influential information they plan to disseminate in the foreseeable future.

Through the Information Quality Act[1] 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." A resulting OMB Bulletin, entitled "Final Information Quality Bulletin for Peer Review," prescribes required procedures for Federal programs.

The OST produced procedures governing modal implementation of this OMB Bulletin that, combined with the OMB Bulletin, serve as the basis and justification for the PHMSA Pipeline Safety R&D Program peer reviews. The purpose of these peer reviews is to uncover technical problems, keep projects on target or aligned with stakeholder needs, and give technical guidance using technically competent, independent, objective experts. These reviews are held annually for active research projects, usually occurring in 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 natural gas and hazardous materials pipelines. PHMSA's focus is an ongoing reduction of incidents on natural gas and hazardous liquid pipelines that result in death, injury, significant property damage, or environmental harm.

PHMSA Pipeline Safety R&D Program supports PHMSA's pipeline safety mission "to ensure the safe, reliable, and environmentally sound operation of America's energy transportation pipelines." 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 environmental impact, and enhance the reliability of the Nation's pipeline transportation system."

PHMSA has regulatory responsibility for the safety of natural gas and hazardous liquid pipelines. In 2001, PHMSA began strengthening its role in the safety of the Nation's pipeline system in

[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.

numerous ways, including promulgating new regulations on integrity management.[2,3,4] 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. To address the need for new integrity-related technologies and information on the validity of these technologies, Congress expanded support for the PHMSA Pipeline Safety R&D Program in 2002.[5] PHMSA, as authorized by Congress, sponsors R&D projects focused on providing near-term solutions to increase the safe, reliable, and environmentally sound operation of America's energy transmission and distribution pipelines.

The R&D Program contributes directly to the PHMSA 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 R&D Program is organized around six program elements that reflect both the DOT's responsibilities under the Five-Year Interagency R&D Program Plan[6] and guidance from pipeline experts and stakeholder groups. 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, each of which bears a direct relationship to the longer-term enhancement of pipeline safety, define the desired outcomes for the R&D projects and are associated with each R&D Program element. Table 1 identifies these program elements and desired improvements.

**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 into the environment. |
| 2. | Leak Detection | Develop new or improved tools and technology solutions to reduce the volume of product released into the environment. |

[2] *Pipeline Integrity Management in High Consequence Areas for Hazardous Liquid Operators.* (49 CFR Part 195). Rules effective May 29, 2001, and February 15, 2002. Retrieved from: http://primis.phmsa.dot.gov/iim/ruletextamended.htm.
[3] *Pipeline Safety: Pipeline Integrity Management in High Consequence Areas (Gas Transmission Pipelines).* Final Rule. December 15, 2003. Retrieved from: http://primis.phmsa.dot.gov/gasimp/docs/GasTransmissionIMRule.pdf.
[4] *Pipeline Integrity Management in High Consequence Areas (Gas Transmission Pipelines).* Final Rule, as amended. May 26, 2004. Retrieved from: http://primis.phmsa.dot.gov/gasimp/docs/FinalRuleAmended_gas_full.pdf.
[5] *Pipeline Safety Improvement Act of 2002*. Retrieved from: http://ops.dot.gov/Pub_Law/107_cong_public_laws.pdf.
[6] *Five Year Interagency R&D Program Plan*. Retrieved from: https://primis.phmsa.dot.gov/rd/psrcjca.htm.

| Table 1: Program Elements of the PHMSA Pipeline Safety R&D Program | | |
|---|---|---|
| | **Program Element** | **Program Element Goal** |
| 3. | Anomaly Detection and Characterization | Develop new or improved tools, technology, and assessment processes to identify and locate critical pipeline defects, improving the capability to characterize the severity of such defects in pipeline systems. |
| 4. | Anomaly Repair and Remediation | Enhance repair materials, techniques, processes, tools, and technology designed to quickly bring pipeline systems back online and serve the Nation. |
| 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 in pipelines and those problems that impact other emerging technological or policy issues on a national scale. |

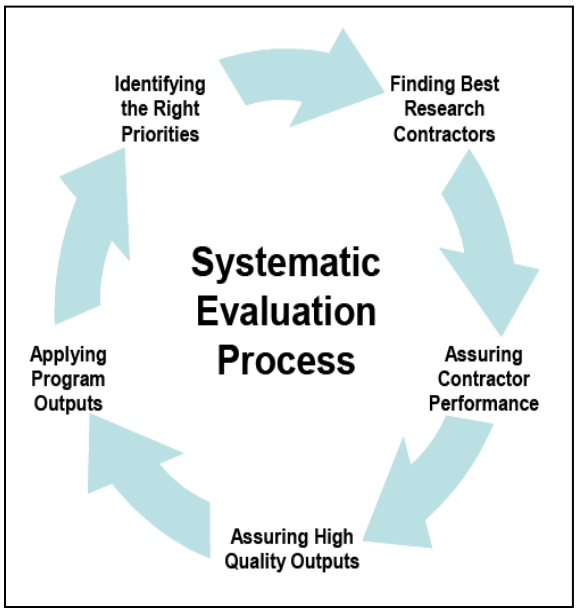
More information on the program strategy is outlined in the R&D Program Strategy portion of the program website at: http://primis.phmsa.dot.gov/rd/.

*Research Program Quality*

To raise and validate R&D program quality, a systematic evaluation process following research projects from inception to implementation was designed and implemented. The systematic process contains five steps, each of which ensures that project outcomes will be of 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. To view more information on this process, please visit: http://primis.phmsa.dot.gov/rd/evaluation.htm.

**Figure 1: Systematic Evaluation Process**




First, the quality of research projects is established and priorities are identified. This preparatory work, which takes place at joint government and industry R&D forums and other meetings, collaboratively identifies the priorities and structures necessary for projects to meet end users' technical needs. 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, priorities and project design are refined and research contractors are found. Representatives from Federal and State agencies, industry, and trade organizations are gathered to form a merit review panel designed to use strong evaluation criteria to review research whitepapers and proposals.

PHMSA uses its Management Information System (MIS) to assure that awarded projects are performing well. The MIS electronically monitors and tracks contractor performance as the project moves toward completion, providing the necessary oversight to ensure contract accounting and specific contractual milestones are systematically followed as prescribed in the award documents. The system design improves and maintains program quality, efficiency, accounting, and accountability. Additional oversight is provided by AORs, who are trained, certified, and assigned to each project in accordance with the Federal Acquisition Regulations.

