

# United States Department of Transportation FY 2019 Annual Modal Research Plans

## Pipeline and Hazardous Materials Safety Administration (PHMSA)

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### Executive Summary

The Pipeline and Hazardous Materials Safety Administration's (PHMSA) mission is to protect people and the environment by advancing the safe transportation of energy products and other hazardous materials (hazmat) that are essential to our daily lives. PHMSA operates in a dynamic and challenging environment in which changes in technology, manufacturing, and energy production affect transportation safety. PHMSA anticipates that the scope and complexity of our safety mission will continue to grow, requiring the agency to fundamentally rethink how it uses information and technology to achieve the Department of Transportation's safety goals.

For example, pipeline energy transportation alone has increased more than 40 percent in recent years. America's pipeline infrastructure spans more than 2.8 million miles, and is used to transport nearly all the natural gas and about two-thirds of the liquid petroleum energy products consumed domestically. Furthermore, our country is developing new energy resources in areas without pipeline infrastructure, and must find ways for it to be transported safely and efficiently.

PHMSA also confronts safety challenges posed by increased transport of hazardous materials across all modes - more than 2.6 billion tons annually and more than 800,000 shipments per day. For these reasons, in December 2016, the Department established a set of research-related objectives to guide PHMSA in meeting these growing needs and fulfilling its broad safety mandate. These objectives include identifying emerging risks, developing technologies, strengthening industry consensus standards, and promoting the best safety management policy and practice.

Due to the importance of energy and hazardous materials to our economy and standard of living, research projects promoting reliability and performance of our transportation system are essential. Therefore, PHMSA funds research that improves safety, ensures reliability of supply, boosts business and government productivity, and enhances the security of our infrastructure, our people, and our environment. To advance safety, improve infrastructure, and foster innovation, PHMSA will pursue Research, Development, and Technology (RD&T) goals in Fiscal Year (FY) 2019 through a variety of projects carried out by its Office of Pipeline Safety (OPS) and the Office of Hazardous Materials Safety (OHMS).

#### Collaboration Efforts

PHMSA collaborates with outside entities and stakeholders. OPS collaboration efforts include joint research projects, in which PHMSA and outside partners pool funds to conduct research. OHMS collaboration is more consultative in nature; while PHMSA welcomes the input from stakeholders in industry, academia, and the public, it contracts for research services rather than forming joint partnerships. Both offices have an annual Research and Development (R&D) Forum to identify safety gaps and research opportunities.

OPS R&D collaboration efforts include both federal and non-federal partners. Historically, OPS reached interagency agreements with the Departments of Energy, Interior, and Commerce to conduct materials research. OPS partners with academic institutions through its Competitive Academic Agreement Program (CAAP). Under CAAP, PHMSA funds 80 percent of basic R&D costs, leaving 20 percent to be funded by university partners. (PHMSA may fund up to 100 percent of R&D costs related to regulatory analysis or other purely governmental purposes.) These levels are specified in and mandated by Section 22 of the *Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016* (PIPES Act). PHMSA expects to meet all mandated requirements for non-federal financial contributions.

### External Partners

PHMSA's research program partners with a wide range of external partners who share the same objectives in developing technology or generating and promoting new knowledge among decision makers. Collaborative forums with academia, departmental, and federal partners help identify pertinent technology and knowledge gaps. The FY 2019 high priority research projects provided are funded by PHMSA, and will be competitively solicited and awarded. Therefore, the awardee/research partners will be known once awards are decided.

### Anticipated Outcomes

PHMSA's pipeline-related research is dedicated to informing improvements in pipeline safety and performance. PHMSA anticipates that OPS research will result in commercialization of cutting edge technology, as well as the issuance of U.S. patents. In addition, as CAAP projects transition to additional phases, PHMSA will be promoting the professional development of qualified experts through both student internships and career employment. Specific research areas for FY 2019 include liquefied natural gas (LNG) facility safety, underground natural gas storage safety, leak detection, damage prevention, and pipeline anomaly detection. PHMSA will use OPS's R&D Forum—a public interactive workshop to be held in September 2018—to discuss and refine its R&D projects with a broad range of stakeholders.

PHMSA's hazmat-related research projects fall under four safety areas: improve risk management and mitigation, foster emerging technologies, promote packaging integrity, and conduct technical analysis to aid in risk assessments. Expected outcomes include better hazardous materials commodity flow data, risk models, and well-informed safety standards. PHMSA also expects that projects will advance the development of new packaging materials and technologies, as well as encourage transport safety through the integration of affordable and practical business friendly safety standards and methods.

### Economic Impact of Regulatory Reform

PHMSA's research proposals explore new technologies, assess emerging risks, strengthen industry consensus standards, and inform safety policy decision makers. This research supports the Department's regulatory reform goals by identifying opportunities for regulatory relief. PHMSA's R&D program analyzes and attempts to select forward-looking initiatives that can diminish possible rulemaking delays and build upon existing peer-supported scientific research. PHMSA's R&D program supports industry compliance with existing standards and works to identify and implement improved standards. Through this process, PHMSA R&D will support the Department's regulatory reform goals while building on PHMSA's safety mission by facilitating the development, deployment, and evaluation of safety products and systems.

### Economic Impact of Permitting Reform

PHMSA's special permits are often requested by industry because opportunities for improved efficiency can be achieved—with equivalent safety performance—using new technology or processes. The R&D program provides data, research outcomes, and technology to industry that can enhance these permitting opportunities and allow industry to improve the cost effectiveness of their regulatory compliance. Over time, as data are accumulated that further demonstrate that more efficient or cost-effective technologies present an equivalent or better level of safety, PHMSA then can incorporate these findings into subsequent deregulatory rulemakings.

### Performance Based Regulations

In some cases, PHMSA's regulatory system establishes minimum safety requirements while allowing industry to determine how best to comply. Industry has the discretion to employ techniques, processes and technologies that have been developed through the R&D program to improve their operational efficiency and find the most cost-effective method to comply with safety standards.

### Potential Impact of Asset Recycling

PHMSA research does not address this issue.

### Potential Impact of Value Capture

PHMSA research does not address this issue.

### Improving the Mobility of Freight

PHMSA's research in hazardous materials packaging serves to enhance the mobility of freight by providing designs and specifications for packages that will perform well independently of transportation mode. Developing standards that encompass all modes reduces potential bottlenecks in intermodal freight transportation. It also allows PHMSA's regulations to be harmonized with international standards, removing barriers to U.S. exports.

### Feasibility of Micro-Transit

PHMSA's initial research in Automated Vehicles (AV) will serve to identify any potential hazardous materials-related barriers to very small vehicle transportation.

### Improving Mobility for Underserved Communities

PHMSA research does not address this issue.

### Cybersecurity

PHMSA research does not address this issue

### **OST-R High Priority Projects**

OST-R has published a list of research topics in “Proposed Research Projects Addressing OST Office Interests and Needs Based on meetings with OGC, OGA, OCIO, S60, OST-P, OST-B, OST-M, OST-A, SLSDC”. [Memo, Keith Nelson, October 17, 2018]. This project addresses the needs for a coordinated Geographic Information System response in emergency situations.

