Five-Year Interagency Research Development and Demonstration Program Plan

For Pipeline Safety and Integrity

Update Report #2 of 2

Fiscal Years 2014-2015

U.S. Department of Transportation and

U.S. Department of Commerce's

National Institute of Standards and Technology

March 2016

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable John Thune
Chairman
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

The Act requires the Secretary of Transportation, in coordination with the Director of the National Institute of Standards and Technology, as appropriate, to prepare a research and development program plan every 5 years, and to transmit a report to Congress every 2 years on the status and the results to date of the implementation of the program.

I have sent a similar letter to the Ranking Member of the Senate Committee on Commerce, Science, and Transportation; the Chairman and Ranking Member of the Senate Committee on Energy and Natural Resources; the Chairman and Ranking Member of the House Committee on Energy and Commerce; the Chairman and Ranking Member of the House Committee on Transportation and Infrastructure; and the Chairman and Ranking Member of the House Committee on Science, Space, and Technology.

Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Bill Nelson
Ranking Member
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Senator Nelson:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Bill Shuster
Chairman
Committee on Transportation and Infrastructure
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Peter A. DeFazio
Ranking Member
Committee on Transportation and Infrastructure
U.S. House of Representatives
Washington, DC 20515

Dear Congressman DeFazio:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Lamar Smith
Chairman
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Congresswoman Johnson:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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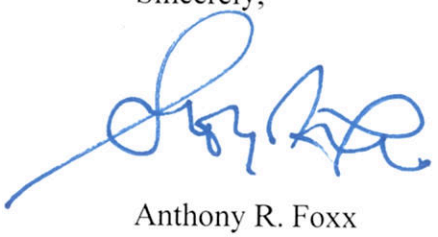
Sincerely,



Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Lisa Murkowski
Chairman
Committee on Energy and Natural Resources
United States Senate
Washington, DC 20510

Dear Madam Chairwoman:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Maria Cantwell
Ranking Member
Committee on Energy and Natural Resources
United States Senate
Washington, DC 20510

Dear Senator Cantwell:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

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THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, DC 20590

April 8, 2016

The Honorable Frank Pallone, Jr.
Ranking Member
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

Dear Congressman Pallone:

I am pleased to submit the second of two update reports on the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration's Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity, as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, Public Law No. 112-90.

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Sincerely,

Anthony R. Foxx

Enclosure

FOREWORD

The U.S. Department of Transportation (DOT) and the U.S. Department of Commerce (DOC) were specifically named as participating agencies in Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011 (PSRCJCA 2011 or the Act), Public Law 112-90. The DOT and the DOC invited the U.S. Department of the Interior (DOI) to participate in the interagency activities described in this plan even though the DOI was not specifically named in the statute.

The Five-Year Plan identifies program-level areas for strategies where annual coordination and collaborative activities and related research funding, primarily for onshore pipelines. The Five-Year Plan was submitted to Congress in 2013 and is publicly available via https://primis.phmsa.dot.gov/rd/psrcjca.htm. This update report describes plan implementation and will be transmitted to Congress every two years after the submission of this plan as required by Section 32 of the Act.

The DOT was the only participating agency to receive specific direct appropriations through PSRCJCA 2011 to fundi pipeline-related research.

Table of Contents

List of Tables and Figures

List of Acronyms

API	American Petroleum Institute
ARPA-E	Advanced Research Projects Agency - Energy
BSEE	Bureau of Safety and Environmental Enforcement
CAAP	Competitive Academic Agreement Program
DHS	Department of Homeland Security
DOA	Department of Agriculture
DOD	Department of Defense
DOC	Department of Commerce
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
EPA	Environmental Protection Agency
NETL	National Energy Technology Laboratory
NIST	National Institute of Standards and Technology
OMB	Office of Management and Budget
PSRCJCA 2011	Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011
PSIA 2002	Pipeline Safety Improvement Act of 2002
PHMSA	Pipeline and Hazardous Materials Safety Administration
R&D	Research and Development
RD&D	Research Development and Demonstration

Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity

Update Report #2

Fiscal Years 2014-2015

A Five-Year Interagency Research, Development, and Demonstration Program Plan for Pipeline Safety and Integrity was submitted to Congress in 2013 as required by Section 32 of the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011[2] (PSRCJCA 2011). The plan was orchestrated by the Department of Transportation (DOT), and extensively coordinated with the Department of Commerce's (DOC) National Institute of Standards and Technology (NIST) and the Department of the Interior's (DOI) Bureau of Safety and Environmental Enforcement (BSEE). Update Report #2 is the second of two biennial reports to Congress that describe the progress in implementing the Five-Year Plan.