This peer review is designed to improve research project quality by keeping projects on track to meet their ultimate goals. PHMSA pipeline safety research projects have a higher probability of being successful and results are used by end users 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. Panelist selection specifics are derived from the OMB Bulletin, and panelists can be academics, independent consultants, active and/or retired regulators, or members of standards development organizations.

The 2017 peer-review panel consisted entirely of academic representatives. Each panelist provided a short biography describing their work history and technical qualifications. Table 2 identifies the 2017 panelists and their biographies are included in Appendix B.

**Table 2: Peer-review Panelists**

| | Name | Affiliation |
|---|---|---|
| 1 | Zhibin Lin, Ph.D., P.E. | Assistant Professor, Department of Civil and Environmental Engineering, North Dakota State University |
| 2 | Ying Huang, Ph.D. | Assistant Professor, Civil and Environmental Engineering Department, North Dakota State University |
| 3 | Yiming Deng, Ph.D. | Associate Professor, Department of Electrical and Computer Engineering, Michigan State University |
| 4 | R. Scott Lillard, Ph.D. | Professor & Carboline Endowed Chair, Department of Chemical & Biomolecular Eng., University of Akron |
| 5 | Ashraf F. Bastawros, Ph.D. | Professor, Aerospace Engineering, Iowa State University |
| 6 | Hao Wang, Ph.D. | Assistant Professor, Department of Civil and Environmental Engineering, Rutgers, the State University of New Jersey |

## 4.0 Panelist Charge

Initially developed in December 2005 and revised annually, the Peer-review Panelist charge is provided to each panelist prior to the peer review. It contains specific instructions regarding what is expected in terms of their 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, which—along with the specific comments—should focus mostly on whether the scientific and technical studies have been applied in a sound manner.

The Peer-review Panelist charge is publicly available for each year's review at: http://primis.phmsa.dot.gov/rd/annual_peer_review.htm, and may be revised after researchers and panelists post review feedback.

## 5.0 Scope of the Peer Review

During the annual peer review of projects, the members of the panel review focused, high-level presentations from researchers that addressed 11 evaluation criteria within four specific evaluation categories. Presentations are scheduled to take no more than 20 minutes, followed by ten minutes for panelist questions and possible written public questions.

In its entirety, the review of each project by the panelists takes approximately two and a half hours to allow for time to review project background information, including reporting, an advance copy of the review slides, and 30 minutes of review and questioning from the panel. It also includes time in post-review that may encompass follow-up questioning, a consensus review meeting, and analysis of the peer-review report. A R&D Program objective is to provide the best assessment of each project's performance, addressing specific criteria without comparing one project to another. Scorecards for rating performance on the specified categories, with each category having equal rating from one to five, are provided to the panelists. The scorecards include the following questions from four performance categories:

1. Project management
    - Is the project being managed on budget and schedule?
    - Is the project making progress toward the work scope objectives?
2. Approach taken for transferring results to end users
    - Is there a plan for dissemination of results, including publication, reporting, and patents?
    - How much end-user involvement is incorporated into the scope of work?
    - For results that may include marketable products and technologies, are commercialization plans established?
3. Project coordination with other related programs
    - Does the project build on or make use of related/prior work?
    - Is the content of the project being communicated to other related research efforts?
    - Has consideration been given to possible future work?
4. Quality of project results
    - Are the intended results supported by the work performed during the project?
    - Are the intended results consistent with scientific knowledge and/or engineering principles?
    - Are the intended results presented in such a manner as to be useful for identified end users?

Projects that rate well on these criteria are expected to have a high likelihood of success. These criteria provide a numeric rating that is converted to a rating of Ineffective, Effective, More than Effective, or Very Effective, a scale designed to illustrate how well a project addresses the goals of the peer review. 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**
The most clarity of method regarding accomplishing its purpose; producing the intended or expected result in a superior manner.

**More than Effective**
Better, clearer, and more distinct than Effective projects regarding accomplishing its purpose; producing the intended or expected result in more than a satisfactory manner.

**Effective**
Adequate to accomplish its purpose; producing the intended or expected result in a satisfactory manner.

**Ineffective**
Not effective; not producing desired results; ineffectual or lacking in the details to support a satisfactory desired outcome.

## 6.0 Associated Research

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

The research assessed during the May 2017 review encompassed multiple technological solutions and projects with a general knowledge focus. A short description of each peer-reviewed project may be found in Appendix D.

## 7.0 Peer-Review Findings

During the May 2017 review, 18 projects were reviewed, with five projects rated Very Effective and 13 ranked More than Effective. The average program rating across all evaluation categories was More than Effective; the average sub-criteria were also rated highly, underpinning these findings.

Panelists made several recommendations associated with each project during the review that were categorized into Strong and Weak points. Recommendations focused on improving what was deemed to be overall good performance. Common project weaknesses identified for projects rated More than Effective were in the categories of scientific knowledge and/or engineering principles and/or communication. The majority of the projects were approximately 70 to 90 percent complete, which means only some projects will be further studied in future reviews.

Specific recommendations will be disseminated to researchers and AORs, as necessary, so that individual decisions on changes in scope can be determined.

Additional information can be found in the following tables:

Table 4: Summarizes overall program performance based on the summary of reviewed projects.

Table 5: Itemizes the project ranking order for projects with the same score and equal rankings.

Table 6: Itemizes the Strong and Weak points collected from all 18 projects reviewed by the six panelists. These points were consistent among several panelists and are reflected in the scoring of multiple evaluation categories.

| Table 4: Summary of Total Average Score & Rating for the Review Categories and Sub-criteria | | |
|---|---|---|
| **Review Categories and Sub-criteria** | **Score** | **Rating** |
| **1. Project management** | **4.4** | **More than Effective** |
| 1.1. Is the project being managed on budget and schedule? | 4.3 | More than Effective |
| 1.2. Is the project making progress toward the work scope objectives? | 4.4 | Very Effective |
| **2. Approach taken for transferring results to end users** | **4.3** | **More than Effective** |
| 2.1. Is there a plan for dissemination of results, including publications, reporting, and patents? | 4.1 | More than Effective |
| 2.2. How much end-user involvement is incorporated into the work scope? | 4.3 | More than Effective |
| 2.3. For results that may include marketable products and technologies, are commercialization plans established? | 4.4 | More than Effective |
| **3. Project coordination with other related programs** | **4.1** | **More than Effective** |
| 3.1. Does the project build on or make use of related/prior work? | 4.3 | More than Effective |
| 3.2. Is the content of the project being communicated to other related research efforts? | 3.9 | More than Effective |
| 3.3. Has consideration been given to possible future work? | 4.0 | More than Effective |
| **4. Quality of project results** | **4.0** | **More than Effective** |
| 4.1. Are the intended results supported by the work performed during the project? | 4.0 | More than Effective |
| 4.2. Are the intended results consistent with scientific knowledge and/or engineering principles? | 3.8 | More than Effective |
| 4.3. Are the intended results presented in such a manner as to be useful for identified end users? | 4.1 | More than Effective |
| **Program Summary** | **4.2** | **More than Effective** |