In the case of DOT mobilization due to natural disasters and other national emergencies, the Office of Intelligence, Security and Emergency Response (S-60) may ask the Chief Information Office (CIO) to mobilize geospatial professionals to provide mapping and analytical support to the Department’s response efforts. The CIO’s office may be asked to provide near-real time mapping support to S-60 for situational awareness and coordinated response services. This study seeks to identify what would be necessary to provide this integrated service to S-60 and DOT -wide customers on an ongoing and continuous basis when the Crisis Management Center (CMC) is activated, particularly with respect to hazardous materials transportation.

## **New High-Priority Research Projects for FY 2019**

PHMSA pipeline research is supported through a combination of federal funding and industry co-funding with a variety of partnering organizations. OHMS research programs are entirely federally funded.

### **1. Preventing Pipeline Threats/Damage – Improved Tools to Locate Buried Pipelines in a Congested Underground**

Digging for construction poses threats to buried pipelines. For this reason, PHMSA funds the development of technologies that can locate existing buried pipes. Research in this area supports DOT's safety and infrastructure goals, by developing tools to alert pipeline operators to possible intrusions to pipelines (e.g., excavation damage), as well as how to map existing pipelines, and locate plastic pipelines. The need for such tools was identified at the 2016 Pipeline R&D Forum, where the ability to locate pipelines in congested undergrounds was identified as an immediate safety gap. These congested rights-of-way are often found in crowded metropolitan centers, where a damaged pipeline can have an enormous impact. PHMSA has conducted research in this arena with its cost-sharing partners, Operations Technology Development, NFP (not-for-profit), but is seeking other sources. Some successes have occurred in this area, however additional applications are sought.

The objective of this research is to develop technology to improve the ability to locate pipe of various ferrous and nonferrous material types in a congested subsurface. The subsurface could be soil or soil combined with other strata (e.g., concrete, concrete with rebar, and/or blacktop). Field demonstration will be a major part of the project. The project is anticipated to introduce a new or improved technology into the market in the next 2 to 4 years, depending on the maturity of the proposed technology in addressing this problem.

The project is proposed to cost \$993,970 in federal funding and will be fully funded in FY 2019 from either carryforward funds from the prior year, from FY 2019 appropriations, or a combination of both. This project will primarily address the DOT strategic goal of safety.

### **2. Improving Pipeline Leak Detection Systems – Increasing Computational Pipeline Monitoring Performance with Liquid Leaks**

Improving leak detection systems is imperative because liquid pipeline leaks, and even some ruptures, can go undetected for long periods of time and result in large releases. During the Marshall, Michigan, pipeline accident of 2010, the pipeline control room took more than 17 hours to recognize the pipeline had ruptured. This resulted in 1 million gallons of crude oil spilled into the Kalamazoo River and surrounding wetlands, with more than 1 billion dollars in total cleanup costs. Therefore, effective hazardous liquid leak detection systems persist as a technological gap to be remedied through project development. Research in this area supports the DOT goals of safety and accountability through the development of new or improved tools and technology solutions or quantifying and reducing the volume of product released into the environment. First, the project will investigate the limitations of current computational pipeline monitoring (CPM) systems as described in American Petroleum Institute Recommended Practice 1130. The scope will address a variety of factors, including instrumentation and uncertainty. The purpose is to understand constraints from pressure and/or flow calibration, alarm management, and filtering and/or prioritization. These are meant to enhance the use of machine learning to assist with alarm management and protocols that address steady state and transient conditions, and shut in pressure testing when leaks are suspected. Discussion and commentary will be included regarding how the role of pressure monitoring points along the pipeline or flow measurement along the pipeline, can aid in the project's objectives. Another purpose is the development of technology that can optimize/balance

reliability with sensitivity of the entire CPM system. Changes in technology and control room management (including human factors) will suffice. The project is anticipated to produce a new or improved technology into the market in 2 to 4 years. The project will be fully funded in FY 2019 from either carry-forward funds from the prior years, from FY 2019 appropriations, or a combination of both. Project details regarding federal funding, cost-sharing amounts, award recipients, and partnering organizations are subject to change since the project will be awarded in FY 2019. This topic aligns with the DOT Strategic goal of safety.

### 3. Development of New Packaging Materials

Accident and incident data collected by PHMSA indicate that the failure of bulk packaging is the most likely cause of death or injury from hazmat transport. Therefore, PHMSA intends to identify, test, and document the performance of new materials, which will improve the thermal and mechanical performance of bulk packaging containing hazardous materials, including railcars, road trailers, International Organization for Standardization tanks, and other bulk packages. Research in this area will inform safety standards that encourage commerce while decreasing deaths, injuries, and environmental impacts. While PHMSA is conducting collaborative research on the performance of existing cryogenic railcars with the Federal Railroad Administration (FRA), and although materials research into composites is broadly performed, research designed to identify and characterize new packaging materials will be novel, and will be solely funded by PHMSA. Once completed, this research will be widely shared with the hazardous materials, package design, and package standards industries, so that new, safer materials can be incorporated into next-generation packaging.

The project aligns with DOT's strategic goals of safety and innovation, by implementing a systematic safety approach to improve packaging and transport of hazmat, as well as by developing new packaging materials and encouraging industry to deploy them. All PHMSA research appropriations are three years in duration, allowing for higher funding obligations than appropriated in any given year using balances carried forward from previous fiscal years. A budget execution plan for FY 2019 will be drafted at the end of FY 2018, once the program can assess its current project obligations.

### 4. Improving Emergency Response Guidance

Rapid access to useful information is essential to safely and successfully responding to a hazardous materials transportation incident. PHMSA conducts outreach to first responders nationwide on safely responding to hazmat accidents and incidents, using tools such as the Emergency Response Guidebook (ERG) and its companion smartphone app, which has been downloaded nearly 1 million times. Similarly, in accordance with the Moving Ahead for Progress in the 21st Century Act (MAP-21) requirements, PHMSA previously invested \$1.5 million into HM-ACCESS—a paperless hazardous communication pilot program completed in 2016. HM-ACCESS evaluated the feasibility and effectiveness of paperless hazmat communication systems and their capability to provide a level of safety equivalent to or better than the current shipping paper requirements. While current efforts are not limited to electronic shipping papers, they are taking advantage of lessons learned for communication, equipment and device limitations, training, and costs. More can be done, however, to help facilitate timely multi-stakeholder communications and information exchange. PHMSA intends to address the technological needs of hazmat transportation stakeholders to achieve rapid, effective responses to a variety of safety and security events, by creating an integrated, flexible solution that meets the hazmat transportation sector's unique requirements.