Executive Summary

The importance of energy pipelines to the U.S. economy and our standard of living suggest that all stakeholders, including the public, have a strong interest in funding pipeline research, with the goal of enabling continual safety, supply reliability, productivity, security, and environmental performance improvements. Effective research solutions will be key in enabling all pipeline stakeholders to take on growing pipeline safety challenges.

This second update report to the Five-Year Plan describes good progress in executing agreed coordination, collaboration, and co-funding activities between the DOT, the DOC, and the DOI. Communication and meetings occurred as needed in order to coordinate activities. This coordination included participation at two different public events, interagency review of pre- and post-award individually funded research, co-funding of new pipeline research, and attendance at technology demonstrations in the field.

Pipeline research awards of 62 individual agency and 2 interagency co-funded projects were made during this reporting period, totaling more than $26M of funding and co-funding from the DOT, the DOC, and the DOI. These investments cover a wide range of technical solutions for the pipeline challenges described in the Five-Year Plan. Interagency and stakeholder coordination during this reporting period are credited for generating targeted and consensus-driven topics and awarding quality research scopes. A full and high-level report is presented in Section 1 and in Table 1, with project-level information presented in Appendix A.

Several research outputs and impacts are reported in Section 2 and Table 2 and correspond to the performance of interagency participation, coordination, and collaboration. During this reporting period, technology demonstrations were held, U.S. Patents were issued, and new technology

[2] Pub. L No. 112-90 (Jan. 3. 2012).

entered the market. Several new research reports were publically posted, and hundreds of stakeholders were reached via the public events and the interagency website.

The Five-Year Plan and both update reports will be provided at: https://primis.phmsa.dot.gov/rd/psrcjca.htm.

Introduction

The DOT and the DOC were named as participating agencies in Section 32 of the PSRCJCA of 2011. The Department of the Interior (DOI) was invited by the DOT and the DOC into the interagency activities described in the Five-Year Plan and update reports even though the DOI was not specifically named as a participating agency. The DOI was invited because of its program expertise in offshore activities. Therefore, the DOT, DOC, and DOI are referred to as the "participating agencies." In addition, it should be noted that other agencies, including the Department of Energy (DOE) were included in the ongoing dialog and participated in many of the activities reported in this report.

Section 32 of PSRCJCA 2011 refers to Section 12(d)(2), of the Pipeline Safety Improvement Act of 2002 (PSIA 2002) by requiring that consultation is required in the preparation of the Five-Year Plan. Specifically, this guidance directs the Secretary of Transportation to "consult with or seek the advice of appropriate representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, and manufacturers, institutions of higher learning, Federal agencies, pipeline research institutions, national laboratories, State pipeline safety officials, labor organizations, environmental organizations, pipeline safety advocates, and professional and technical societies."

The Five-Year Plan represents program-level areas or strategies where annual coordination and collaborative activities, in addition to related research funding, will be reported for onshore pipelines, primarily. The Five-Year Plan was submitted to Congress in 2013 and is publicly available at https://primis.phmsa.dot.gov/rd/psrcjca.htm. The update reports describe the success in implementing that plan and will be transmitted to Congress every 2 years after the submission of this plan as required by Section 32 of the Act.

1.0 Interagency Coordination and Collaboration Activities Fiscal Years 2014-2015

As stated in PSRCJCA 2011, which amended Section 12(d) of the PSIA 2002, the goal of this Five-Year Interagency RD&D Program Plan is to guide activities needed to carry out a program of research, development, demonstration, and standardization to ensure the integrity of pipeline infrastructure. The attainment of this goal involves recognizing legitimate differences among the priorities of individual agencies and, where practicable, harmonizing these priorities to ensure that critical developmental needs and opportunities are addressed and achieved.

The following summarizes the joint activities taken by the participating agencies where possible and appropriate to attain the stated goal during fiscal years 2014 and 2015:

1. *Periodic interagency meetings to coordinate program activities.*
    a. Each participating agency will periodically schedule and host coordination meetings as needed.