| Table 5: Summary Ranking & Rating of Individually Reviewed Research Projects | | | | | |
|---|---|---|---|---|---|
| **Rank** | **Project ID** | **Project Title** | **Contractor** | **Rating** | **Score** |
| 1 | DTPH5615T00015 | Natural Gas Pipeline Leak Rate Measurement System | *Physical Sciences Inc.* | Very Effective | 4.8 |
| 2 | DTPH5615T00007 | Slow Crack Growth Evaluation of Vintage Polyethylene Pipes | *Gas Technology Institute* | Very Effective | 4.5 |
| 2 | DTPH5615T00014 | Use of Electromagnetic Sensors to Quantify Strength and Toughness in Steel Pipelines In and Out of Service | *Generation 2 Materials Technology L.L.C.* | Very Effective | 4.5 |
| 2 | DTPH5615T00016 | Rapid Aerial Small Methane Leak Survey | *Ball Aerospace & Technologies Corp.* | Very Effective | 4.5 |
| 2 | DTPH5616T00003 | Development of High Performance Gas-coupled Ultrasonic Transducers for Inspection of Unpiggable Natural Gas Pipelines | *Quest Integrated, L.L.C.* | Very Effective | 4.5 |
| 3 | DTPH5615T00006L | Characterization and Fitness-for-Service of Corroded Cast Iron Pipe | *Gas Technology Institute* | More than Effective | 4.4 |
| 3 | DTPH5615T00010L | Human-centric Approach to Improve Pipeline Non-destructive Evaluation (NDE) Performance and Reliability | *Battelle Memorial Institute, Corporate Operations* | More than Effective | 4.4 |
| 3 | DTPH5615T00018 | EMAT Sensor for Small-diameter and Unpiggable Pipes; Prototype and Testing | *Operations Technology Development* | More than Effective | 4.4 |
| 4 | DTPH5615T00019 | Intrinsically Locatable Technology for Plastic Piping Systems | *Operations Technology Development* | More than Effective | 4.3 |
| 4 | DTPH5616T00002 | Development of EMAT Sensors for Corrosion Mapping of Unpiggable Natural Gas Pipelines Using ILI Tools | *Quest Integrated, L.L.C.* | More than Effective | 4.3 |
| 5 | DTPH5615T00005L | Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools | *CH-IV International* | More than Effective | 4.2 |
| 5 | DTPH5615T00017L | Pipeline Damage Prevention Radar | *Ball Aerospace & Technologies Corp.* | More than Effective | 4.2 |
| 5 | DTPH5616T00004 | EMAT-guided Wave Technology for In-line Inspections of Unpiggable Natural Gas Pipelines | *ULC Robotics* | More than Effective | 4.2 |
| 6 | DTPH5615T00020 | Combined Vibration, Ground Movement, and Pipe Current Detector | *Operations Technology Development* | More than Effective | 3.8 |
| 7 | DTPH5614H00004 | Improving Models to Consider Complex Loadings, Operational Considerations, and Interactive Threats | *Kiefner Applus RTD* | More than Effective | 3.7 |
| 8 | DTPH5615T00009 | Development of Comprehensive Pressure Test Design Guidelines | *Kiefner Applus RTD* | More than Effective | 3.6 |
| 8 | DTPH5615T00013 | Development of an AMR Eddy Current-based Crack Detection Sensor for the Live Inspection of Unpiggable Natural Gas Transmission Pipelines | *Northeast Gas Association/NYSEARCH* | More than Effective | 3.6 |
| 9 | DTPH5615T00012L | Emissions Quantification Validation Process | *Northeast Gas Association/NYSEARCH* | More than Effective | 3.1 |

## 8.0 PHMSA's Official Response to Panelists' Findings and Recommendations

The CY 2017 reviews were the tenth structured peer review of PHMSA's Pipeline Safety R&D Program. PHMSA supports the process for conducting these reviews, and PHMSA accepts the findings and recommendations provided by the peer-review panelists. The panel indicated that some immediate actions, summarized in Table 6 of Appendix C, can be taken to further empower research projects to achieve contractual milestones. The official PHMSA response memorandum detailing PHMSA's plan to address specific recommendations with the project co-sponsors and researchers, using these to improve the likelihood that project scopes can achieve proposed goals, can be found in Appendix A.

PHMSA will continue refining the annual peer-review process, as needed, by incorporating feedback submitted by the researchers and peer-review panelists. Other specific recommendations from panelists will be disseminated to researchers and AORs, as necessary. A number of initiatives are planned to provide further guidance on the commercialization of technology projects and better coordination with projects' strengthening standards, thereby bringing transparency to the panel's recommendations. As there is always room for improvement, PHMSA will continue to make improvements despite high annual ratings.

# APPENDIX A

## PHMSA Acceptance Memorandum

U.S. Department
of Transportation

Pipeline and Hazardous
Materials Safety
Administration

1200 New Jersey Avenue, SE
Washington, D.C. 20590

**MEMORANDUM FOR THE RECORD**

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

Subject: Pipeline Safety Research Program Peer-Reviews Report, May 3 and 10, 2017

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**SUMMARY**

Since 2006, the Pipeline and Hazardous Materials Safety Administration's (PHMSA) Pipeline Safety Research and Development (R&D) Program has held annual structured peer reviews of active research projects to maintain research data quality, in accordance with mandates from the Office of Management and Budget (OMB) and the Office of the Secretary of Transportation (OST).

During the May 2017 review, 18 projects were reviewed, with five projects rated Very Effective and 13 ranked More than Effective. The average program rating across all evaluation categories was More than Effective; the average sub-criteria were also rated highly, underpinning these findings.

Panelists made several recommendations associated with each project during the review that were categorized into Strong and Weak points. Recommendations focused on improving what was deemed to be overall good performance. Common project weaknesses identified for projects rated More than Effective were in the categories of scientific knowledge and/or engineering principles and/or communication. The majority of the projects were approximately 70 to 90 percent complete, which means only some projects will be further studied in future reviews.