PHMSA will develop a Safety Monitoring and Reporting Tool (HazSMART) as a proof-of-concept. HazSMART is intended to be a solution to disjointed hazmat information technologies with segregated information flows and communication silos. In its fully developed state, HazSMART will provide seamlessly integrated, real-time sharing of critical hazmat information among diverse stakeholder groups across multiple transportation modes. HazSMART will allow each stakeholder to access relevant, proximity-based information on desktop and mobile platforms, so that any safety precautions or actions can be implemented swiftly and effectively. When fully developed, HazSMART will be transferred to the private sector. The project aligns with DOT's strategic goals of safety by implementing a systematic safety approach to improve hazard communication and hazard response, as well as innovation by developing new information technology systems which can be deployed by cities, regions or states.

#### 5. Carriage of Hazardous Materials by Autonomous Vehicles

Hazardous materials have long been shipped via roads, air, rail, and sea. It is inevitable that all four modes of transportation will see the integration of both autonomous and remotely piloted vehicles. In the longer term, as highly autonomous vehicle (HAV) technologies improve, removing the human driver, pilot, engineer, or captain from the controls of a transport vehicle is expected to decrease the likelihood and cost of major incidents. However, at the current state of technological development, the use of HAV technologies to transport hazardous materials introduces new considerations and risks that may increase the chance of major incidents. Currently, PHMSA is collaborating with DOT surface modes and operating administrations to foster open dialogue and research on emerging HAV technologies. PHMSA intends to conduct research to ensure that this emerging technology is introduced safely, and ultimately delivers on the promise of lower risk of incidents, fatalities, or injuries through risk management and sufficient package integrity.

While research on the development of HAV technologies is conducted by all modes, research into the safe packaging, carriage, and transport of hazmat by HAV technology is unique to the PHMSA mission. HAV research is a new field of study for PHMSA and has had no previous funding. The objective of this research project is to identify, characterize, and quantify risks associated with using HAV technology for hazmat transport. The project aligns with DOT's strategic goals of safety and innovation by implementing a systematic safety approach to address the use of HAV technology to hazmat transport, and by developing risk management tools to properly implement the safety approach identified in the research.

#### 6. Development of Annual Hazmat Packaging and Commodity Flow Data

PHMSA is the primary regulator of hazmat packaging. Currently, PHMSA obtains information on packaging from industry, investigators, engineers, and incidents. No formal quantifiable collection exists of the types of hazmat packaging in transportation. This agreement will have the Census Bureau develop an annual survey to collect data on hazmat packaging in transportation.

This agreement will have the Census Bureau perform a literature review on hazmat packaging, develop a background data crosswalk on the costs and testing costs required for each packaging type, develop a sample, develop a collection instrument, develop an estimation technique, and develop data products. Subsequently, the Census Bureau will perform the collection on an annual basis for two years, perform quality assurance on the data, estimation, and produce a data product. This agreement will have options to extend the collection for an additional 2 years.

## High-Priority Completed Projects in 2017-2018

### 1. Comprehensive Study to Understand Longitudinal Electric Resistance Welded Seam Failures

This project was undertaken in response to the 2010 San Bruno, California, accident, which led to the National Transportation Safety Board (NTSB) recommendation PAR-09-1 addressing the safety risk of buried pipelines. The outcomes of the first two objectives of this project helped favorably close that recommendation. The project, which ended in FY 2018, integrated industry and PHMSA pipeline performance data to quantify vintage seam failure statistics with focus on low frequency electric resistance welded (ERW) seams. Additionally, it researched longitudinal ERW seam failures and on that basis, quantified the effectiveness of inspection and hydrotesting to manage integrity, and ensure safety to avoid/eliminate catastrophic failures. The project is aligned to the DOT safety strategic goal.

The project produced broad new knowledge in a summary of failure history and current practices of managing ERW seam challenges. It also ascertained the effectiveness of in-line inspection and hydrotesting in detecting seam challenges, and increased experience with predictive modeling. It improved understanding for characterizing and quantifying the resistance of ERW seams and their response to pressure, as well as the validity of predictive models of pipeline failure for such seams. It also improved understanding of the selective seam weld corrosion challenge. The project made recommendations on quantifying the susceptibility of a seam to the selective seam weld corrosion failure mechanism and developed guidelines to mitigate this mechanism. The project conducted round robin testing on several technologies to determine their ability to detect, if not measure, seam cracking in its various forms. Finally, it developed and deployed PipeAssess PI Software, which can be used to evaluate the remaining life of pipe and similar cylindrical pressure vessels with pre-existing axial crack-like defects.

Project outputs resulted in final technical reports covering a wealth of various metallurgical, engineering, statistical, and technological subjects. More than 20 public presentations were given, and findings were shown in newspapers, journal articles, webinars, and video tutorials. Thousands of project reporting downloads between 2017 and 2018 occurred. The project also supported the development of the PipeAssess PI Software, intended to improve integrity decisions. Project outcomes supported the development/refinement of the IWEX Tool; the first ever technology to detect cracking. The R&D 100 Award was granted to research partner Battelle for the PipeAssess PI Software, which played a major role in the favorable closure of the NTSB Safety Recommendation. PHMSA does not believe further research is required. Total project costs were \$4,597,858, of which PHMSA funded \$4,562,858 and \$31,980 was non-federal leveraged funding. Please visit <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=390> for more information and project reporting.

### 2. Lithium Battery Safety

The safe transport of lithium batteries has been an ongoing concern for PHMSA and other Operating Administrations of the Department. Lithium batteries pose unique challenges because, unlike other hazardous materials, they contain both a chemical and an electrical hazard. This combination of hazards, when involved in a fire encompassing significant quantities of lithium batteries, poses challenges related to thermal runaway and toxic inhalation hazards, and has previously exceeded the fire suppression capabilities of aircraft, leading to catastrophic airframe failure resulting in fatalities.



For this reason, PHMSA entered into research agreements with the Naval Research Laboratory (NRL) and the Naval Surface Warfare Center Carderock (NSWCC). NRL research focused on the identification of trigger mechanisms of lithium-ion battery cell failure related to the formation of internal short circuits caused by lithium dendrites (also known as thermal runaway). NSWCC performed research into large format batteries, internal short circuit mechanisms, and failure analysis. Projects aligned with DOT's strategic goals of safety by implementing a systematic safety approach to analyze and mitigate the risks associated with the transport of lithium batteries, as well as innovation by developing risk management tools and new packaging materials and configurations to address these risks. The multiyear projects were extremely successful. Highlights included the assessment of current air transport regulations limiting lithium-ion battery quantities to 35 kg per package (for cargo aircraft). The project identified when criteria for conducting shock testing on large format batteries become unrealistic in a transportation environment. Additional accomplishments include:

- Evaluating existing early failure detection devices for transportation applications;
- Improving understanding of lithium battery failure mechanisms, such as internal short and over-discharge, and the physical interaction of dendrite and polymer separators, which can mitigate lithium battery internal short-circuits;
- Developing testing protocols that enhance, initiate, or simulate the internal shorting caused by lithium dendrites; and
- Identifying and assessing factors that contribute to battery failure in transport through abuse testing (specific abuse tests included high temperature abuse, overcharge, over-discharge, and short circuit).