    Update: An interagency meeting was held to coordinate participating agency activities as well as the drafting of Update Report #2. The meeting included the DOT, DOC, DOI and DOE and was held on August 4, 2015, hosted by the DOC at NIST offices in Boulder, Colorado. Two conference calls were held in October of 2013 and in May of 2014 to discuss the coordination and drafting of Update Report #1.

    The DOC was very active with the DOT and other Federal and nonfederal stakeholders during this reporting period. The DOC hosted or participated in five meetings focused on the transportation of hydrogen in pipelines. Much of this coordination revolves around ongoing DOT/DOC co-sponsored efforts included in Update Report #1 and further updated later in this report. The five are itemized below:

    1. Joint DOC/DOT/DOE Meeting on Hydrogen Fuel Research, December 11, 2013
    2. DOE Hydrogen Transportation Workshop, February 2014, hosted by National Renewable Energy Laboratory
    3. Joint DOE/DOC meeting on H2 Testing/Modelling for Pipelines, February 2015, hosted by DOE
    4. DOT/PHMSA (PS R&D) H2 properties of welds project kickoff meeting, July 2015
    5. DOT/PHMSA (MSA R&D) Project Kick-off meeting, September 2015

    The DOI met with DOT representatives in July 2015 regarding potential pipeline construction and oversight responsibilities associated with the Hillcorp Beaufort Sea LIBERTY project. The DOI also held meetings every 6 months (3 for this reporting period) with the Alaska Interagency Working Group,[3] which includes representatives from the DOD, DOC, DOA, DOE, DHS, EPA, and the Office of the Federal Coordinator for Alaska Natural Gas Transportation Projects. Finally, the DOI met in August 2015 with the DOT and other state/local agencies and organizations to discuss technical challenges on smart pigging, pipeline change of service, pipeline shut-ins, and pipeline materials review.

2. *Attendance and participation in RD&D related public events that gather stakeholder input on issues, candidate technologies, and development priorities.*
    a. Each agency will share public meeting information with the participating agencies on related research meetings in order to provide another agency with time to consider attending.

[3] https://www.whitehouse.gov/the-press-office/2011/07/12/executive-order-13580-interagency-working-group-coordination-domestic-en

b. Each agency will review agendas for public or other related research meetings and solicit participating agency involvement where appropriate.

Update (a & b): The DOT hosted a public Pipeline Research & Development Forum on August 6-7, 2014. The meeting's information was shared with the participating agencies. Each agency reviewed the agenda and participated in one or more working groups. The DOC presented an update on work addressing Fatigue Flaw Reference Standard Development for Non-Destructive Evaluations during the working group sessions. The DOE, EPA, and the Environmental Defense Fund (EDF) participated in the research road mapping, which crafted topics in methane leak detection and measurement. More information is provided at https://primis.phmsa.dot.gov/rd/mtg_080614.htm.
The DOC participated in the DOE Fuel Cell Technology Office - Hydrogen Transmission and Distribution Workshop, February 25-26, 2014,[4] which reviewed ongoing research and generated gaps where further research could be funded.

3. *Participate on agency-solicited research merit review panels to identify and recommend complementary research.*
   a. One representative from each participating agency will be solicited to participate on merit review panels for another agency's pre-award research solicitation.

Update: The DOC participated on the pre-award merit review panel for DOT Research Announcement # DTPH-56-15-RA-00001. This research announcement solicited topics collaboratively determined at the August 2014 Pipeline R&D Forum as noted above. In addition, the DOE and EPA were also invited and participated in the merit review since they assisted in the road mapping discussed in the above program activity. The DOC also participated in the DOE Hydrogen and Fuel Cells Annual Merit Review in June 2014 and the DOE Hydrogen and Fuel Cells Annual Merit Review in June of 2015 to select new hydrogen fuel cells research.

The DOE also participated on the pre-award merit review panel for DOT Funding Opportunity Announcement # DTPH-56-14-SN-000006, which was seeking new research under the DOT's Pipeline Safety Research Competitive Academic Agreement Program (CAAP).

The DOT participated in the DOE, Advanced Research Projects Agency, Methane Observation Networks with Innovative Technology to Obtain Reductions merit review in October 2014 to select innovative technology to detect and measure methane from exploration and production activities.

4. *Where appropriate co-sponsor research projects that are aimed at developing new technologies or improve current technologies.*
   a. Agencies will propose opportunities to co-sponsor research projects or other related initiatives where appropriate.