Specific recommendations will be disseminated to researchers and Agreement Officers' Representatives, as necessary, so that individual decisions on changes in scope can be determined.

PHMSA will continue refining the annual peer-review process as needed and PHMSA will continue to make improvements despite high annual ratings.

# APPENDIX A

## PHMSA Acceptance Memorandum

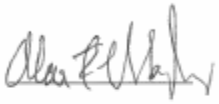


**RECOMMENDATION**

The PHMSA Pipeline Safety Program accepts the findings and recommendations summarized in the Peer Review Report for peer reviews conducted May 3 and 10, 2017.

Attachment

The Associate Administrator for Pipeline Safety

APPROVED: 

DISAPPROVED: _____

COMMENTS: _____

DATE: 9-11-17

## APPENDIX B

## Peer-review Panelist Biographies

### Zhibin Lin, Ph.D., P.E.

Dr. Lin is a tenure-track assistant professor in the Department of Civil and Environmental Engineering at North Dakota State University (NDSU) in Fargo, North Dakota. He received his Ph.D. from the University of Wisconsin—Milwaukee.

Dr. Lin has over 14 years of experience in advanced materials and structural health monitoring. His current research focuses on corrosion mitigation and weldment, development of coating and characterization, structural health monitoring, and damage detection. Dr. Lin has published in excess of 30 conference papers and presentations and more than 30 peer-reviewed journal papers. He is a co-author of one book, entitled "Solid and Structural Analysis with the Finite Element Method." Dr. Lin's research has received awards from the DOT, PHMSA, the Minnesota State Department of Transportation, the North Dakota State Department of Commerce, the National Natural Science Foundation of China, the North Dakota State Department of Transportation's Transportation Innovations Program (TRIP), the North Dakota (ND) Established Program to Stimulate Competitive Research (EPSCoR), and the ND National Aeronautics and Space Administration (NASA) EPSCoR. Dr. Lin is the secretary of the American Concrete Institute Committee 523, a member of subcommittees of 447—Finite Element Analysis of Reinforced Concrete Structures and 446—Fracture Mechanics of Concrete, and served as a panelist for the National Science Foundation (NSF).

### Ying Huang, Ph.D.

Dr. Ying Huang is an assistant professor in the Civil and Environmental Engineering department of the College of Engineering at NDSU in Fargo, North Dakota. Dr. Huang's research interests include intelligent transportation systems, multi-hazard mitigation in harsh environments, big data for transportation, pipeline corrosion mitigation and assessment, and smart structures and structural health monitoring. Her research team is developing novel fiber optic sensing systems for traffic analysis, pavement health condition monitoring, and pipeline assessment.

Dr. Huang serves as an editorial board member for five international journals, a committee member for five distinguished professional societies, and a peer reviewer for 30 different international journals and conferences. She also serves as a panelist and reviewer for the DOT, the NSF, and the National Science Foundation of Singapore. Dr. Huang received the 2017 NDSU Researcher of the Year award for the NDSU College of Engineering, as well as the 2017 NDSU Centennial Endowment Award.

### Yiming Deng, Ph.D.

Dr. Yiming Deng is an associate professor in the Nondestructive Evaluation Laboratory of Electrical and Computer Engineering department of the College of Engineering at Michigan State University. Dr. Deng's research interests include electromagnetic and acoustic NDE;

structural health monitoring (SHM) for multi-scale, multi-resolution, and multi-parameter damage diagnostics; and prognostics, applied electromagnetics, acoustics, and computational modeling. His research team is developing novel NDE/SHM actuators and sensors and sensing systems that involve multiphysics simulations for understanding imaging physics. Dr. Deng and his team are also conducting experimental validations and actuators/sensors prototyping for a wide range of engineering applications to assure safety, security, reliability, and sustainability to defense, critical energy, and transportation infrastructures.

Dr. Deng is an associate editor of the Institute of Electrical and Electronics Engineers (IEEE) Transactions on Reliability, Materials Evaluation, and Reliability and Maintainability (RAMS) Proceedings. He serves as a panelist and reviewer for the DOT, the NSF, the Department of Energy (DOE), the Department of Defense (DOD) National Defense Science and Engineering Graduate (NDSEG) Program with the American Society for Engineering Education (ASEE), and more than 30 scientific journals. Dr. Deng is a senior member of IEEE and a member of American Society for Nondestructive Testing, Inc. (ASNT); he was also the ASNT faculty grant award winner for 2010 and 2017.

### R. Scott Lillard, Ph.D.

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 over 90 technical publications, and is a NACE International fellow. His research is focused on environmental degradation with an emphasis in 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.

### Ashraf Bastawros, Ph.D.

Dr. Bastawros is the T.A. Wilson Professor of Aerospace Engineering at Iowa State University in Ames, Iowa, where he also holds courtesy appointments with the departments of Mechanical Engineering and Material Sciences & Engineering. He received his B.S. from Cairo University in Mechanical Engineering in 1988, his first M.S. from Cairo University in Mechanical Engineering in 1991, a second M.S. in Applied Mathematics from Brown University in 1995, and a Ph.D. in Solid Mechanics from Brown University in 1997. Dr. Bastawros was a postdoctoral fellow at Harvard University until 1999, during which time he worked with two of the pioneers of fracture and failure analysis, John Hutchinson and Anthony Evans. He has close

to 30 years of experience in the area of fracture and failure analysis of complex material systems; size effects on the electro-, chemo-, and thermo-mechanical response of dense and cellular materials (with applications regarding the reliability of pipeline safety, electronic packaging, mechanics of micro- and nano-manufacturing, and surface finishing); and fractal analysis of fractured surfaces. Dr. Bastawros authored and co-authored more than 100 technical publications in journals and conference proceedings, was the recipient of an NSF Career Award and an Iowa State University Young Engineering Faculty Research Award, and has been an associate of the Ames National Lab (a DOE lab) since 1999. He managed research grants from government agencies and industry in excess of $10 million, chaired the prestigious 47$^{th}$ Annual Meeting of the Society of the Engineering Science, was the chair of the Fracture and Failure committee at the American Society of Mechanical Engineers (ASME) from 2009-2012, and has served as an associate editor for the ASME Journal of Materials Technology since 2011. As an educator, Dr. Bastawros has nurtured and mentored 3 assistant professors, 3 postdoctoral students, 8 Ph.D. students, 21 M.S. students, and 60 undergraduate students in the area of the mechanics of materials.

