Peer-Review Report

Pipeline and Hazardous Materials Safety Administration

Pipeline Safety Research & Development Program

Peer Reviews Conducted
May 21, 2018

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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 2018 peer-review panel, which consisted of three academic representatives, reviewed five 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 score for the five projects assessed during the May 2018 review was More than Effective; the average sub-criteria were also rated highly, underpinning these findings. All peered projects and the overall program retained the rating of More than Effective—the same rating received in 2017. Table 4 outlines overall program performance based on the summary of the reviewed projects, while Table 5 itemizes the project ranking order for projects of the same score that have equal rankings. Additional details are available in Section 7, Tables 4 and 5, and Appendix C of this report.

PHMSA is satisfied with the process performed to conduct these reviews, as well as the calendar year (CY) 2018 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

The purpose of this document is to report findings from PHMSA's Pipeline Safety R&D Program research peer reviews held on May 21, 2018. The findings and recommendations in this report are derived from the scoring and comments collected from the peer-review panelists.

The Department of Transportation (DOT) Operating Administrations (OA) 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 the ongoing reduction of incidents on natural gas and hazardous liquid pipelines that result in death, injury, significant property damage, or environmental harm.

The intent of the PHMSA Pipeline Safety R&D Program is to support PHMSA's pipeline safety mission, which is "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 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. Beginning in 2001 PHMSA began strengthening its role in assuring the safety of the Nation's pipeline system in numerous ways, including promulgating new regulations on integrity management.[2,3,4] Both these regulations and the new inspection processes used by regulators to

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[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.

[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.

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. In order 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.
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.

[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.

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.

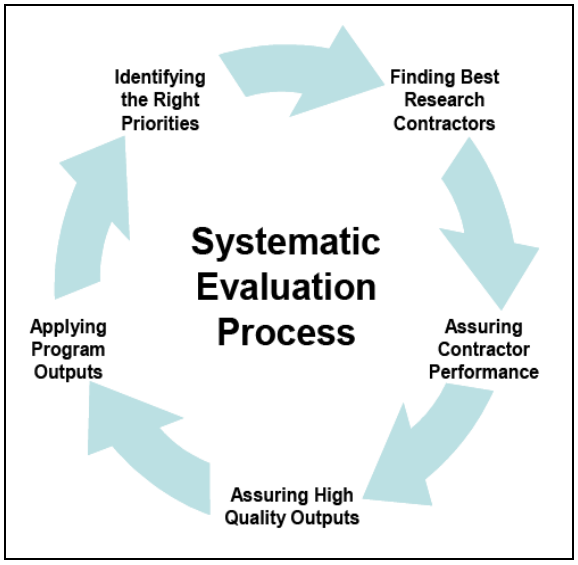
More information on the program strategy is outlined in the R&D Program Strategy portion of the program website at: http://primis.phmsa.dot.gov/rd/.

Research Program Quality

To improve R&D program quality, PHMSA designed and implemented a systematic evaluation process to follow research projects from inception to implementation. 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 the best 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 Agreement Officers' Representatives (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 -- meaning the 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 primarily of academic representatives, as well as one government employee, and 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	Tingyue Gu, Ph.D.	Professor of Chemical Engineering, Ohio University
2	Genda Chen, Ph.D., P.E., F.ASCE, F.SEI	Distinguished Chair in Civil Engineering, Department of Civil, Architectural, and Environmental Engineering, Missouri University of Science and Technology
3	Hota Gangarao, Ph.D., P.E., F.ASCE, F.SEI	Director, National Science Foundation's Center for Integration of Composites into Infrastructure, Director, Constructed Facilities Center, West Virginia University

4.0 Panelist Charge

The Peer-review Panelist charge, initially developed in December 2005 and revised annually, 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 a separate document not attached to this report. It 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 address 11 evaluation criteria within 4 specific evaluation categories. Presentations are scheduled to take no more than 20 minutes, followed by 10 minutes for panelist questions and possible written public questions.

In its entirety, the review of each project by the panelists should take approximately 2.5 hours. This allows 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. An underlying 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, on which each category has 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?

Essentially, 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 Very Effective, More than Effective, Effective, or Ineffective, 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 2018 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 2018 review, the average program rating across all evaluation categories was More than Effective; the average sub-criteria were also rated highly. For this year, five projects were reviewed and all rated More than Effective. The majority of peered projects and the overall program retained the rating of More than Effective -- the same rating received in 2017. Table 4 summarizes overall program performance based on the summary of reviewed projects, while Table 5 itemizes the project ranking order for projects with the same score and equal rankings.