[4] http://energy.gov/sites/prod/files/2014/07/f17/fcto_2014_h2_trans_dist_wkshp_summary_report.pdf

Update: In Update Report # 1, it was reported that the DOC called for a new research partnership with the DOT during the August 2012 Interagency Coordination Meeting. The DOT then proposed topic areas, based on the July 2012 Pipeline R&D Forum, which are best-aligned to the DOC mission/capabilities and awarded Interagency Agreement (IA) DTPH56-13-X-000013 to the DOC in July 2013. A third task order was added in FY 2015 to the IA that further expanded the investigations into hydrogen pipelines.[5]

Also during this reporting period, the DOI solicited the DOT's technical participation and co-funding in a project addressing the composite repairs of offshore pipelines. Both participating agencies are active participants in the relevant standards groups, which creates a strong and united regulatory position on offshore pipeline systems having dual jurisdiction.[6]

More information is provided at the DOT research project pages. These projects are also tallied in Table 1 of Section 2 and also listed in the Appendix A. The cost sharing was listed for the DOC and is part of the total from all funded projects.

5. *Attend and participate in technology demonstrations involving co-sponsored or other related key pipeline infrastructure research.*
    a. Each agency will share demonstration information with the participating agencies on related research meetings in order to provide time for another agency to attend.
    b. In the case where another agency may want to participate, each agency will coordinate any related subject research demonstrations by co-sponsoring or sending related research contractors to participate where appropriate.

    Update (a & b): No updates.

6. *Participation on agency post-award research peer review panels.* *
    a. One representative from each participating agency will be solicited to participate on post-award peer review panels for another agency.

    Update: Retired DOC and active DOI staff participated as panelists on the 2015 post-award research peer review of the DOT's active research projects. More information is provided at https://primis.phmsa.dot.gov/rd/peer_review_15.htm.

    The DOC also participated in the DOE Hydrogen and Fuel Cells Annual Merit Review in June 2014 and the DOE Hydrogen and Fuel Cells Annual Merit Review in June of 2015 to peer review awarded research by the DOE.

**Peer review process follows all applicable OMB Guidelines*

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[5] Task Order #3: The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of Welds in X52 and X70 Pipelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=625

[6] Composite Repair Guideline Document for Nonmetallic Repairs for Offshore Applications https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=658

7. *Ensure public access to research information, results, and impacts.*
    a. Each agency will publicly post project- and program-related activities, investments, impacts relevant to this program plan, and more.

    Update: Related research information is provided at the following URLs:

    Participating Agencies per PSRCJCA 2011:
    https://primis.phmsa.dot.gov/rd/psrcjca.htm

    DOT Pipeline Research: https://primis.phmsa.dot.gov/rd/index.htm

    DOC Pipeline Research:
    http://www.nist.gov/mml/acmd/structural_materials/pipeline-safety.cfm

    DOI Pipeline Research: http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/Categories/Pipelines/

These seven activities create an environment that supports the goals of the Five-Year Plan.

2.0 Performance Metrics Fiscal Years 2014-2015

The Five-Year Interagency Research Development and Demonstration Program Plan states that update reports will embody several performance metrics that depict the level of progress achieved in executing the plan. The activity level of interagency coordination and collaboration described in Section 1 creates an environment that directly supports the goals of the plan and provides for success in reporting quantitative performance metrics.

The following tables report the quantitative performance metrics identified in the management plan for Fiscal Years 2014 to 2015. This information reflects activity from the collective group of participating agencies. Funding cycles, project durations, research types (i.e., general knowledge vs. technology development), and other influences can dictate how much information is reported in a given reporting period and from an individual agency.

Table 1: Participating Agency Research Projects and Funding by Programmatic Area

Programmatic Area	Participating Agency Relevant Research Projects				
	DOT	**DOC**	**DOI**	**Total # of Projects**	**Total Funding[4]**
1. Threat Prevention	20	N/A	2	22	**$4,514,115**
2. Leak Detection & Mitigation	6		0	6	**$3,753,146**
3. Anomaly Detection & Characterization	12		0	12	**$6,989,113**
4. Anomaly Remediation & Repair	5[1]		1	6[2]	**$1,128,481**
5. Design, Materials, & Welding/Joining	10	1[3]	0	11[2]	**$6,551,012**
6. Alternative Fuels, Climate Change, & Other	6	N/A	1	7	**$2,647,929**
Total # of Projects:	**59[2]**	**1[2]**	**4[2]**	**64**	
Total Funding[4]:	**$24,351,757**	**$0.00**	**$1,232,039**		**$25,583,796**