Research outcomes included guidance for shippers and manufacturers on lithium battery transportation safety (short circuit causes, new packaging, etc.), as well as testing protocols to enhance, initiate, or simulate the internal shorting caused by lithium dendrites. The project identified next-generation battery and packaging materials for cylindrical cells and shipping containers and developed a lithium battery health-monitoring device to anticipate issues with battery shipments without affecting packaging capacity and weight (i.e., the battery tester which can be used to test the health of batteries in transport).

PHMSA is not planning follow-on research for this project in FY 2019. Over the past three years, PHMSA has invested \$1,500,000 on lithium battery research. This research was entirely federally funded.

### **3. Crude Oil Characteristics Research Study**

The Crude Oil Characteristics Research Study (Sandia Study) is a congressionally mandated effort in response to a train derailment resulting in large scale explosions and crude oil releases. The Study is being performed by Sandia National Laboratories (a Department of Energy facility), co-sponsored by DOE and DOT with in-kind contribution from Transport Canada. The study determines whether unconventional crude oil (Bakken, shale oil) presents a measurably higher level of hazard in transportation compared to conventional crude oil by recreating explosions in a controlled environment.

## FY 2019 RD&T Program Funding Details

RD&T Program Name	FY 2019 Annualized CR (\$000)	FY 2019 Basic (\$000)	FY 2019 Applied (\$000)	FY 2019 Development (\$000)	FY 2019 Technology (\$000)
<b>Pipeline Safety</b>	<b>\$16,363</b>			<b>\$16,363</b>	
Anomaly Detection and Characterization	1,700			1,700	
Leak Detection	1,500			1,500	
Threat Prevention	4,000			4,000	
Repair/Rehabilitation	1,300			1,300	
Liquefied Natural Gas	2,500			2,500	
Underground Storage	2,000			2,000	
Competitive Academic Agreement Program	2,000			2,000	
Administrative Expenses	1,363			1,363	
<b>Hazmat Safety</b>	<b>\$8,116</b>		<b>\$8,116</b>		
Risk Management and Mitigation	900		900		
Emerging Technology	2,670		2,670		
Packaging Integrity	2,000		2,000		
Technical Analysis to Aid Risk Assessments	2,000		2,000		
Administrative Expenses	546		546		
<b>Total PHMSA R&amp;D</b>	<b>\$24,479</b>		<b>\$8,116</b>	<b>\$16,363</b>	

## FY 2019 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2019 Annualized CR (\$000)	SAFETY (\$000)	INFRASTRUCTURE (\$000)	INNOVATION (\$000)	ACCOUNTABILITY (\$000)
<b>Pipeline Safety</b>	<b>\$16,363</b>	<b>\$6,134</b>	<b>\$993</b>		<b>\$5,236</b>
Anomaly Detection and Characterization	1,700	1,063			637
Leak Detection	1,500	340			1,160
Threat Prevention	4,000	3,000			1,000
Repair/Rehabilitation	1,300		575		725
Liquefied Natural Gas	2,500	2,500			
Underground Storage	2,000	2,000			
Competitive Academic Agreement Program	2,000	750			1,250
Administrative Expenses	1,363	481	418		464
<b>Hazmat Safety</b>	<b>\$8,116</b>	<b>\$6,087</b>		<b>\$2,029</b>	
Risk Management and Mitigation	900	900			
Emerging Technology	2,670	777		1,893	
Packaging Integrity	2,000	2,000			
Technical Analysis to Aid Risk Assessments	2,000	2,000			
Administrative Expenses	546	410		136	
<b>Total PHMSA R&amp;D</b>	<b>\$24,479</b>	<b>\$16,221</b>	<b>\$993</b>	<b>\$2,029</b>	<b>\$5,236</b>

## Section 1 – FY 2019 Program Descriptions

### Pipeline Safety Funding Request (\$16,363,000)

#### Program Description/Activities

The Pipeline Safety RD&T Program submits future budget requests at the program level, meaning that some requested information cannot be exactly identified and will be estimated. Activities designed to prevent pipeline damage will develop tools to alert pipeline operators to possible intrusions to pipelines (e.g. excavation damage), as well as develop techniques for mapping existing pipelines and enabling plastic pipelines to be intrinsically locatable. Further opportunities in this subprogram will investigate high altitude imaging, machine learning, and predictive analytics to mitigate third-party damage, as well as other external threats to our Nation's pipeline infrastructure. To improve pipeline leak detection systems, activities will develop new or improved tools and technology solutions for quantifying and reducing the volume of product released into the environment. Further opportunities in this subprogram will focus on identifying leaks before they lead to catastrophic ruptures. Improving anomaly detection and characterization activities will support the integrity verification process proposed in current PHMSA rulemakings. This subprogram, authorized by PHMSA Rulemaking Docket No. 20011-0023, will support efforts to identify interacting threats within pipelines, and give operators the most sophisticated instrumentation possible to allow for accurate remediation measures.

To improve anomaly remediation and pipe repair and replacement options, activities will seek to bring automated technologies to market and to refine standards and best practices for operators and contractors. Further opportunities in this subprogram area will investigate cured-in-place liners as a rehabilitation method for cast iron systems, providing operators with another viable option for urban replacement programs. Activities devoted to improving safety systems for underground gas storage (UGS) will refine integrity requirements for UGS, supporting the prevention of incidents such as the 2015 Aliso Canyon gas storage well release of over 5 billion cubic feet of methane. These activities support improvements to safe operations and will reduce environmental impact due to uncontrolled releases. Activities devoted to improving safety systems for LNG facilities will examine standards incorporated into the Code of Federal Regulations for LNG, performance gap analysis, and examined quantitative risk assessment methodologies, so that they can keep pace with the growing energy export market. Further opportunities in this subprogram area will address the reduction of risk at every type of facility during operations, maintenance, and transfer, purging, startup, and shutdown activities. The CAAP will potentially address research in subprograms which show promise, to promote future commercialization.

#### Statutory Requirements

This research program is mandated in Section 12 of the *Pipeline Safety Improvement Act of 2002* (Public Law No. 107-3552002) and further reauthorized via Section 22 of the *Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016* (Public Law No: 114-183). In accordance with these statutes, research will play a large role in addressing and mitigating risks associated with the international and domestic transportation of natural gas and hazardous liquids by pipeline. Research programs conducted also support the mandate for R&D found in the *Fixing America's Surface Transportation Act of 2015*, or the FAST Act (Public Law No. 114-9). Section 6014 of the FAST Act authorizes PHMSA to conduct research activities including, but not limited to:

- Emergency planning and response, including information and programs that can be readily assessed and implemented in local jurisdictions;
- Risk analysis, perception, and data assessment;
- Commodity flow data, including voluntary collaboration between shippers and first responders, for secure data exchange of critical information;
- Integration of safety and security;
- Cargo packaging and handling;
- Hazmat release consequences; and
- Materials and equipment testing.

