

United States Department of Transportation Annual Modal Research Plans Fiscal Year 2018

PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION

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Executive Summary

The Pipeline and Hazardous Materials Safety Administration (PHMSA) operates in a dynamic and challenging environment in which changes in technology, manufacturing, and energy production impact transportation safety. PHMSA's mission is to protect people and the environment by advancing the safe transportation of energy products and other hazardous materials that are essential to our daily lives.

PHMSA anticipates that the scope and complexity of our safety mission will continue to grow, requiring the agency to fundamentally rethink how it uses data, information, and technology to achieve safety goals. In responding to our varied agency goals and objectives, PHMSA conducts research mandated by Congress, directed by administration objectives and in support of entities affected by its regulations. This has resulted in a program that spans the research spectrum from initial concepts to implementation.

PHMSA has established a set of long-term strategic goals and objectives that also anticipate the president's FY 2019 Research and Development Budget Priorities:

- PHMSA R&D promotes continuous improvement in safety performance across regulated communities supporting regulatory streamlining, improved transportation container and pipeline performance, and better management of community exposure to underground natural gas storage;
- Invest in innovations that improve safety and system performance and efficiency in both the pipeline and hazardous materials transportation sectors to promote and protect American Health;
- Build stakeholder and public trust through proactive and targeted outreach, engagement, responsiveness, and transparency;
- Engage in cutting edge research in early-stage basic research (where congressionally permitted) that can be leveraged with public-private partnerships to bring concepts into implementation;
- Cultivate organizational excellence through engagement in interagency collaboration and public and private sector research partnerships to promote American Energy Dominance;
- Drive decision-making by pursuing operational excellence through consistent and efficient business processes that promote American Prosperity.

The Office of Pipeline Safety (OPS): Our nation uses petroleum energy products to power much of our modern economy by producing electricity, fueling the commercial transportation industry, and powering the personal transportation industry. Energy sources also provide raw materials that are manufactured into many industrial and consumer products. OPS was mandated by the Congress to conduct research and development to further pipeline safety in the Pipeline Safety Improvement Act of 2002.

The U.S. pipeline infrastructure, which spans more than 2.7 million miles, is the primary means of transporting all natural gas and about two-thirds of all liquid petroleum energy products consumed in the U.S. Because of the importance of energy pipelines to the U.S., both in terms of the economy and our

standard of living, research projects assuring reliability and performance are necessary. Topics addressing the management of plastic pipes, longitudinal pipe seam failures, and applications of robotics for inspecting transmission pipelines help to industry to maintain the optimal operational state of this critical asset to American Prosperity. Stakeholder engagement — including the public, academia, and industry — is imperative to ensure such research is effective. PHMSA's role in this area is to fund research that relies heavily on public /private partnerships to improve safety, supply reliability, productivity, and security while minimizing environmental impact. OPS plays a crucial role in the expansion of energy exports in natural gas and Liquefied Natural Gas (LNG), and has international collaboration with the governments of Canada and Mexico, and industry.

This interagency research program plan is the first step toward developing and deploying needed solutions through effective and efficient research coordination.

The Office of Hazardous Materials Safety (OHMS): While hazardous materials are transported daily by trained professionals operating in well-defined systems, incidents resulting in serious injury, loss of life, destruction of property, and environmental damage still occur. The OHMS research program analyzes transport operations, packaging technologies and systems, and emerging technologies to look for innovative methods and practices which will minimize the risks associated with the transportation of hazardous materials in commerce. OHMS was reauthorized to continue conducting hazardous materials research by the Fixing America's Surface Transportation Act (FAST Act) of 2015.

The mission of the research program includes researching and identifying best practices regarding hazardous materials transport, with improved and standardized classification processes; development of new packaging materials and technologies; and conducting engineering and scientific analysis in order to reduce regulatory burdens. The program also relies heavily in interagency collaboration to conduct multi-modal programs supporting improved energy availability and access. American Prosperity and Energy Dominance are facilitated through the expansion of LNG surface transportation by road and rail; all topics are addressed by OHMS basic research. OHMS improved packaging and equipment designs that help to improve American Health and Safety through research into lightweight materials that will improve the thermal and mechanical performance of bulk packages. OHMS is also developing design standards for cylinders constructed of new, high strength steels and for fiber reinforced tanks, and lithium ion battery packages and inspection all of which serve to protect American Health and safety. OHMS consults and partners with other modal administrations (FRA, FMCSA, FAA) on mode-specific hazard evaluation and reduction. OHMS also partners with other Departments (DOE, DOD) on research to understand particularly complex transportation hazards. One example is understanding the hazards of unprecedented volume of crude oil being transported by rail, and the quantification of incremental hazard in a derailment as a function of the crude oil's specific properties. Another recent example is the hazard of lithium battery transport by air, with potentially catastrophic consequences of a fire scenario onboard.