Table 1 Footnotes

1. *Includes the same project listed under DOI for this programmatic area. See Table 6 in Appendix A for more information.*
2. *Includes one project two times since co-funded by two participating agencies.*
3. *Includes the same project listed under DOT for this programmatic area. See Table 7 in Appendix A for more information.*
4. *Includes all federal co-funding from either DOI/DOT or DOT/DOC.*

Table 2: Participating Agency Quantitative Performance Metrics

Quantitative Performance Metric	Level of Performance
Number of technology demonstrations held from all awarded research	**11**
Number of U.S. Patent applied/issued resulting from all awarded projects	**3** 62103315, 62103332 & 62103346
Number of commercialized technology improvements	**2** Project #1 https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=490 Project #2 https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=441
Number of final reports made publicly available	**6**
Number of conference/journal papers based on awarded research	**45**
Number of Interagency Research Coordination Meetings held	**13***
Number of solicitations issued having Interagency Merit Review Panels	**4***
Number of post award peer review panels having Interagency Involvement	**3***
Number of public events having Interagency Participation	**3***
Number of stakeholders reached at public events	**230****

Number of website visits to the Interagency Research webpage	**225**
Number of website downloads from the Interagency Research webpage	**103**
NOTES * *See Section 1* ** *Data only collected from the DOT Pipeline Research & Development Forum on August 6-7, 2014. See Section 1.*	

The appendix to this update report lists the number and investment amount of jointly or individually funded projects by the participating agencies and by Programmatic Area.

Appendix A

The appendix is organized by the six Programmatic Areas. Each area includes background narrative explaining the subject(s) involved within each area with a summary table itemizing the number and investment amount of jointly or individually funded projects by the participating agencies and for that Programmatic Area including those funded under the Competitive Academic Agreement Program (CAAP) by the DOT. See Appendix B for a summary of this new DOT program.

1. Threat Prevention

Damage to pipes by excavation and damage from outside forces during transportation or construction continue to be leading causes of pipeline failure for onshore pipelines.[7] Preventing or reducing damage to pipes by excavation and damage from outside forces during transportation will improve pipeline safety. Damage from anchor drop/drag can cause failure for Outer Continental Shelf or offshore pipelines. Mechanical damage can result from a number of causes, including but not limited to contact with mechanized equipment (mechanical contact), fabrication and handling mishaps (fabrication damage), and pipelines settling on rocks (rock dents).

Research in this area may develop new or improved tools and technologies that should reduce damage to pipelines and may prevent releases to the environment. Related research outputs may include pipeline locating technology; emergency response best practices; Right of Way monitoring technology; best practices for preventing damage at steel mills, during transportation or in-ditch; improved padding or backfill techniques; improved coatings and application practices; and best practices for identifying or mitigating geo-forces.

Table 3: Threat Prevention Research

	Application Area	Project Title and Project Page URL	Federal Funding
1.	Onshore	Combined Vibration, Ground Movement, and Pipe Current Detector https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=655	$299,030
2.	Onshore	Pipeline Damage Prevention Radar https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=652	$760,196
3.	Onshore	Intrinsically Locatable Technology for Plastic Piping Systems https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=654	$468,118
4.	Onshore	Definition of Geotechnical and Operational Load Effects on Pipeline Anomalies https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=561	$147,000

[7] http://primis.phmsa.dot.gov/comm/DamagePrevention.htm?nocache=90

5.	Onshore	Threat/Anomaly Mitigation Decision-Making Process https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=558	$354,820
6.	Onshore	(CAAP) Application of Amorphous Metals for Plastic Pipeline Detection https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=629	$100,000
7.	Onshore	(CAAP) Advancement in the Area of Intrinsically Locatable Plastic Materials https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=632	$100,000
8.	Onshore	(CAAP) Embedded Passive Radio Frequency Tags towards Intrinsically Locatable Buried Plastic Materials https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=628	$100,000
9.	Onshore	(CAAP) Electromagnetic Strategies for Locatable Plastic Pipe https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=633	$297,432
10.	Onshore	(CAAP) Enhanced Mitigation of Pipeline Biocorrosion Using A Mixture of D-Amino Acids with A Biocide https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=512	$101,325
11.	Onshore	(CAAP) Mitigating External Corrosion of Pipelines Through Nano-Modified Cement-Based Coatings https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=510	$96,751
12.	Onshore	(CAAP) Composite Self-Sensing Thermal Sprayed Coatings for Pipeline Corrosion Prevention and Mitigation https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=509	$101,483
13.	Onshore	(CAAP) Laser Peening for Preventing Pipe Corrosion and Failure https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=570	$100,000
14.	Onshore	(CAAP) Improved Coatings for Pipelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=568	$100,000
15.	Onshore	(CAAP) Corrosion Under Insulation (CUI): Innovative Solutions to Cold Climate Corrosion Challenges https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=637	$214,321
16.	Onshore	(CAAP) Understanding and Mitigating the Threat of Alternating Current Induced Corrosion on Buried Pipelines	$238,424

