



THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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 first of two reports updating 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 Chair and Ranking Member of the Senate Committee on Energy and Natural Resources; and the Chairmen and Ranking Members of the House Committees on Energy and Commerce, on Transportation and Infrastructure, and on Science, Space, and Technology.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Anthony R. Foxx', is written over a light blue horizontal line. The signature is stylized and cursive.

Anthony R. Foxx

Enclosure



THE SECRETARY OF TRANSPORTATION  
WASHINGTON, DC 20590

March 4, 2015

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

Dear Senator Nelson:

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Sincerely,



Anthony R. Foxx

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THE SECRETARY OF TRANSPORTATION  
WASHINGTON, DC 20590

March 4, 2015

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

Dear Mr. Chairman:

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THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Congressman DeFazio:

Enclosed is the first of two reports updating 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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THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Mr. Chairman:

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THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Congresswoman Johnson:

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THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Ms. Chairman:

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## THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Senator Cantwell:

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March 4, 2015

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

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THE SECRETARY OF TRANSPORTATION

WASHINGTON, DC 20590

March 4, 2015

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

Dear Congressman Pallone:

Enclosed is the first of two reports updating 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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Anthony R. Foxx

Enclosure

# **Five-Year Interagency Research Development and Demonstration Program Plan**

For Pipeline Safety and Integrity

**Update Report #1 of 2**

**Fiscal Years 2012-2013**

**U.S. Department of Transportation and  
U.S. Department of Commerce's  
National Institute of Standards and Technology**

**January 2015**

## **FOREWORD**

The U.S. Department of Transportation (DOT) and the U.S. Department of Commerce (DOC) were officially 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 U.S. Department of the Interior (DOI) was invited, by the DOT and DOC, into the interagency activities described in this plan even though the DOI was not officially named as a participating agency.

The 5-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 5-year plan was submitted to Congress in 2013 and is publically available via <https://primis.phmsa.dot.gov/rd/psrcjca.htm>. This update report describes the success in implementing the plan 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 appropriated directly and officially by PSRCJCA 2011 for the purpose of funding pipeline-related research.

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## List of Acronyms

API	American Petroleum Institute
BSEE	Bureau of Safety and Environmental Enforcement
DOC	Department of Commerce
DOI	Department of the Interior
DOT	Department of Transportation
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 #1**

Fiscal Years 2012-2013

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<sup>1</sup> (PSRCJCA 2011). That plan was orchestrated by the Department of Transportation (DOT), with extensive coordination 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 #1 is one 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 dictates that all stakeholders, including the public, participate 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 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 32 individual agency and 2 interagency co-funded projects were made during this reporting period, summing to over \$10.3M 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 interagency 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

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<sup>1</sup> Pub. L No. 112-90 (Jan. 3, 2012).

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

This interagency participation will continue into fiscal years 2014 and 2015, and progress made in executing the Five-Year Interagency Research Development and Demonstration Program Plan for Pipeline Safety and Integrity will be reported in the second of two interagency update reports. 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 officially as participating agencies in Section 32 of the PSRCJCA of 2011. The Department of the Interior (DOI) was invited by DOT and DOC into the interagency activities described in the five-year plan and update reports even though DOI was not officially named as a participating agency. The DOI was invited because of its program expertise in offshore activities. Therefore, DOT, DOC, and DOI are referred to as the “participating agencies.”

Section 32 of PSRCJCA 2011 refers to Section 12, Paragraph 2, of the PSIA 2002 by stating that the consultation guidance must be followed 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 publically 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 two years after the submission of this plan as required by Section 32 of the Act.

### 1.0 Interagency Coordination and Collaboration Activities Fiscal Years 2012-2013

As stated in PSRCJCA 2011, which incorporates Paragraph 2 of Section 12 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 conducive, 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 2012 and 2013:

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

**Update:** Two interagency meetings were held to coordinate activities by all the participating agencies. The first, held on August 15, 2012, was hosted by DOI, and the second was held August 26, 2013, via conference call.

Researchers from DOC and DOI met on July 26, 2013, at the Denver Federal Center to share information about Non-Destructive Evaluation inspection technologies and to discuss opportunities for the two agencies to collaborate in the future.

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

**Update (a & b):** DOT hosted a public Pipeline Research & Development Forum on July 18-19, 2012. The meeting's information was shared with the participating agencies. Each agency reviewed the agenda and participated in one or more working groups. DOC agreed to lead Working Group #5 on Design/Materials/Welding-Joining/Valves in order to conduct a technical gap analysis and road mapping exercise relevant to these subjects. More information is provided at [https://primis.phmsa.dot.gov/rd/mtg\\_071812.htm](https://primis.phmsa.dot.gov/rd/mtg_071812.htm).