The table below details the funds needed to support crucial research that will ensure pipeline safety. The funding is broken into research, development, and technology (RD&T) programs within both the OPS and OHMS departments.

Fiscal Year (FY) 2018 Program Funding Details

RD&T Program Name	FY 2018 Pres. Budget (\$000)	FY 2018 Basic (\$000)	FY 2018 Applied (\$000)	FY 2018 Development (\$000)
Preventing Pipeline Damage	\$1,897			\$1,897
Improving Pipeline Leak Detection Systems	\$2,000			\$2,000
Improving Pipeline Anomaly Detection & Characterization	\$2,000			\$2,000
Improving Pipeline Anomaly Remediation, Repair, Rehabilitation, or Replacement Options	\$1,500			\$1,500
Enhancing Pipeline Design, Materials & Welding/Joining	\$880			\$880
Investigating the Impact on Pipelines from Underground Storage and Other National Challenges	\$1,700			\$1,700
Competitive Academic Advancement Program	\$2,000			\$2,000
Pipeline Administrative Expenses	\$1,363			\$1,363
Office of Pipeline Safety Total	\$13,340			\$13,340
Hazardous Materials Risk Management and Mitigation	\$1,300		\$1,300	
Hazardous Materials Emerging Technology	\$1,700		\$1,700	
Hazardous Materials Packaging Integrity	\$2,056		\$2,056	
Hazardous Materials Administrative Expense	\$546		\$546	
Office of Hazardous Material Safety Total	\$8,102		\$8,102	
PHMSA Totals	\$21,442		\$8,102	\$13,340

**FY 2018 Program Budget Request
by Critical Transportation Topic Areas**

RD&T Program Name	FY 2018 Pres. Budget (\$000)	Promoting Safety (\$000)	Improving Mobility (\$000)	Improving Infrastructure (\$000)	Preserving the Environment (\$000)
Preventing Pipeline Damage	\$1,897	\$1,897			
Improving Pipeline Leak Detection Systems	\$2,000	\$500			\$1,500
Improving Pipeline Anomaly Detection & Characterization	\$2,000	\$2,000			
Improving Pipeline Anomaly Remediation, Repair, and Rehabilitation/ Replacement Options	\$1,500			\$1,500	
Enhancing Pipeline Design, Materials, & Welding/Joining	\$880	\$880			
Investigating the Impact on Pipelines from Underground Storage and Other National Challenges	\$1,700	\$1,000			\$700
Competitive Academic Advancement Program	\$2,000	\$2,000			
Pipeline Administrative Expense	\$1,363	\$1,363			
Pipeline Safety Total	\$13,340	\$9,640		\$1,500	\$2,200
Hazardous Materials Risk Management and Mitigation	\$1,300	\$1,300			
Hazardous Materials Emerging Technology	\$1,700	\$1,700			
Hazardous Materials Packaging Integrity	\$2,056	\$2,056			
Hazardous Materials Technical Analysis to Aid Risk Assessments	\$2,500	\$2,500			

Hazardous Materials Administrative Expense	\$546	\$546			
Hazardous Materials Total	\$8,102	\$8,102			
PHMSA Totals	\$21,442	\$17,742		\$1,500	\$2,200

Preventing Pipeline Damage

\$1,897,000

Program Description: Damage to pipe by excavation and outside force continues to be a leading cause of pipeline failure. Preventing or reducing such damage would dramatically improve pipeline safety. Damage is most often caused by contact with the pipe during excavation activities, including operators' and contractors' use of backhoes, bulldozers, and even shovels but also by earth movements and river scour.

Program Objectives: Research in this area will develop new or improved tools and technology for preventing/reducing damage which may be caused by third party activity, to pipelines that will prevent/lessen releases into the environment. This is achieved with technologies making pipes intrinsically locatable, examining construction fault tree models, and others.

Anticipated Program Activities: This program will fund research, development, and demonstration of various technology types that support the program objectives and that may be deployed sub-surface, on the surface or airborne. These tools will all be used to locate and inform those performing construction activities about threats they may be posing to existing pipelines.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents. Technologies that are commercialized as a result of this collaboration will fill existing safety and technical gaps, informing construction entities not previously available. Knowledge generated from this work will be made available to the industry, allowing adoption of best practices and filling knowledge gaps.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating Administrations (OA) to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Improving Pipeline Leak Detection Systems

\$2,000,000

Program Description: Leak detection continues to be a challenge, particularly in pipelines with very small hazardous liquid leaks. Ecological and drinking water resources can be impacted by pipelines with small hazardous liquid leaks that are not quickly or easily detected. Standardization of performance metrics of natural gas detection sensors also remains as an outstanding gap.

Program Objectives: Research in this area will develop new or improved technology solutions to reduce the volume of product released into the environment and to identify leaks before they lead to catastrophic ruptures.