**Program Alignment with Strategic Goals**

<b>DOT Strategic Goal</b>	<b>DOT RD&amp;T Critical Transportation Topic</b>
Safety Infrastructure Accountability	Promoting Safety Improving Infrastructure Preserving the Environment

The Pipeline Safety Research Program (PSRP) will advance the safe transportation of energy and other hazardous materials essential to our daily lives by conducting research supporting safety, infrastructure and accountability. Impacts from this work address both national and local challenges in urban and rural communities. The PSRP will improve the durability and extend the life of transportation infrastructure by conducting research that will enhance repair materials, techniques, processes, tools, and/or technology designed to quickly bring pipeline systems back online. Research will address ways to improve the repair process by bringing automation to market, and by improving standards or best practices for operators and contractors. The PSRP is mitigating environmental impacts of energy transportation and storage activities by conducting research that will develop new or improved tools and/or technology solutions designed to reduce the volume of product released into the environment.

**Program Objectives**

Damage to pipe by excavation and outside force continues to be a leading cause of pipeline failures. Preventing or reducing damage would dramatically improve pipeline safety. PHMSA’s intended research will develop new or improved tools and technology to aid in the prevention and reduction of damage to pipelines, thereby preventing or diminishing releases into the environment. Leak detection continues to present a challenge, particularly in pipelines with very small liquid leaks. Ecological and drinking water resources can be affected by pipelines with even small hazardous liquid leaks, which are not quickly or easily detected. Research will develop monitoring systems capable of detecting small releases, small-leak detection sensors, aerial surveillance technologies such as drones, improvements in cost and effectiveness of current leak-detection systems, and related satellite imaging capabilities. The detection and characterization of anomalies in pipeline systems require solutions that integrate people, processes, and technology into a comprehensive program. Detection capability must progress past simple corrosion to complex anomalies involving a mixture of dents, gouges, and corrosion. Research will also develop new or improved tools, technology, and assessment processes to identify and locate critical pipeline defects and to improve characterization of their severity. Damaged coatings and corrosion damage can be major problems for pipelines; reliable methods for repairing these issues and bringing pipeline systems back online are of paramount importance. This program will result in enhanced repair materials, techniques, processes, tools, and/or technology designed to directly support this objective. The energy resurgence requires the LNG industry to rapidly adapt to becoming exporters, and regulators such as PHMSA must

step up efforts to provide clear regulatory guidance within the changing energy landscape. Research will support a wide range of safety system testing, quantitative risk assessments, and various hazard mitigation models for both large and small LNG facilities.

After the 2015 Aliso Canyon Gas Storage Field leak, Congress provided PHMSA with significant new statutory authorities to regulate underground natural gas storage. Integrity management programs will be required for the more than 17,000 wells across 400 interstate and intrastate underground natural gas storage facilities estimated to be operating in the United States as of January 18, 2017. Research will focus on risk assessments, well-casing strength evaluations, subsurface safety valve testing and analysis, and investigations into equipment monitoring at both the subsurface and the facility level. The CAAP intends to spur innovation by enabling an academic research focus on high risk and high reward solutions for the many pipeline safety challenges. The CAAP will also expose undergraduate, graduate, and doctoral research students to common pipeline safety challenges and illustrate how their engineering or technical discipline is highly desired and needed in the pipeline field.

### **Research Collaboration Partners**

PHMSA periodically sponsors Pipeline and HazMat R&D Forums to conduct technical gap analysis and research topic road mapping with hundreds of public and private stakeholders that share the same objectives in developing technology or generating and promoting new knowledge among decision makers. These stakeholders identify technology and knowledge gaps within our subprogram areas, which are then incorporated into PHMSA pipeline research solicitations. This process allows PHMSA to focus on technology and knowledge gaps, as well as avoid duplicating efforts from other public or private funding entities. This process creates stakeholder-based justifications for federal investment in nationally recognized pipeline safety challenges. An example of a prior forum can be found in the PRIMIS database, at <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=234>. PHMSA anticipates holding the next Pipeline and HazMat R&D Forum in September 2018. PHMSA also coordinates with other DOT Operating Administrations to identify partnerships of mutual interest through monthly department research meetings.

Congress has directed PHMSA to co-fund research with such groups via Section 22 of the *Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016*. These partnerships provide clear opportunities to leverage prior or ongoing successes, co-fund research on mutual challenges, and remove duplication. Trade associations and the pipeline industry are briefed throughout the year on the research program and are consulted on individual projects (if not already involved via co-funding) when the project is in their sphere of expertise. A list of research collaboration partners, including many government and non-government partners who co-fund research with PHMSA, is provided below.

- American Gas Association
- American Petroleum Institute
- American Public Gas Association
- American Society of Mechanical Engineers
- Association of Oil Pipe Lines
- California Energy Commission
- Department of Agriculture
- Department of Commerce: National Institute of Standards and Technology

- Department of Energy
- Department of the Interior: Bureau of Safety and Environmental Enforcement
- Environmental Protection Agency
- Interstate Natural Gas Association of America
- NACE International
- National Association of Pipeline Safety Representatives
- National Energy Board of Canada
- Northeast Gas Association/NYSEARCH
- Operations Technology Development

## **Acquisition/Assistance**

PHMSA's Pipeline Safety Research Program continues to utilize a competitive procurement process to manage the pre-award activities leading up to new project awards. Solicitations are publicly announced in either [FBO.gov](https://www.fbo.gov) or [Grants.gov](https://www.grants.gov). A Merit Review Panel (MRP) reviews proposals and applications received using focused review criteria to find the best researchers for each project. The MRP is comprised of representatives from PHMSA, other federal and state agencies, and representatives from the hazardous liquid, natural gas transmission, and natural gas distribution industries. These stakeholders help PHMSA leverage successes and remove duplication when compiling a list of award recommendations. An MRP typically reviews several dozen submitted white papers and proposals, and recommends 15-20 new project awards. The full solicitation and award lifecycle can take the better part of a calendar year.

R&D appropriations have a three-year period of availability. PHMSA's OPS research typically also leverages outside funding. Typically, approximately 30 percent of funding for a given project is from non-federal entities—20 percent in the case of CAAP partnerships with universities—although PHMSA may fund up to 100 percent of the cost of R&D for purely governmental purposes.

## **Technology Transfer (T2)**

PHMSA seeks to promote the use of technology from its R&D programs in commercial applications, and therefore tracks a variety of research performance measures. PHMSA's policy is to plan for and continually track T2 activities, when possible following-up even in cases where activities occur beyond the contractual timeline of research projects. Final-end users and technology service providers cannot be fully identified until after projects are awarded and T2 occurs. For this reason, PHMSA includes several contractual stipulations in its agreements with research partners to best promote and track the transfer of technology to the market. The three rules below are intended to improve the chances of success with transferring research results into the market.