## Hao Wang, Ph.D.

Dr. Hao Wang is an associate professor in the Civil and Environmental Engineering Department at Rutgers, the State University of New Jersey, in New Brunswick, New Jersey. He obtained his Ph.D. from the University of Illinois at Urbana-Champaign, his M.S. from Virginia Tech, and his B.S. from Southeast University, all in Civil Engineering. Dr. Wang's research covers material-, structure-, and mechanics-related challenges throughout the broad spectrum of infrastructure engineering, including highway, airport, pipeline, and railway engineering. His current research focuses on life-cycle analysis, the development of a multi-functional coating system for infrastructure protection and repair, and multi-scale characterization and modeling of infrastructure material. Dr. Wang's research has been supported by the NSF, PHMSA, the Federal Railroad Administration, the Federal Highway Administration, the Federal Aviation Administration, the DOT's Office of the Assistant Secretary for Research and Technology, and several State transportation agencies. He has published more than 70 peer-reviewed journal papers, over 30 conference papers, and his research was selected as a 2014 High Value Research Project by the American Association of State Highway and Transportation Officials (AASHTO). Dr. Wang served as a panelist for the NSF and the DOT, is an editorial board member of ASTM International's Journal of Testing and Evaluation, and is an associate editor for the American Society of Civil Engineers' (ASCE) Journal of Transportation Engineering.

**APPENDIX C**

**Table 6 – Peer-Reviewed Project Strong and Weak Points**

(In order, as shown in Table 5)

| Project Title | Strong Points | Weak Points |
|---|---|---|
| Natural Gas Pipeline Leak Rate Measurement System | Making good progress toward work scope objectives. Excellent plan for dissemination of results. Great end-user involvement. Clear communication to other related efforts. Results to date seem well supported by the work performed. | Impact from wind velocity was unclear, but no major weaknesses of mention. |
| Slow Crack Growth Evaluation of Vintage Polyethylene Pipes | Very good end-user involvement. Great use of prior related project results. Good plan for dissemination of results and commercialization. | Looking for more technical information to be presented. Suggest comparison of crack detection accuracy to current state-of-the-art. Suggest defining crack failure to service life. |
| Use of Electromagnetic Sensors to Quantify Strength and Toughness in Steel Pipelines In and Out of Service | Promising results. Great end-user involvement. Excellent plan for dissemination of the results. | Difficult to assess the full results and the quality of the project from the information presented. Data visualization should be improved/clarified. |
| Rapid Aerial Small Methane Leak Survey | Good end-user involvement. Excellent plan for dissemination of the results. Great use of prior related project results. Clear presentation of milestones accomplished to date. | Suggest comparison of tech performance with ground-based systems, but no major weaknesses to mention. Project weakness: only validating with one operator, which has ceased. Suggest working with different operators than mentioned. |
| Development of High-performance Gas-coupled Ultrasonic Transducers for Inspection of Unpiggable Natural Gas Pipelines | On schedule. Results to date seem well supported by the work performed. Good end user involvement. Very well-planned-out scope. | Project may need another phase of work to validate sensor performance and for integration onto a robotic platform. No major weaknesses of mention. |
| Characterization and Fitness-for-Service of Corroded Cast Iron Pipe | Very good end-user involvement. Great use of prior related project results. Excellent technical progress with comparison of Fitness-for-Service model with both finite element analysis and historical data. | The proposed analytical/numerical protocol was vague and it was difficult to ascertain its validity or significance. No major weaknesses of mention. |

## APPENDIX C

### Table 6 – Peer-Reviewed Project Strong and Weak Points

(In order, as shown in Table 5)

| Project Title | Strong Points | Weak Points |
|---|---|---|
| Human-centric Approach to Improve Pipeline Non-destructive Evaluation (NDE) Performance and Reliability | Great end-user involvement. Excellent plan for dissemination of results. Great use of prior related project results. | Concern over limited data pools used for the analysis. How can the subjective data be better analyzed? |
| Electro Magnetic Acoustic Transducer (EMAT) Sensor for Small-diameter and Unpiggable Pipes; Prototype and Testing | Very well organized and managed. Very good end-user involvement. Technology has high sensitivity. | Need validation under real pipeline operation conditions. Looking for more info on how well cracks can be characterized. Suggest work on data visualization. |
| Intrinsically Locatable Technology for Plastic Piping Systems | Very good end-user involvement. Great use of prior related project results. Very well organized and managed. Good plan for dissemination of results and commercialization. | Suggestion to investigate markers to pipe more than 4 feet of cover and field testing to investigate environmental effects. Field conditions used for the testing may be limited. Suggest additional field testing. Enhance effort to communicate to other research efforts. |
| Development of EMAT Sensors for Corrosion Mapping of Unpiggable Natural Gas Pipelines Using In-line Inspection (ILI) Tools | The project is well managed and making very good progress toward the objectives. Very good end-user involvement. Great use of prior related project results. | Suggest validation under real pipeline operating conditions. Project may need another phase of work for integration into a robotic platform. Suggest work on data visualization. Suggest more communication to related efforts, as possible. |
| Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools | Very well organized and managed. | Looking for additional avenues for dissemination of results. Perhaps consider bigger picture on how results can be implemented or further investigated. |
| Pipeline Damage Prevention Radar | Good progress to date and clear presentation of milestone progress. | Looking for more details on the funds spent to date, as well as the commercialization plan. No specific info presented on the dissemination plan. Suggest work on validating change detection. Seems to be a lack of buy-in from the operator community. |

## APPENDIX C

### Table 6 – Peer-Reviewed Project Strong and Weak Points

(In order, as shown in Table 5)

| Project Title | Strong Points | Weak Points |
|---|---|---|
| EMAT Guided-wave Technology for ILI of Unpiggable Natural Gas Pipelines | Scope seems well matched to the project goals. | Suggestion to define sensitivity, resolution, and inspection speed under real conditions. Suggestion to communication to other related efforts. No significant details presented on end-user involvement and commercialization plans. |
| Combined Vibration, Ground Movement, and Pipe Current Detector | Well connected to industry partners and service providers. | Looking for more information on how this work builds off of prior mentioned work. Validation needed to confirm removal of interference from natural-based noises. Understanding of detection accuracy is unknown. Suggestion to redefine the project objectives and expected deliverables, with some standalone demos. |
| Improving Models to Consider Complex Loadings, Operational Considerations, and Interactive Threats | Scope seems well matched to the project goals. | Looking for more details on which milestones were completed versus which still have yet to be done. Unclear how results will be validated. More dissemination efforts beyond what was presented may benefit the results acceptance greatly. |
| Development of Comprehensive Pressure Test Design Guidelines | Great literary review. Knowledge potentially very important to resolving challenge. | Encouraged to incorporate more end users into the program. Suggest more dissemination activities. |
| Development of an Anisotropic Magnetoresistive (AMR) Eddy Current- (EC) based Crack Detection Sensor for the Live Inspection of Unpiggable Natural Gas Transmission Pipelines | Very strong end-user involvement. Sensor has direct connection to the commercial robotic deployment platform. | Slightly behind schedule. Looking for more info presented on costs spent to date. No detailed plan for results dissemination. Missing info on the sensor performance. |