At the time of the reviews, the majority of the projects were approximately 60 to 90 percent complete. The panelists made several recommendations associated with each project during the course of the review that were categorized into Strong and Weak points. However, none of these comments identified the critical actions required to salvage a project from failure, but instead recommended actions to further improve good performance.

Table 6 in Appendix C itemizes the Strong and Weak points collected from all five projects reviewed by the three panelists. These points were consistent among several 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 on 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. Project management	**4.2**	**More than Effective**
1.1. Is the project being managed on budget and schedule?	4.2	More than Effective
1.2. Is the project making progress toward the work scope objectives?	4.2	Very Effective
2. Approach taken for transferring results to end users	4.1	**More than Effective**
2.1. Is there a plan for dissemination of results, including publications, reporting, and patents?	**4.3**	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?	4.3	More than Effective
3. Project coordination with other related programs	**3.9**	**More than Effective**
3.1. Does the project build on or make use of related/prior work?	3.9	More than Effective
3.2. Is the content of the project being communicated to other related research efforts?	4.0	More than Effective
3.3. Has consideration been given to possible future work?	3.8	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?	4.2	More than Effective
4.2. Are the intended results consistent with scientific knowledge and/or engineering principles?	3.7	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	**4.1**	**More than Effective**

Table 5: Summary Ranking & Rating of Individually Reviewed Research Projects					
Rank	**Project ID**	**Project Title**	**Contractor**	**Rating**	**Score**
1	DTPH5616T00003	Development of High Performance Gas-coupled Ultrasonic Transducers for Inspection of Unpiggable Natural Gas Pipelines	*Quest Integrated, L.L.C.*	More than Effective	4.3
1	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
2	DTPH5615T00018	EMAT Sensor for Small-diameter and Unpiggable Pipes; Prototype and Testing	*Operations Technology Development*	More than Effective	4.1
3	DTPH5616T00004	EMAT-guided Wave Technology for In-line Inspections of Unpiggable Natural Gas Pipelines	*ULC Robotics*	More than Effective	4.0
4	DTPH5615T00010L	Human-centric Approach to Improve Pipeline Non-destructive Evaluation (NDE) Performance and Reliability	*Battelle Memorial Institute, Corporate Operations*	More than Effective	3.8

8.0 PHMSA's Response to Panelists' Findings and Recommendations

The CY 2018 reviews were the 13th structured peer review of PHMSA's Pipeline Safety R&D Program. PHMSA is satisfied with the process for conducting these reviews, as well as the findings and recommendations provided by the peer-review panelists, which PHMSA accepts. 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 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. 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. PHMSA receives comments from these reviews as an opportunity to continually improve.

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, May 21, 2018

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 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) 2018, the majority of peered projects and the overall program retained a rating of More than Effective -- the same rating received in 2017. The CY 2018 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 Officers' Representatives, who will decide if these recommendations warrant any changes in scope.

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 Peer Review Report.

The Associate Administrator for Pipeline Safety

APPROVED: _____

DISAPPROVED: _____

COMMENTS: _____

DATE: 8-3-18

APPENDIX B

Peer-review Panelist Biographies

Tingyue Gu
Ph.D.

Dr. Tingyue Gu obtained his B.S. degree in Chemical Engineering from Zhejiang University in 1985. He earned a Ph.D. degree in Chemical Engineering from Purdue University in 1990. He worked as a postdoctoral biotechnologist for Miller Brewing Company in Milwaukee, Wisconsin, for one year before joining Ohio University in 1992, where he is currently a full professor in the Department of Chemical and Biomolecular Engineering. He is a leader in biocorrosion research who developed several mechanisms, theories and a mechanistic biocorrosion prediction model. He has done sponsored research in biocorrosion for PHMSA, ExxonMobil, BP, Saudi Aramco, Total, SABIC, Petronas, PTTEP, and other companies.

Dr. Gu has reviewed proposals for National Science Foundation, US Department of Energy, US Department of Transportation, US Department of Agriculture, US Civilian Research & Development Foundation, as well as many foreign agencies. He is on the editorial boards of Bioprocess and Biosystems Engineering journal, Separation and Purification Technology and Journal of Chemistry. He has served as an ad hoc reviewer for at least 90 journals.

Genda Chen
Ph.D., P.E., F.ASCE, F.SEI

Dr. Genda Chen is Professor and Robert W. Abbett Distinguished Chair in Civil Engineering at Missouri University of Science and Technology (Missouri S&T). He is currently directing the Inspecting and Preserving Infrastructure through Robotic Exploration University Transportation Center (INSPIRE-UTC) funded by the U.S. Department of Transportation (USDOT). He is also Director of the System and Process Assessment Research Laboratory (SPAR Lab). He was elected to American Society of Civil Engineers (ASCE) Fellow in 2007 and Structural Engineering Institute (SEI) Fellow in 2013. In 2016, he was nominated and inducted into the Academy of Civil Engineers at Missouri S&T and became an honorary member of Chi Epsilon.