		https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=636	
17.	Onshore	(CAAP) An Inorganic Composite Coating for Pipeline Rehabilitation and Corrosion Protection https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=635	$279,308
18.	Onshore	(CAAP) Mitigating Pipeline Corrosion Using A Smart Thermal Spraying Coating System https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=634	$299,607
19.	Onshore	(CAAP) Chemically Bonded Porcelain Enamel Coated Pipe for Corrosion Protection and Flow Efficiency https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=631	$35,000
20.	Onshore	(CAAP) Experimental Characterization and Monitoring of Early Stage Corrosion Degradation of Pipeline Steels https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=566	$100,000
21.	*-Offshore-*	Slug Loading and Response in Pipeline Joint Industry Project http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/Projects/Project-695/	$208,500
22.	*-Offshore-*	Safebuck Phase III and Safebuck Geo Joint Industry Project http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/Projects/Project-664/	$12,800
		Total:	**$4,514,115**

2. Leak Detection and Mitigation

Leak detection continues to present a challenge, especially when small pipeline leaks are involved. Ecological and drinking water resources can be impacted even by small hazardous-liquid pipeline leaks if they are not detected quickly. Among the possibilities for improving leak detection are automated monitoring systems that can detect small releases, sensors for small leak detection, technologies for aerial surveillance of airborne chemicals, improvements in the cost and effectiveness of current leak detection systems, and satellite imaging.

Effective leak detection also relies heavily on the environment in which it is installed and operated as well as how well the technology is implemented through people and procedures.

Research in this area may develop new or improved technology solutions and guidance for reducing the volume of product that is released to the environment.

Table 4: Leak Detection & Mitigation Research

	Application Area	Project Title and Project Page URL	Federal Funding
1.	Onshore	Emissions Quantification Validation Process https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=647	$144,670
2.	Onshore	Natural Gas Pipeline Leak Rate Measurement System https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=650	$226,794
3.	Onshore	Rapid Aerial Small Methane Leak Survey https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=651	$849,856
4.	Onshore	Framework for Verifying and Validating the Performance and Viability of Leak Detection Systems for Liquid and Natural Gas Pipelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=657	$1,663,882
5.	Onshore	Improving Leak Detection System Design Redundancy & Accuracy https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=560	$832,036
6.	Onshore	(CAAP) Small-Scale Differential Absorption Lidar for Methane Detection https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=630	$35,908
		Total:	**$3,753,146**

3. Anomaly Detection and Characterization

Detecting and characterizing anomalies in pipelines requires solutions that use people, processes, and technologies as part of a comprehensive program. The ability to detect anomalies should progress beyond the detection of simple corrosion anomalies and evolve into the detection of complex anomalies that feature dents, gouges, and cracks with possible corrosion characteristics. Solutions for complex defects and interactive threats are key goals in this program element. Detection is the first step in the process of engineering critical assessments; the ability to accurately characterize anomalies requires validated measurement technologies, procedures, and analysis based on referenced standards.

Another emerging concern is the ability of assessment algorithms to correctly calculate the remaining strength of larger anomalies in lower grade steels (under API 5L X70) and various anomalies in higher strength steels (above API 5L X80).

Research in this area may develop new or improved tools, technology, and assessment processes for identifying and locating critical pipeline defects and will improve the capability to characterize the severity of such defects identified in pipeline systems.