## APPENDIX C

### Table 6 – Peer-Reviewed Project Strong and Weak Points

(In order, as shown in Table 5)

| Project Title | Strong Points | Weak Points |
|---|---|---|
| Emissions Quantification Validation Process | Very strong end-user involvement. | Looking for more info presented on costs spent to date. Only generalities presented about decision tree protocols. Suggest extensive validation of protocols. |

# 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/**

### Natural Gas Pipeline Leak Rate Measurement System

*Physical Sciences, Inc.*

This research will prioritize leak remediation by enhancing capabilities to detect, locate, and quantify small natural gas pipeline leaks. We will assemble and use field tests to evaluate a system comprised of a cost-effective synthesis of side-scan lasers, sensitive laser-based point sampling, and advanced data-processing algorithms installed on a mobile leak survey platform. The research results will lead to advanced products and methodologies which may be deployed by the leak survey industry to reduce the environmental impact of natural gas.

### Slow Crack Growth Evaluation of Vintage Polyethylene Pipes

*Gas Technology Institute*

This collaborative project will develop an integrated set of quantitative tools to provide a structured approach to reducing operational risk in vintage plastic distribution systems susceptible to slow crack growth failures. A novel endoscopic structured light scanning tool will be developed and prototyped for internal inspection of small-diameter plastic pipe. After being reduced to its essential parameters, the data generated by the tool will be synthesized into a Fitness-for-Service evaluation with additional available system information, including external conditions, inspection records, leak records, historic data, and subject matter expertise. This assessment will include a probabilistic estimate of the remaining effective lifetime of individual segments of vintage plastic pipe, as well as a yes/no determination regarding whether a short-term pressure test is capable of validating the maximum defect size in the system. The Bayesian network methods employed are ideally suited to evaluating interacting threats, investigating root causes, and predicting the effect of mitigation strategies based on conditional probabilities calculated from available data.

### Use of Electromagnetic Sensors to Quantify Strength and Toughness in Steel Pipelines In and Out of Service

*Generation 2 Materials Technology, L.L.C.*

Generation 2 Materials Technology, L.L.C. (G2MT), in collaboration with Quest Integrity, proposes a two-year research program to develop nondestructive testing technology to rapidly evaluate pipeline mechanical properties. This proposal is in response to the PHMSA Broad Agency Announcement (BAA) DTPH5615RA00001 for the topic Development of Inspection Tools to Quantify Pipe Strength and Toughness. G2MT and Quest Integrity Group will

collaborate to produce a new nondestructive electromagnetic sensor for assessment of bulk strength and toughness of new and vintage steel pipelines operating in any environment. The strength and toughness of the steel pipelines, as determined by the electromagnetic system, will be linked with other inspection and materials characterization testing to provide improved risk-based integrity management. The proposed sensor development will provide an effective method to determine the actual integrity of steel pipelines in or out of service, thereby supporting 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 technology will enable optimized transport through pipelines by predicting the highest safe operating pressure based on real-world measurements of mechanical properties, including both strength and toughness.

### Rapid Aerial Small Methane Leak Survey

*Ball Aerospace & Technologies Corp.*

The aim of this R&D project is to develop new airborne differential absorption lidar (DIAL) technology capable of substantially reducing the cost of methane leak surveys compared to the ground-based, vehicle-mounted, in-situ sensors used today. It will do this by swath mapping broad areas of gas distribution networks at 12 times the speed per unit area of traditional vehicle-mounted systems. The wide-swath approach—which combines novel high-energy lasers and high-speed, low-noise detectors—includes high-speed electronics that perform signal processing 100 times faster than existing DIAL. The new instrument will be capable of surveying broad areas more than five times faster than existing DIAL, which is designed to survey narrow transmission pipeline corridors rather than gas distribution networks. The project will employ end-user participation to guide research, support flight testing, and evaluate the resulting data. This project benefits from academic collaboration with a University of Colorado research laboratory that provides Grade 3 leak rate quantification, allowing for prioritization of leak repair.

### Development of High-performance Gas-coupled Ultrasonic Transducers for the Inspection of Unpiggable Natural Gas Pipelines

*QUEST Integrated, L.L.C.*

This aim of this project is to develop new single-crystal, dry-coupled, high-efficiency, ultrasonic transducers that will be investigated to determine their feasibility for ILI in unpiggable gas pipelines. The new sensor type—which will allow accurate wall thickness data to be fed into American Petroleum Institute (API) 579 Fitness-for-Service analysis—is anticipated to improve system sensitivity by a full order of magnitude. Failure criteria may also be entered into the API 579 Fitness-for-Service analysis, enabling the calculation of remaining wall strength for risk assessment, appraisal of pipeline integrity, and materials evaluation.

## APPENDIX D

## Peer-review Project Summaries

(In order, as shown in Tables 5-6)

### Characterization and Fitness-for-Service of Corroded Cast Iron Pipe

*Gas Technology Institute*

Cast iron gas mains, which have existed since the 1830s, make up approximately 32,400 miles of pipeline across the United States, with about 50 percent located in New Jersey, New York, Massachusetts, and Pennsylvania. Local distribution companies (LDC) have developed procedures for surveillance of their cast iron facilities consistent with the Federal requirements contained in 49 Code of Federal Regulations (CFR), allowing them to identify problems and take appropriate action concerning leaks, breakage, and graphitization. Recent incidents have prompted State regulators to evaluate and modify the utilities' procedures regarding the frequency of cast iron surveillance. The vulnerability and integrity of cast iron pipelines are further highlighted in the PHMSA Safety Advisory Bulletin, which requires gas operators to implement a program to identify and replace cast iron piping systems in a planned, timely manner. The program must be based on factors such as age, pipe diameter, operating pressure, soil corrosiveness, existing graphitic damage, leak history, and external loading. The goal of this project is to provide a Fitness-for-Service model and method for operators to characterize and grade graphitic corrosion defects on cast iron natural gas pipe. This will lead to more educated monitoring, repair, and replacement decisions, as well as the prioritization of replacement program decisions, leading to improved safety and supply stability.