DOC hosted a Biocorrosion Workshop on July 22-23, 2013, where members discussed unique materials and chemical challenges that occur with the manufacturing, transport, and storage of alternative fuels. DOT attended this event to learn how these challenges impact pipeline transportation. More information is provided at <http://nist.gov/mml/acmd/biocorrosion.cfm>.

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:** Both DOC and DOI participated on the pre-award merit review panel for DOT Research Announcement DTPH56-13-RA-000001. This research announcement solicited topics collaboratively determined at the July 2012 Pipeline R&D Forum as noted above.

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.

**Update:** DOC called for a new research partnership with DOT during the August 2012 Interagency Coordination Meeting. 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 in July 2013. Two task orders, which involved high-strength steels and hydrogen pipelines, were immediately approved under the IA. 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. The cost sharing was listed for DOC and is part of the total from all funded projects.

Task Order #1: Characterization of Modern High Toughness Steels for Fracture Propagation and Arrest Assessment

<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=489>

Task Order #2: The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of the Heat-Affected Zones in X52 and X70 Pipelines

<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=491>

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):** DOT shared technology demonstration information with DOI in 2012. The demo, which occurred on a live natural gas Southern California Gas Company pipeline, involved new robotic inspection technology funded by DOT. DOI attended since this technology also has merit with offshore pipelines. More information on this technology is provided at <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=353>.

6. *Participation on agency post-award research peer review panels\*; and*

- 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 2012 post-award research peer review of DOT's active research projects. More information is provided at [https://primis.phmsa.dot.gov/rd/peer\\_review\\_12.htm](https://primis.phmsa.dot.gov/rd/peer_review_12.htm).

Retired DOC and retired DOI staff also participated as panelists on the 2013 post-award research peer review of DOT's active research projects. More information is provided at [https://primis.phmsa.dot.gov/rd/peer\\_review\\_13.htm](https://primis.phmsa.dot.gov/rd/peer_review_13.htm).

*\*Peer review process follows all applicable OMB Guidelines*

7. *Ensure public access to research information, results, and impacts.*

- a. Each agency will publically 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](http://www.nist.gov/mml/acmd/structural_materials/pipeline-safety.cfm)

DOI Pipeline Research: <http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research/tarprojectcategories/Pipeline-Research.aspx>

These seven activities create an environment that supports the goals of the plan.

## 2.0 Performance Metrics Fiscal Years 2012-2013

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 2012 to 2013. 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
1. Threat Prevention	4	N/A	3	7	\$1.4M
2. Leak Detection & Mitigation	6		0	6	\$2.3M
3. Anomaly Detection & Characterization	10		0	10	\$4.2M
4. Anomaly Remediation & Repair	3		0	3	\$915K
5. Design, Materials, & Welding/Joining	5	*2	2	7	**\$1.4M
6. Alternative Fuels, Climate Change, & Other	0	N/A	1	1	\$79K
<b>Total # of Projects:</b>	<b>28</b>	<b>*2</b>	<b>6</b>	<b>*34</b>	
<b>Total Funding:</b>	<b>\$9.1M</b>	<b>**\$560K</b>	<b>\$654K</b>		<b>**\$10.3M</b>
<b>Notes</b>					
* Two co-funded projects between DOT & DOC are listed but not counted under the programmatic area					

#5 shown above or in the total number of projects. See Table 7 in Appendix A for more information.  
 \*\* Includes all funding including DOT/DOC co-funding. See Table 7 in Appendix A for more information.

**Table 2: Participating Agency Quantitative Performance Metrics**

<b>Quantitative Performance Metric</b>	<b>Level of Performance</b>
Number of technology demonstrations held from all awarded research	<b>5</b>
Number of U.S. Patent applied/issued resulting from all awarded projects	<b>3</b> 8,353,317, 5,054,706 & 8,453,515
Number of commercialized technology improvements	<b>5</b> Project #1 Project #2 Project #3 Project #4 Project #5
Number of final reports made publicly available	<b>11</b>
Number of conference/journal papers based on awarded research	<b>4</b>
Number of Interagency Research Coordination Meetings held	<b>3</b>
Number of solicitations issued having Interagency Merit Review Panels	<b>1</b>
Number of post award peer review panels having Interagency Involvement	<b>2*</b>
Number of public events having Interagency Participation	<b>2</b> Event #1 Event #2
Number of stakeholders reached at public events	<b>290</b>
Number of website visits to the Interagency Research webpage	<b>132**</b>
Number of website downloads from the Interagency Research webpage	<b>13**</b>
<b>NOTES</b>	
* See Section 1 - Activity Area #6	
** Interagency Research Website visits and download tracking commenced in July 2013	

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

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.