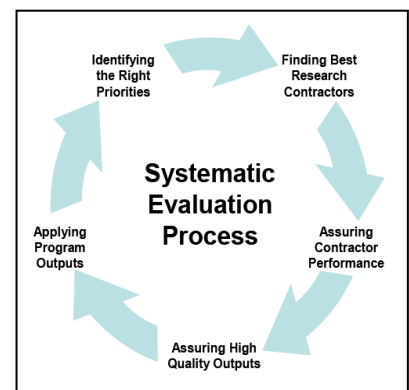
- Plan for technology transfer while identifying research priorities.
- Involve end users (i.e., regulators, pipeline operators, and service providers) in the research gap analysis and road mapping activities.
- Gauge a technology's readiness using demonstrations in front of potential service providers and other end-users.

In each contract, PHMSA mandates several actions that the researcher must take to promote project results. This is our approach for all PHMSA R&D awards. Mandated actions include promoting commercialization at the end of the contract. For example, demonstrating a technology in front of

vendors who may seek to commercialize it for use in the pipeline industry is encouraged. In some cases, this commercialization happens long after the end of the contract, limiting PHMSA’s ability to observe and track it. PHMSA ensures that awarded research is promoted to decision makers, by contractually obliging awardees to:

- Submit results to a peer reviewed public conferences, forums, symposiums, workshops, or trade journals;
- Report any application for a U.S. patent;
- Conduct an output-focused final meeting via a webinar or in person with invited decision makers and stakeholders;
- Collaborate at public events, such as R&D Forums and workshops, where ongoing work or results are presented;
- Participate in annual R&D Peer Reviews, where knowledge of research is reviewed and promoted; and
- Post project progress reports and results on PHMSA's Pipeline Safety R&D website.

In addition, pipeline research has public project pages filed under the PHMSA research program website, as well as the USDOT Research Hub and NTL Digital Library. PHMSA is tracking the utilization of final reporting and net improvement. Contractual requirements are supported by a five-step process, depicted in Figure 1 to the right. This process was developed by conducting program logic modeling, which systematically considers the transfer of research results to identified end-users (i.e., regulators, pipeline operators, service providers, standard-developing organizations, and the public). This process governs program execution and considers technology transfer objectives in each step. T2 performance metrics are captured as part of the overall program performance metrics, and are reported in real time on the program webpage: <https://www.phmsa.dot.gov/research-and-development/pipeline/program-performance>. This supports responding to the Annual T2 Performance data calls managed by the Office of the Assistant Secretary for Research and Technology (OST-R).



**Figure 1**

**Evaluation Performance Measurement**

PHMSA manages the planning, implementation, and reporting of the R&D projects. PHMSA employs close relationships with research partners throughout a project to ensure that it remains on track and is achieving its intended results. Tasks are put in place to ensure contractor results align with DOT strategic goals. These have been tracked since 2002, which is the modern inception of the program via Public Law No. 107-3552002. These are then presented as relevant to the *DOT Strategic Plan, Annual Performance Plan*, or any Program Evaluation requested of this program. The number of projects that develop and demonstrate new technology helps the program assess how many U.S. patent applications have occurred as a result. To promote knowledge for use by decision makers, publicly available final reports are given, along with conference and journal papers, websites, downloaded files. The number of stakeholders reached via public events is also recorded.

PHMSA’s observable strategic plan objectives are unlikely to be directly affected by the outcomes of the R&D activity in any year. While we promote safety with our research, commercialization of technology is a long process, and is often not directly observable. PHMSA program managers use project management best practices to track and evaluate project progress towards defined objectives/outcome

goals, ensure agreed to milestones and commitments with planning documents are on track, monitor/control program risk, and monitor program funds to ensure they are expended in a timely manner. Additionally, they evaluate projects with respect to research needs, considering key aspects such as timeframes for when results are needed, alignment to the DOT strategic goals, likelihood of achieving expected benefits, criticality, risk, interdependencies, and available funding. Program managers incorporate results of completed projects into concept planning during periodic evaluations of concept status and progress.



## Hazardous Materials Safety

### Funding Request (\$8,116,000)

#### Program Description/Activities

R&D supports PHMSA's goal of safe transport of hazardous materials. While 1,200,000 safe hazardous materials shipments occur daily, incidents resulting in loss of life and environmental damage still occur. In FY 2019, PHMSA intends to continue research in the areas of risk management and mitigation, package integrity, emerging technologies, and technical analysis to aid risk assessments.

**Risk management and mitigation research** informs efforts to minimize the probability of hazmat transport incidents and associated consequences. Specific projects in this strategic area include identification and development of risk management methods to assess hazmat transport, as well as identification of communication tools and best practices to ensure results are communicated to the transport industry.

PHMSA research also focuses on **packaging integrity** (i.e., ensuring hazmat remains contained within its packaging during transport). Research in this strategic area evaluates and verifies the suitability and effectiveness of packaging standards and practices and improves transport safety by developing, evaluating, and testing new packaging technologies and materials. Specific research areas will include testing and evaluation of existing packaging materials and packaging technologies; analysis, evaluation, and performance evaluation of emerging packaging materials and methods; and evaluation of component materials of combination packaging.

PHMSA research informs safety standards and policy related to **emerging risks and technologies**. Emerging technology includes new energy sources, transport systems, and packaging technologies. Research analyzes transport of emerging materials (lithium products, Liquefied Natural Gas, different varieties of crude), processes, packaging technologies, and transport operations. PHMSA hazmat research on emerging technologies and materials will focus on analysis of emerging energy products, including various grades of crude oil and liquefied natural gas; analysis of new packaging materials and technologies; analysis of transportation systems and operations; and international collaborative research to improve export of U.S. energy products.

Lastly, PHMSA research focuses on technical analysis to aid **risk assessments**. Change is a constant in both the hazmat and transportation industries. The risk assessments, conceptual models and frameworks, and the evaluation methods used to evaluate activities, events, and incidents must adapt constantly to keep pace. Research strives to inform options to prevent fatalities and injuries resulting from hazmat transportation incidents. Planned research activities include analysis of individual incidents and accidents involving hazmat to determine root cause; determine patterns or anomalies within packaging or systems; and develop new inspection and test methods to classify materials and certify packaging.

#### Statutory Requirements

The research programs conducted by PHMSA support the mandate for R&D found in the *Fixing America's Surface Transportation Act of 2015*, or the FAST Act. Section 6014 of the FAST Act authorizes PHMSA to conduct research activities including, but not limited to, emergency planning and response (including information and programs that can be readily assessed and implemented in local

jurisdictions); risk analysis, perception, and data assessment; commodity flow data (including voluntary collaboration between shippers and first responders for secure data exchange of critical information); integration of safety and security; cargo packaging and handling; hazmat release consequences; and materials and equipment testing.

Research plays a large role in finding the technical solutions to national, regional, and local hazmat safety and environmental challenges.