### Human-centric Approach to Improve Pipeline Nondestructive Evaluation (NDE) Performance and Reliability

*Battelle Memorial Institute, Corporate Operations*

NDE is critical for safe and efficient pipeline operation, but these ditch inspections are often riddled with human error, resulting in lost lives and staggering property damage. The Battelle Team proposes a powerful research program to tackle this critical deficiency, piloting both technology and human solutions in the next two to three years towards future commercialization. Battelle has human factor evaluation experts who will lead the investigation and closely collaborate with partnering NDE vendors Mistras Group, Inc.; JENTEK Sensors, Inc.; and Applus RTD. In order to identify and prioritize detrimental human-shaping factors, extensive interviews, protocol reviews, field observations, and control tests with field pipe defects will be systematically analyzed within the first 12 months of this program. Battelle experts will also optimize the well-established Saba™ Peak Performance System, accompanied by Human Performance Technology Front-end Analysis, to ensure the most effective evaluation. Solutions will be developed and piloted over the second and third years of the program, with Phase 2 dedicated to human interventions and Phase 3 to technology interventions.

## APPENDIX D

### Peer-review Project Summaries

(In order, as shown in Tables 5-6)

### EMAT Sensor for Small-diameter and Unpiggable Pipes; Prototype and Testing

*Operations Technology Development*

The objective of this project is to build and test an EMAT sensor prototype to detect and quantify wall loss and longitudinal cracks in metallic pipes. The sensor will be used to assess small-diameter and unpiggable pipes that contain fittings and other restricting features, with an initial target pipe diameter of 8 inches. The commercial goal, however, is to build tools that can navigate in 6- to 12-inch pipes, as these are the sizes typically used in unpiggable natural gas transmission and distribution systems. Other sizes will be considered based on industry needs. The work tasks in this proposal build on the results from Phase 1 of this research, in which a laboratory assembly (bench-scale unit) was successfully completed and tested. The work undertaken during the course of this project will include building a prototype of the unit with the data management system, building a pull-out mechanism for internal testing of pipe sections with controlled and natural cracks and flaws, and establishing the performance criteria and minimum flaw sizes that are reliably detected by the device.

### Intrinsically Locatable Technology for Plastic Piping Systems

*Operations Technology Development*

The objective of this project is to develop and test a viable solution for intrinsically locatable polyethylene (PE) materials with an integral electronic marking system. The project will cover completing the development, defining and testing the electronic marker capability, validating the attachment design, and performing laboratory and field testing. Operations Technology Development, N.F.P., plans to partner with the Gas Technology Institute (GTI), 3M Company (3M), and a large pipe manufacturer for the duration of this project. 3M will develop the electronic markers and work with the pipe manufacturer to attach the marker to the PE pipe and GTI will provide third-party testing and analysis of the developed system. Electronic markers are detectable passive devices that do not use any batteries and include electrical or mechanical resonators. Resonators can be energized by an above-ground transceiver (or portable locator) that causes them to generate their own magnetic field at their resonant frequency. The precise location of a buried electronic marker is indicated by the portable locator's display and sound output. Marking buried plastic pipe with an electronic marker gives a unique detection signature for each utility by frequency selection, provides nearly continuous location detection of the pipe path, and allows the estimation of the depth to the pipe.

## APPENDIX D

### Peer-review Project Summaries

(In order, as shown in Tables 5-6)

**Development of EMAT Sensors for Corrosion Mapping of Unpiggable Natural Gas Pipelines Using ILI Tools**

*QUEST Integrated, L.L.C.*

The project will develop EMAT wall thickness sensors that are optimized for use in small-diameter and traditionally unpiggable pipelines. These sensors will be investigated and integrated into a bench-scale EMAT system that would allow information—such as wall thickness—to be entered into an API 579 Fitness-for-Service analysis. Failure criteria could be also be fed into this analysis, enabling the calculation of remaining wall strength for pipeline integrity assessment. Of particular importance is the optimization of the EMAT sensor's performance in the presence of corrosion.

**Comparison of Exclusion-zone Calculations and Vapor Dispersion Modeling Tools**

*CH-IV International*

The DOT's regulations in 49 CFR Part 193.2059 state that all liquefied natural gas facilities that fall under the scope of 49 CFR Part 193 are required to calculate vapor dispersion exclusion zones in accordance with National Fire Protection Association 59A (2001), as incorporated by reference. Interpretations issued by PHMSA in July 2010 clarified certain requirements for performing vapor dispersion exclusion zone modeling to satisfy the requirements of 49 CFR 193.2059. The objective of this project will be to provide PHMSA with a comparison of the different methodologies used to determine a "single accidental leakage source," as well as a comparison of the modeling results for those sources using the Dense Gas Dispersion (DEGADIS), Phast, and Flame Acceleration Simulator models. These models were approved by PHMSA for the calculation of vapor dispersion exclusion zones, in accordance with 49 CFR Part 193.2059. This comparison will help PHMSA better define the criteria to determine a "single accidental leakage source" for use in vapor dispersion exclusion zone calculations.

**Pipeline Damage Prevention Radar**

*Ball Aerospace & Technologies Corp.*

Ball Aerospace will manage a 14-month program designed for demonstration and evaluation of a dual-band airborne Synthetic Aperture Radar (SAR) that can reliably detect excavation damage threats in areas where the pipeline routes may be obscured by dense brush, forest canopy, low cloud cover, smoke, fog, haze, precipitation, or low-light conditions. SAR is widely used by the DOD for threat detection, imaging, and change detection from airborne platforms. Pipeline damage prevention will offer a new application for SAR, using it to increase the likelihood of excavation threat detection and improve safety. The proposed development will reduce false positives, allow for fewer repeat flight passes, and diminish weather-related aircraft downtime, resulting in operations cost savings. Flight testing, which will begin near the SAR vendor's

## APPENDIX D

### Peer-review Project Summaries

(In order, as shown in Tables 5-6)

facility in Utah, will verify aircraft interfaces, installation processes, flight operations, and validate performance of SAR data-processing algorithms optimized for detection and imaging of targets hidden beneath forest canopies. System demonstration flight testing, using aircraft and personnel contributed by our operator partner Pacific Gas and Electric, will be performed over foliage-covered pipeline located in California. A final report will include a detailed assessment of excavation damage, threat detection performance, and a plan for commercialization of the airborne SAR.