Table 5: Anomaly Detection & Characterization Research

	Application Area	Project Title and Project Page URL	Federal Funding
1.	Onshore	Evaluation of Corroded Cast Iron Pipe https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=641	$514,140
2.	Onshore	Development of an Anisotropic Magneto Resistive Eddy Current-Based Crack Detection Sensor for the Live Inspection of Unpiggable Natural Gas Transmission Pipelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=648	$905,791
3.	Onshore	Electro-Magnetic Acoustic Transducer Sensor for Small Diameter and Unpiggable Pipes; Prototype and Testing https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=653	$591,777
4.	Onshore	Pipeline Integrity Assessment using In-Line Inspection https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=624	$499,189
5.	Onshore	Improving Models to Consider Complex Loadings, Operational Considerations, and Interactive Threats https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=557	$470,056
6.	Onshore	Consolidated Project Full Scale Testing of Interactive Features for Improved Models https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=555	$3,297,555
7.	Onshore	A Novel Approach to Establishing Remaining Strength of Line Pipe and Fittings with Corrosion Type Defects https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=623	$150,000
8.	Onshore	In-situ Sensors for Cathodic Protection Interrelationships Modeling https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=563	$149,802
9.	Onshore	(CAAP) Robust Anomaly Matching for Internal Cleaning and Inspection Pigs: Reducing Pipeline Assessment Uncertainty Through 4-Dimension Anomaly Detection and Characterization https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=569	$100,000
10.	Onshore	(CAAP) Radio Frequency Identification Smart Corrosion Coupon https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=505	$103,258
11.	Onshore	(CAAP) Permanently Installed Pipeline Monitoring	$102,750

		Systems https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=507	
12.	Onshore	(CAAP) Proactive and Hybrid Sensing based Inline Pipeline Defects Diagnosis and Prognosis https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=508	$104,795
		Total:	**$6,989,113**

4. Anomaly/Pipe Remediation and Repair

Reliable methods to repair damaged coatings and corrosion damage are important to achieving safety goals and promoting continued operation. Research in this area plans to address improving the repair process by bringing automation to market and possibly establishing standards or best practices for operators and contractors. Composite materials are now more common for pipeline repairs, but further testing is needed to understand their integrity over the long-term while they are exposed to complex loading.

Research in this area may enhance repair materials, techniques or processes, repair tools, and technologies to bring pipeline systems back online quickly.

Table 6: Anomaly/Pipe Remediation/Repair Research

	Application Area	**Project Title and Project Page URL**	**Federal Funding**
1.	Onshore	Repair/Replacement Considerations for Pre-Regulation Pipe https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=559	$177,196
2.	Onshore	(CAAP) Wall Break-Through in Composite Repaired Defects https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=565	$99,815
3.	Onshore	(CAAP) Patch and Full-Encirclement Repairs for Through-Wall Defects https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=564	$99,877
4.	Onshore	(CAAP) Scaling Factors and Self-Sensing in Composite Repairs of Corrosion Defects https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=506	$102,073
5.	*-Offshore-*	Composite Repair Guideline Document for Nonmetallic Repairs for Offshore Applications *(DOI/DOT Co-funded)* https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=658	$649,520*
	** Includes DOI ($502,020) + DOT ($147,500) Funding*	**Total:**	**$1,128,481**

5. Design, Materials, and Welding/Joining

In some instances, improved pipeline materials and design may mitigate or minimize integrity threats. They can also increase capacity so that pipelines can operate at higher pressures. The welding and joining of these systems may require automation and inspection capabilities that improve the efficiency of construction activities in a safe manner. In addition to an increased demand on material performance in order to realize economic gains, there is a possible need to improve the integrity of the system in remote and harsh environments such as the frontier locations of Alaska and locations offshore. Both environments present unique installation, inspection, maintenance, and performance challenges for the materials. Quality management system guidelines aim to improve construction-related quality, which in turn may reduce the likelihood of girth-weld failures after welding, during the lowering-in (installation) of pipe, during hydrostatic testing, and during the expected service life of the pipeline.

Research in this area may improve the design and construction of safe and long-lasting pipelines that use the most appropriate materials and welding/joining procedures for the operating environment.