**Program Alignment with Strategic Goals**

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety Innovation	Promoting safety Improving mobility

PHMSA’s hazardous materials research program solves complex problems in the packaging and movement of hazardous materials. This includes identification of best practices regarding hazmat transportation (e.g., better classification of the most dangerous products), development of new packaging materials and methods to contain such products, and conducting engineering and scientific analysis to reduce regulatory burdens. The program funds multi-modal programs supporting improved packaging and equipment designs that improve performance of highway transport vehicles, rail cars, airplane cargo holds, and vessels used to transport hazmat. It places significant emphasis on innovative ways to facilitate efficiency of commerce, while enhancing safety.

**Program Objectives**

PHMSA’s hazardous materials research Risk Management Program’s goal is to improve public safety and protect the environment by identifying transport risks and developing mitigation strategies. Risk reduction strategies are designed to lower transport-related injuries and fatalities, increase packaging and operational safety, and improve system reliability. Specific outcomes for projects funded under the initiative include: improving transport safety through development and application of new risk models and methodologies; using data analytics in hazmat transport research; raising public confidence in regulatory agencies by incorporating stakeholder feedback; fostering transportation industry innovation; supporting the development of national and international transport and packaging standards; and identifying industry best practices and publicizing lessons learned.

The PHMSA Emerging Technology Program’s intended outcomes are designed to improve public safety and protect the environment by developing new packaging materials and new transport systems. This risk reduction strategy is designed to lower the probability of hazmat transport incidents or accidents, and lower the consequences of such incidents and accidents through enhanced containment of hazmat. Outcomes for projects funded under the initiative will demonstrate the feasibility of innovative transport systems and technologies to improve the safety of hazmat transport, share PHMSA’s successes with its modal and industry partners, and advance the development of new packaging materials and technologies to improve package performance. Lastly, it supports the improvement of packaging safety standards, the development of hazmat transport best practices, and the documentation of lessons learned in safety operations.

The PHMSA Packaging Integrity Program’s intended outcomes are designed to improve public safety and protect the environment by improving bulk and non-bulk packaging designs, packaging standards, and

packaging performance test requirements. Improved package design and performance testing will lower transportation-related injuries and fatalities and better protect the environment because they will contain materials better, making them easier to handle and transport. Outcomes for projects funded under the initiative will decrease transportation accidents and incidents by improving packaging integrity, thereby enhancing a package's ability to contain its contents during hazmat-transportation incidents and accidents. This program will decrease deaths and serious injuries resulting from package failure or improper use of packages, as well as improve safety, by promoting better understanding packaging performance. Lastly, it will decrease accidents and incidents caused by human error by improving and simplifying operating and handling instructions.

The PHMSA Technical Assessment Program's intended outcomes are to improve public safety and protect the environment by using data analytics, accident analysis, failure modelling, and newly developed risk-management methodologies and strategies to lower accident rates and decrease material releases. Projects funded under the initiative will provide the hazmat transportation community with the means to improve safety by applying the preventative and corrective measures that result from the modeling, research, and analysis of transport accidents and incidents. Projects will also provide transport community with the means to take advantage of technology and integrate affordable and sustainable technology solutions that improve transport safety. Lastly, projects will increase effectiveness and efficiency of hazmat transportation by identifying processes and methods that support continuous improvement in transportation industry, safety management, and regulatory development.

### **Research Collaboration Partners**

PHMSA periodically sponsors R&D Forums to generate the most promising research ideas and proposals through discussion with public and private stakeholders. These stakeholders identify technology and knowledge gaps within our strategic areas, which are then incorporated into PHMSA's hazmat research needs statements. This process allows PHMSA to focus on actual technology and knowledge gaps and avoid duplicating the efforts of other public or private funding entities. This process creates stakeholder-based justifications for federal investment in nationally recognized hazmat safety challenges. The most recent R&D Forum took place in May 2018.

PHMSA coordinates with other DOT Operating Administrations to identify mutually beneficial partnerships through monthly department research meetings, as well as meetings between PHMSA and individual modes. Such partnerships clear opportunities to leverage prior or ongoing successes and co-funding research on mutual challenges. Modal authorities (FRA, Federal Aviation Administration, Federal Motor Carrier Safety Administration, and the U.S. Coast Guard) are consulted and briefed on the overall research program and on projects involving their specific mode. This coordination allows PHMSA to eliminate duplication, as well as helping to illuminate whether the government should lead in a specific area or defer to industry. PHMSA receives support in conducting and verifying safety gap analyses and developing programs to address gaps. PHMSA also provides feedback on research and program plans through the Transportation Research Board's Hazardous Materials Cooperative Research Program. PHMSA also solicits research needs statements and enters into agreements with federal entities including Volpe National Transportation Systems Center, Argonne National Laboratory, Sandia National Laboratory, National Institute of Standards and Technology, and the Transportation Research Board. PHMSA also coordinates with international regulatory entities including the United Nations, International Maritime Organization, International Civil Aviation Organization and the International Atomic Energy Agency. The list below provides additional external entities with which PHMSA has partnered, and which are options for future projects in FY19:

- Association of American Railroads
- American Chemistry Council
- American Fuel and Petrochemical Manufacturers
- American Pyrotechnic Association
- American Petroleum Institute
- American Short line and Regional Railroad Association
- American Trucking Associations
- Compressed Gas Association
- Chlorine Institute, Inc.
- Council on Safe Transportation of Hazardous Articles
- Commercial Vehicle Safety Alliance
- Dangerous Goods Advisory Council
- Institute of Makers of Explosives
- Industrial Packaging Alliance of North America
- National Association of Chemical Distributors
- National Industrial Transportation League
- National Propane Gas Association
- National Tank Truck Carriers
- Rechargeable Battery Association
- Reusable Industrial Packaging Association
- Railway Supply Institute
- Fertilizer Institute
- Sulphur Institute
- US Census Bureau

### **Acquisition/Assistance**

PHMSA's Hazmat Safety Research Program has historically used a competitive procurement process to manage the pre-award activities leading up to new project awards, and intends to continue doing so. Solicitations are publicly announced on the FedBizOpps website. PHMSA review panels use focused evaluation criteria to find the best researchers for each project. Review panels comprise subject matter experts for each strategic area, from both PHMSA and other federal agencies. Research appropriations have a three-year period of availability, allowing for focused stakeholder and end-user engagement. This review process typically begins with 75 to 100 white papers and proposals being submitted, and from these, the review panels select approximately 15 new projects for funding annually. This program execution can take just over one calendar year, leading to an acquisition frequency that is not consistent over a multi-year period.

### **Technology Transfer (T2)**

PHMSA seeks to promote the use of technology from its R&D programs in commercial applications, and therefore tracks a variety of research performance measures. PHMSA's policy is to plan for and continually track T2 activities, when possible following-up even in cases where activities occur beyond the contractual timeline of research projects. Final-end users and technology service providers cannot be fully identified until after projects are awarded and T2 occurs. For this reason, PHMSA includes several contract stipulations in its agreements with research partners to best promote and track the transfer of technology to the market. The three rules below are intended to improve the chances of success with transferring research results into the market.