### EMAT Guided-wave Technology for In-line Inspections of Unpiggable Natural Gas Pipelines

*ULC Robotics*

ULC's objective for this project is to evaluate an EMAT guided-wave sensor for operation in cast iron or steel plates and pipes. The project will work to optimize the sensor's performance, demonstrate its capabilities in the lab, and perform conceptual design and evaluation for the integration of the sensor with the CIRRIS XITM robot. By the end of this project, ULC would like to: validate the wave propagation in the material, show that the sensors detect wave and defect interactions, attain optimized sensor performance, depict concepts that show how the sensors could be integrated with the CIRRIS XI robot, recommend modifications to the robot and/or EMAT guided-wave sensor for integration with the CIRRIS XI, and show that a manual operator can use the EMAT guided-wave sensor output to classify cracks, corrosion, pitting, wall thinning, and dents in steel and cast iron pipes. Upon completion of the project, ULC would be able to begin preliminary and detailed design tasks that would lead to commercialization of the technology.

### Combined Vibration, Ground Movement, and Pipe Current Detector

*Operations Technology Development*

The objective of this project is to demonstrate the feasibility of a pipeline right-of-way (ROW) defense system based on stationary sensors mounted on or adjacent to a pipeline. The sensor data from multiple locations along the pipe will be wirelessly forwarded to a central location where analytics will correlate data from multiple sensors, alerting operators with minimal latency to any events of interest occurring within the ROW. The proposed methodology recommends the application of sophisticated analytics based on Causal Bayesian Networks to data captured from multiple sensor types and locations within the ROW. The ability to simultaneously capture distinct categories of data from multiple locations will allow these analytics to more positively identify when an event of interest is occurring on the ROW. The following sensor types will be examined during the course of the proposed work: acoustic vibration sensors mounted directly on the pipe that detect approaching threats or impacts, strain gauges mounted directly on the pipe that determine changes in compressive or tensile stresses, current sensors in metallic contact with

## APPENDIX D

## Peer-review Project Summaries

(In order, as shown in Tables 5-6)

the pipe that measure induced or cathodic protection currents, and seismic or earth-movement sensors in the soil adjacent to the pipe that determine the presence of earthquakes, subsidence, or washout events. In order to make them available to sponsors and filed test operators, the data storage, data analytics, and user interface will be located in the cloud. It is anticipated that one or more gas utility operators will provide test sites for this project.

### Improving Models to Consider Complex Loadings, Operational Considerations, and Interactive Threats

*Kiefner Applus RTD*

This project is designed to produce guidance, decision processes, and data to identify/evaluate complex situations, thereby preventing pipeline failures. The causes of some pipeline failures suggest that current pipeline inspection/analysis needs to account for more complex situations than are currently considered. Even under conditions that are normally considered to be safe, the interactions of pipe defect conditions with variable loadings, increased loadings, complex loadings, or changing conditions have led to failures. The industry should apply a second level of complexity to the evaluation of degraded conditions where one or all of the following circumstances could exist: loadings are biaxial, loadings vary with time, or environments interact with conditions to adversely alter stability or the rate of degradation. Recognizing and quantifying these effects will require the integration of data from ground or aerial patrols, ILIs (perhaps from tools an operator would not normally use, such as slope-curvature tools or crack-detection tools), or, at some sites, actual monitoring or measurement of changing conditions. This project will produce guidance in the form of decision processes and data needs for the identification and evaluation of complex and/or interactive situations.

### Development of Comprehensive Pressure Test Design Guidelines

*Kiefner Applus RTD*

The objective of this project is to develop comprehensive guidelines for the design of pressure tests that could be incorporated into industry standards, such as ASME B31.4, ASME B31.8, ASME B31.8S, and/or API RP 1160. These standards have served as valuable test guidance and requirements for many years, but may no longer reflect the most current knowledge and industry needs. It is expected that the proposed work will draw heavily on lessons learned by pipeline operators and pressure-testing contractors who have performed pressure tests on thousands of miles of pipelines. The project also will account for the significant amount of pressure-testing research carried out by the Pipeline Research Council International, PHMSA, and other organizations from the 1960s to the present day. In particular, the recent PHMSA-sponsored work on the behavior of electric resistance welded pipe and repair/replace considerations for pre-regulation pipe will be considered, with respect to implications for best testing practices. This

## APPENDIX D

### Peer-review Project Summaries

(In order, as shown in Tables 5-6)

work is being proposed by a team of pipeline integrity specialists at Kiefner and Associates, Inc., an Applus RTD Company.

### Development of an AMR Eddy Current-based Crack Detection Sensor for the Live Inspection of Unpiggable Natural Gas Transmission Pipelines

*Northeast Gas Association/NYSEARCH*

This is a project for the development, laboratory testing, field testing, and commercialization of an AMR EC-based sensor system for the live, in-line crack inspection of piggable and unpiggable natural gas pipelines. The sensor will incorporate an EC-based technology, developed by Radiation Monitoring Devices, Inc. (RMD), that can be integrated onto the Explorer 6/8 robotic platform (6-inch to 8-inch pipelines). The Explorer 6/8 robotic platform, which was developed with PHMSA co-funding, was commercialized in 2010 by NYSEARCH and Invodane Engineering (via Pipetel Technologies, the commercial service company of Invodane Engineering). NYSEARCH is currently partnering with RMD to develop the basic sensory technology for this project, which will be integrated into the Explorer 6/8 robotic platform. While the proposed crack sensor will be built for the 6-inch to 8-inch pipe size range, the design is expected to be easily scalable to platforms for smaller and larger pipe sizes. The proposed project will be conducted by a team consisting of NYSEARCH, RMD, and Invodane Engineering over the course of 27 months, resulting in the commercialization of the technology.

### Emissions Quantification Validation Process

*Northeast Gas Association/NYSEARCH*

The overall objective of this project is to collaborate as an industry group and with others to validate the quantitative flow rate of methane emissions from non-hazardous natural gas infrastructure leaks, thereby aiding in the prioritization of repair decisions. The project will identify, apply, and test a methodology or set of methodologies allowing gas distribution operators to validate the accuracy of measuring, locating, and quantifying the flow rate of methane emissions. If successful in validating a technology or combination of technologies to accurately quantify these emissions, the proposed effort would allow for more data-driven decisions based on the greenhouse gas emission contribution of individual non-hazardous leaks.

**APPENDIX E**

The Peer-Review Coordinator (PRC) organizes, coordinates, monitors, and facilitates the annual panel peer review. The PRC is the main contact for panelists, the researchers involved with a peer review, and public inquiries. The PRC for the 2017 peer reviews was Mr. Robert Smith of PHMSA.


## Robert Smith

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