Dr. Chen received his Ph.D. degree in civil engineering from State University of New York at Buffalo in 1992 and joined Missouri S&T in 1996 after over three years of bridge design, inspection, and construction practices with Steinman Consulting Engineers in New York City. He was granted two patents and authored over 350 publications in structural health monitoring, smart structures, interface mechanics and deterioration, bridge engineering, and multi-hazard effects. Dr. Chen has led and been involved in over $16M grant research from National Science Foundation (NSF), Army Research Laboratory and USDOT. He received the 1998 National Science Foundation CAREER Award, the 2004 Academy of Civil Engineers Faculty Achievement Award, and the 2009, 2011, and 2013 Missouri S&T Faculty Research Awards. He is Chair of the 9th International Conference on Structural Health Monitoring of Intelligent Infrastructure in 2019, Section Editor of Intelligent Sensors, and Associate Editor of the Journal

of Civil Structural Health Monitoring. Dr. Chen is a member of ASCE, American Concrete Institute (ACI), Earthquake Engineering Research Institute (EERI), Transportation Research Board (TRB), and the International Society for Optics and Photonics (SPIE).

Hota Gangarao
Ph.D., P.E., F.ASCE, F.SEI

Dr. Hota Gangarao is a Maurice and Jo Ann Wadsworth Distinguished Professor of Civil and Environmental Engineering at West Virginia University (WVU) and serves as the Director of the Constructed Facilities Center and Director of National Science Foundation Industry -- University Cooperative Research Centers Program Center for Composites Infrastructure at WVU. Dr. Gangarao's main areas of research include fiber reinforced polymer composite bridge structures, advanced materials research, recycling of thermoplastic composites, composites for blast and fire resistance, and rapid retrofit of infrastructure systems using composites. During his tenure at WVU, Dr. Gangarao has advised over 300 Ph.D. and MS students, and has published over 500 papers and conference proceedings relating to his broad range or research programs. He co-authored and published the text book "Reinforced Concrete Design with FRP Composites" with two others, in addition to authoring a dozen of book chapters. Dr. Gangarao has received 12 patents. Dr. Gangarao received his Ph.D. in Civil Engineering at North Carolina State University and is a register Professional Engineer (P.E.). Dr. Gangarao has received numerous awards for his research and professional services. He has been cited as one of the Top Five Outstanding Researchers of the College of Engineering and Mineral Resources at WVU for two decades. He serves as chairman on several committees at WVU and national professional organizations. Dr. Gangarao is the Chairman of the Structural Composites and Plastics Sub-Committee for the American Society of Civil Engineers (ASCE) and Chairman of the World Association for Waterborne Transport Infrastructure (PIANC) Working Group (WG) 191 Composites for Hydraulic Structures.

APPENDIX C

Table 6 – Peer-Reviewed Project Strong and Weak Points

(In order, as shown in Table 5)

Project Title	Strong Points	Weak Points
Development of High-performance Gas-coupled Ultrasonic Transducers for Inspection of Unpiggable Natural Gas Pipelines	Very good end-user involvement and communication to related efforts. Great use of prior related project results. Good progress with crystal growth.	Project may need another phase of work to validate sensor performance and for integration onto a robotic platform. No major weaknesses of mention. Suggest conference & publication activities to disseminate results once full patent in place.
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 even with a slight schedule delay. Very good end-user involvement and communication to related efforts. Great use of prior related project results. Good plan for dissemination of results and commercialization.	Suggest validation under real pipeline operating conditions. Project may need another phase of work for integration into a robotic platform. Suggest conference & publication activities to disseminate results once full patent in place.
Electro Magnetic Acoustic Transducer (EMAT) Sensor for Small-diameter and Unpiggable Pipes; Prototype and Testing	Very well organized and managed. Project is slightly ahead of schedule and making good progress in achieving objectives. Very good end-user involvement.	Need validation under real pipeline operation conditions. Looking for more info on how well cracks can be characterized. Suggest conference & publication activities to disseminate results once full patent in place.
EMAT Guided-wave Technology for ILI of Unpiggable Natural Gas Pipelines	Scope seems well matched to the project goals.	Need models to better validate experimental data. Should conduct additional demos to gain more validation data. Suggestion to increase the applicability of the technology by adding a wider suite of sensors. Increase awareness of this work by publication.
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.	Due to the nature of the scope, suggestion made to be as visual and scientific as possible in conveying projects results in a method readers can easily follow.

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/

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.

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 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.

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.

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 aims 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.

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 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 2018 peer reviews was Mr. Robert Smith of PHMSA.

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