Table 7: Design, Materials, and Welding/Joining Research

	Application Area	Project Title and Project Page URL	Federal Funding
1.	Onshore	The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of Welds in X52 and X70 Pipelines *(DOT/DOC Co-funded)* https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=625	$105,187*
2.	Onshore	Use of Electromagnetic Sensors to Quantify Strength and Toughness in Steel Pipelines In and Out Of Service https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=649	$1,597,000
3.	Onshore	Development of a Hardness Tester for Quantification of Material Properties in Live Natural Gas Transmission Pipelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=646	$208,682
4.	Onshore	Development of Comprehensive Pressure Test Design Guidelines https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=645	$259,777
5.	Onshore	Slow Crack Growth Evaluation of Vintage Polyethylene Pipes https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=643	$995,191
6.	Onshore	Improving Quality Management Systems for Pipeline Construction Activities https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=504	$300,000

7.	Onshore	Effects of Hydrocarbon Permeation on Plastic Pipe Strength and Fusion Performance https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=554	$649,916
8.	Onshore	Strain-Based Design and Assessment of Segments of Pipelines with and without Fittings https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=556	$2,035,259
9.	Onshore	(CAAP) Bayesian Network Inference and Information Fusion for Accurate Pipe Strength and Toughness Estimation https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=627	$300,000
10.	Onshore	(CAAP) Optimized Diagnosis and Prognosis for Impingement Failure of PA and PE Piping Materials https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=567	$100,000
Total: * *Includes DOT ($105,187) Funding & no new DOC In-Kind Co-Funding beyond what was reported in Update Report #1.*			**$6,551,012**

6. Alternative Fuels, Climate Change, and Other

Reducing integrity threats and sharing new knowledge across the industry on best practices and consensus standards are important actions for promoting the safe pipeline transportation of any alternative fuel. Sometimes, emerging issues such as Liquefied Natural Gas, risk, and human factors require broad studies to understand better how they impact the other pipeline safety research activities described in this document. General knowledge research and studies will be conducted as needed when these emerging issues materialize.

Research in this area may identify and remove technical issues that prevent the safe transportation of alternative fuels in pipelines and will address other emerging technological or policy issues of a national scale.

Table 8: Alternative Fuels, Climate Change, and Other Research

	Application Area	Project Title and Project Page URL	Federal Funding
1.	Onshore	Critical Review of Candidate Pipeline Risk Models https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=656	$276,982
2.	Onshore	White Paper on Risk Tolerance https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=639	$170,840
3.	Onshore	Approaches for Preventing Catastrophic Events https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=638	$195,758
4.	Onshore	Human Centric Approach to Improve Pipeline Non-Destructive Evaluation (NDE) Performance and	$947,602

		Reliability https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=644	
5.	Onshore	Statistical Review and Gap Analysis of LNG Failure Rate Table https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=642	$418,058
6.	Onshore	Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=640	$129,970
7.	*-Offshore-*	Decommissioning Methodology and Cost Evaluation http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/Projects/Project-738/	$508,719
		Total:	**$2,647,929**

Appendix B

Summary of the DOT's Competitive Academic Agreement Program

In 2013, PHMSA's Pipeline Safety Research Program implemented a new program entitled Competitive Academic Agreement Program (CAAP), breathing further innovation into pipeline safety research. CAAP targets university students for the future pipeline safety workforce. PHMSA's initial vision for this program was to select five or more projects annually utilizing $100,000 PHMSA plus a 30 percent cost sharing by our university partners per project. With congressional assistance, PHMSA then revised this strategy in 2015 in order to award up to $2 million a year in this program, which corresponds to $300,000 per project at a university cost sharing level of 20 percent per project. These are Cooperative Agreements that are competitively selected and can run up to 36 months in duration. However, the number of awards is dependent upon quality of submissions and budget limitations. These initiatives are intended to research a wide set of solutions for many known pipeline integrity challenges.

The CAAP is intended to spur innovation through enabling an academic research focus on high risk and high pay-off solutions for wide ranging pipeline safety challenges. The CAAP is different in focus, execution and reporting from PHMSA's core program on Pipeline Safety Research. It is intended to potentially deliver desired solutions that can be "handed-off" to further investigations in CAAP or in PHMSA's core research program that employs partnerships with a variety of public/private organizations. One goal in this strategy would be to validate proof of concept of a thesis or theory potentially all the way to commercial penetration into the market.

Another goal for CAAP is to expose graduate and PhD research students to subject matter common to pipeline safety challenges for illustrating how their engineering or technical discipline is highly desired and needed in the pipeline field. The pipeline industry and Federal/State regulators are all experiencing low numbers of entry level applications to positions that are engineering or technically focused. Public conferences, meetings, and journals have identified similar shortfalls. The ultimate benefits from this goal would be to reflect new talent in all aspects of pipelining similar to how programs at other Federal agencies and non-profit organizations have provided talent to other industries over time.

Please visit https://primis.phmsa.dot.gov/rd/universitypartners.htm for much more information.