### 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<sup>2</sup> Preventing or reducing damage to pipes by excavation and damage from outside forces during transportation might 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Onshore	Subsurface Multi-Utility Asset Location Tool	\$125,998
2.	Onshore	Real-Time Multiple Utility Detection During Pipe Installation Using Horizontal Directional Drilling System	\$512,119
3.	Onshore	Improving Quality Management Systems for Pipeline Construction Activities	\$300,000
4.	Onshore	Radio Frequency Identification (RFID) Smart Corrosion Coupon	\$99,512
5.	-Offshore-	Slug Loading and Response in Pipeline (SLARP) Joint Industry Project	\$140,000

<sup>2</sup> <http://primis.phmsa.dot.gov/comm/DamagePrevention.htm?nocache=90>

6.	-Offshore-	Freeze-up Study of the Alaskan Beaufort and Chukchi Seas	\$130,297
7.	-Offshore-	Perform a Bathymetric Survey of Grounded Ice Feature in Chukchi Sea	\$121,888
<b>Total:</b>			<b>\$1,429,824</b>

## 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 by small, hazardous-liquid pipeline leaks that 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Onshore	Smart Pipeline Network - Seal Sensor System	\$150,000
2.	Onshore	Smart Pipeline Network - Cased Pipe for Monitoring and Sensor System	\$150,000
3.	Onshore	Smart Pipeline Network - Pipe & Repair Sensor System	\$150,000
4.	Onshore	Ino Technologies Assessment of Leak Detection Systems for Hazardous Liquid Pipelines	\$513,353
5.	Onshore	Advanced Leak Detection LiDAR	\$976,462
6.	Onshore	Advanced Development and Technology Transfer of a Methane/Natural Gas Microsensor	\$412,388
<b>Total:</b>			<b>\$2,352,203</b>

### 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Onshore	Development, Field Testing and Commercialization of a Crack and Mechanical Damage Sensor for Unpiggable Natural Gas Transmission Pipelines	\$840,396
2.	Onshore	EMAT Sensor for Small Diameter and Unpiggable Pipe	\$315,000
3.	Onshore	Improve and Develop ILI Tools to Locate, Size, and Quantify Complex/Interacting Metal Loss Features	\$176,000
4.	Onshore	Utilization of a Test Facility for Qualifying Processes for Inline Inspection Technology Evaluation and Enhancements	\$796,000
5.	Onshore	Above-ground Detection Tools Including Disbondment and Metal Loss for all Metals Including Cast-Iron Graphitization	\$385,021
6.	Onshore	In-Ditch Validation Methodology for Determination of Defect Sizing	\$359,000
7.	Onshore	Permanently Installed Pipeline Monitoring Systems	\$100,000
8.	Onshore	Proactive and Hybrid Sensing based Inline Pipeline Defects Diagnosis and Prognosis	\$100,000

9.	Onshore	Advanced Nondestructive Characterization of Pipeline Materials	\$100,000
10.	Onshore	A Quantitative Non-destructive Residual Stress Assessment Tool for Pipelines	\$1,000,000
<b>Total:</b>			<b>\$4,171,417</b>

#### 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Onshore	Evaluation of Structural Liners for the Rehabilitation of Liquid and Natural Gas Piping Systems	\$425,650
2.	Onshore	Technology Transfer, Demonstrations and Post-Mortem Testing of Cast Iron and Steel Pipe Lined with Cured-in-Place Pipe Liners	\$390,166
3.	Onshore	Scaling Factors and Self-Sensing in Composite Repairs of Corrosion Defects	\$99,635
<b>Total:</b>			<b>\$915,451</b>

#### 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Onshore	Characterization of Modern High Toughness Steels for Fracture Propagation and Arrest Assessment <i>(DOT/DOC Co-funded)</i>	*\$420,000
2.	Onshore	The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of the Heat-Affected Zones in X52 and X70 Pipelines <i>(DOT/DOC Co-funded)</i>	*\$600,000
3.	Onshore	Composite Self-sensing Thermal Sprayed Coatings for Pipeline Corrosion Prevention and Mitigation	\$98,507
4.	Onshore	Mitigating External Corrosion of Pipelines Through Nano-Modified Cement-Based Coatings	\$95,032
5.	Onshore	Enhanced Mitigation of Pipeline Biocorrosion Using A Mixture of D-Amino Acids with A Biocide	\$99,999
6.	-Offshore-	Formulating Guidance on Hydrotesting Deepwater Oil and Gas Pipelines	\$80,143
7.	-Offshore-	Seabed Scour and Buried-Pipeline Deformation Due to Ice Ridges: Pipeline Stress and Deformation	\$102,837
<b>Total:</b>			<b>\$1,496,518</b>
* Includes DOT Funding & DOC In-Kind Co-Funding			

#### 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 for 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**

	<b>Application Area</b>	<b>Project Title and Project Page Hyperlink</b>	<b>Federal Funding</b>
1.	Offshore	Timeframe for Flushing and Filling Out of Service Pipelines Based on Service	\$79,150
<b>Total:</b>			\$79,150