- Plan for technology transfer while identifying research priorities.
- Involve end users (i.e., regulators, pipeline operators, and service providers) in the research gap analysis and road mapping activities.
- Gauge a technology's readiness using demonstrations in front of potential service providers and other end-users.

In each contract, PHMSA mandates several actions that the researcher must take to promote project results. This is our approach for all PHMSA R&D awards. Mandated actions include promoting commercialization at the end of the contract. For example, demonstrating a technology in front of vendors who may seek to commercialize it for use in the hazmat transport industry is encouraged. In some cases, this commercialization happens long after the end of the contract, limiting PHMSA's ability to observe and track it. PHMSA ensures that awarded research is promoted to decision makers, by contractually obliging awardees to:

- Submit results to peer reviewed public conferences, forums, symposiums, workshops, or trade journals;
- Report any application for a U.S. patent;
- Conduct an outcome-focused final meeting via a webinar or in person with invited decision makers and stakeholders;
- Collaborate at public events, such as R&D Forums and workshops, where ongoing work or results are presented;

In addition, hazmat research has public project pages filed under the USDOT Research Hub and NTL Digital Library.

### **Evaluation/Performance Measurement**

As the number of projects funded and level of individual project funding varies from year to year, establishing future performance targets such as the level of tech transfer, number of technology demonstrations, and patent activity is not an exact science. In addition, the funding and timeline of research projects are modified in response to development challenges or to expand the scope of promising research. For example, technology demonstrations to commercializing vendors may pick up the technology and offer it to the hazmat transportation industry. If these modifications occur after such a snapshot estimate, it presents difficulties in tracking achievement of program targets. The same holds true for commercialization of R&D projects. Often technology is not commercialized at the end of the project timeline. It may take years for this to happen to attempt to capture this data, PHMSA conducts an annual survey on post-completion technology development to inquire whether project technology was commercialized. The program is developing performance measurement tracking tools for R&D and T2 and intends to incorporate them on the PHMSA program website. These tracking tools will also be presented as relevant to the *DOT Strategic Plan*, *PHMSA Strategic Plan*, *Annual Performance Plan*, or any data call requested of this program.

## Section 2 - FY 2020 Program Descriptions

### Pipeline Safety Funding Request (\$16,363,000)

#### Program Description/Activities

PHMSA Pipeline Safety RD&T submits its fiscal budget requests at the program level. It intends to hold an R&D Forum in September 2018. For this reason, it is not yet feasible to fully elaborate our research strategy for FY 2020. However, it is likely that the FY 2019 subprograms will remain in place, with changes in nuance and emphasis based on challenges and opportunities encountered. In addition, not having the FY 2020 Administration budget target also impedes the ability to predict future subprogram priorities. We will continue to use the R&D Forum to focus on technology and knowledge gaps and avoid duplicating efforts from other public or private funding entities, thereby creating stakeholder-based justifications for federal investment in nationally recognized pipeline safety challenges and providing key input on technical attributes of the research that should be solicited.

#### Program Alignment with Strategic Goals

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety Infrastructure Accountability	Promoting Safety Improving Infrastructure Preserving the Environment

The Pipeline Safety Research Program (PSRP) will advance the safe transportation of energy and other hazardous materials essential to our daily lives by conducting research supporting safety, infrastructure and accountability. Impacts from this work address both national and local challenges in urban and rural communities. The PSRP will improve the durability and extend the life of transportation infrastructure by conducting research that will enhance repair materials, techniques, processes, tools, and/or technology designed to quickly bring pipeline systems back online. Research will address ways to improve the repair process by bringing automation to market, and by improving standards or best practices for operators and contractors. The PSRP is mitigating environmental impacts from transportation or energy storage activities by conducting research that will develop new or improved tools and/or technology solutions designed to reduce the volume of product released into the environment. This research program is mandated in Section 12 of the *Pipeline Safety Improvement Act of 2002* (Public Law No. 107-3552002), which was reauthorized most recently in Section 22 of the *Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016* (Public Law No: 114-183).

**Hazardous Materials Safety  
Funding Request (\$8,116,000)**

**Program Description/Activities**

R&D plays a vital role in helping PHMSA achieve its goal of enhancing the safe transport of hazardous materials. While hazardous materials are transported daily by trained professionals operating in well-defined systems, accidents resulting in loss of life and environmental damage still occur. In FY 2019, PHMSA intends to continue its focus on research efforts within the core areas of risk management and mitigation, package integrity, emerging technologies, and technical analysis to aid risk assessments.

Risk management and mitigation research aims to minimize the probability of hazmat transport incidents and associated consequences. Specific projects in this strategic area include identification and development of risk management methods to assess hazmat transport, as well as identification of communication tools and best practices to ensure results are communicated to the transport industry.

PHMSA research also focuses on packaging integrity (i.e., ensuring hazmat remains contained within its packaging during transport). Accordingly, R&D efforts in this strategic area are designed to evaluate and verify the suitability and effectiveness of packaging standards and practices and improving transport safety by developing, evaluating, and testing new packaging technologies and materials. Specific research areas will include testing and evaluation of existing packaging materials and packaging technologies; analysis, evaluation, and performance evaluation of emerging packaging materials and methods; and evaluation of component materials of combination packaging.

PHMSA research also focuses on understanding and promoting emerging technologies. Transport of emerging technology expands proportionally to the increase in U.S. production efforts. This expansion includes both new energy sources, transport systems and packaging technologies. Research is designed to identify and analyze emerging materials, processes, packaging technologies, and transport operations, as well as to assess their potential risks or benefits to the existing hazmat transport network. PHMSA hazmat research on emerging technologies and materials will focus on analysis of emerging energy products, including various grades of crude oil and liquefied natural gas; analysis of new packaging materials and technologies; analysis of transportation systems and operations; and international collaborative research to improve export of U.S. energy products.

Lastly, PHMSA research focuses on technical analysis to aid risk assessments. Change is a constant in both the hazmat and transportation industries. The risk assessments, conceptual models and frameworks, and the evaluation methods PHMSA uses to evaluate activities, events, and incidents must adapt constantly to keep pace. Research strives to identify options to prevent fatalities and injuries resulting from hazmat transportation incidents. Planned research activities include analysis of individual incidents and accidents involving hazmat to determine root cause; determine patterns or anomalies within packaging or systems; and develop new inspection and test methods to classify materials and certify packaging.

**Program Alignment with Strategic Goals**

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
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Safety Innovation	Promoting safety Preserving the environment
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The PHMSA R&D program’s mission is designed to solve complex problems in the packaging and movement of hazardous materials. This includes identification of best practices regarding hazmat transportation (e.g., better classification of the most dangerous products), development of new packaging materials and methods to contain such products, and conducting engineering and scientific analysis to reduce regulatory burdens. The program funds multi-modal programs supporting improved packaging and equipment designs that improve performance of highway transport vehicles, rail cars, airplane cargo holds, and vessels used to transport hazmat. It places significant emphasis on innovative ways to facilitate efficiency of commerce, while enhancing safety.