Anticipated Program Activities: This program will fund research, development, and demonstration of various types of leak detection technology for both natural gas and hazardous liquid research. Such systems can be deployed internally, externally or airborne. In addition, assessment frameworks may be developed to assist in standardizing the performance of such systems.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents by raising the level of liquid leak detection capabilities, thereby better informing pipeline operators when an incident is occurring. This knowledge can then be used to minimize liquid leak impacts.

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Improving Pipeline Anomaly Detection & Characterization

\$2,000,000

Program Description: Detecting and characterizing anomalies in pipelines require solutions having people, processes, and technology as part of a comprehensive program. The ability to detect must progress past simple corrosion to complex anomalies having a mixture of dents, gouges and corrosion characteristics. Solutions for complex defects and coming from a variety of threats are a key goal. Handheld tools for in-the-ditch or above-ground inspection, improvements to traditional and robotic in-line inspection are a focus as well as for cast iron systems.

Project Objectives: Research in this area will develop new or improved technology and assessment processes to identify and locate critical pipeline defects and to improve the capability to characterize the severity of such defects identified in pipeline systems. Such capabilities could be to detect stresses in pipelines, inspecting traditionally difficult-to-inspect pipelines, or further developing nascent characterization technologies.

Anticipated Project Activities: This program will fund research, development, and demonstration of inspection technology for use on metallic and non-metallic pipeline material types that either matches or exceeds the current capabilities of Probability of Detection and Probability of Identification. This technology will have functionality and/or performance requirements for the identification and characterization of pipeline defects—particularly cracks—with a focus on wide ranging pipeline diameters.

Expected Project Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents, and could be disseminated with reports or recommended practices.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating Administrations (OA) to first disseminate our subject activities and to then build possible synergies with other OA programs.

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**Improving Pipeline Anomaly Remediation, Repair,
Rehabilitation, or Replacement Options
\$1,500,000**

Program Description: Reliable methods to repair damaged pipelines are of paramount importance in regards to bringing pipeline systems back online. Research in this area will improve the repair process by bringing automation to the market and raising standards and best practices for operators and contractors.

Program Objectives: Research in this area will enhance repair materials, techniques or processes, repair tools and technology for quickly bringing pipeline systems back on line and serving the Nation.

Anticipated Program Activities: This program will fund research, development, and demonstration of repair/replacement considerations for vintage/pre-regulation and newer onshore liquid or natural gas pipelines. These considerations could be technologies enhancing the strength of existing pipe, repairing inservice pipe, or methodologies for ranking at-risk vintage pipe.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents. The 20-year trend for pipeline incidents have been an increase in the annual costs associated with them; this research is positioned to address a tremendous challenge facing pipeline operators.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

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Enhancing Pipeline Design, Materials, and Welding/Joining

\$880,000

Program Description: Operators in frontier areas, such as Alaska and offshore platforms, are pushing for pipeline material improvements that will safely allow for increased operating pressures, thereby maximizing throughput. The welding of these improved systems will require automation and inspection capabilities that safely enhance the efficiency of construction activities. There is also demand for construction-related quality improvements directed toward reducing the likelihood of girth weld failures shortly after welding, during lowering-in, during hydrostatic testing, and in subsequent service.

Program Objectives: Research in this area will improve industry's ability to design and construct safe, long-lasting pipelines using the most appropriate materials and welding/joining procedures for a given operating environment.

Anticipated Program Activities: This program will investigate the essential variables required to ensure property consistency and update modern materials and welding standards that cover qualification procedures for modern welding techniques. The program will also continue an international collaborative research initiative designed to improve pipeline design, materials, and welding/joining issues.

Expected Program Outcomes: This program will develop and demonstrate a comprehensive set of testing methods for modern, high-strength steel types, and their mechanical strength properties. The results of this project are expected to enhance industry's use of modern materials, fabrication standards, and procedures while ensuring property consistency throughout their product.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA periodically enters into an interagency agreement with the National Institute of Standards and Technology to address technical challenges within this program area. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the

natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

**Investigating the Impact on Pipelines from Underground Storage
and Other National Challenges**
\$1,700,000

Program Description: It is critical to remove integrity threats and generate new knowledge for use in industry best practices/consensus standards in order to enable the safe pipeline transportation of fuels to and from underground storage. Sometimes emerging issues for LNG, risk management and human factors require broad studies to understand how they impact the other pipeline safety research activities described in this document. The underground natural gas storage topic area will conduct general knowledge research and studies as needed when these emerging issues materialize. As this is a new research area to the program, developing a body of knowledge will inform the direction for future research

Program Objectives: Research in the area of safety/reducing environmental impact will facilitate the identification and mitigation of technical issues preventing the safe transportation of fuels to and from underground storage, as well as addressing other emerging technological or policy issues on a national scale, which will be informed by research conducted and stakeholders as this topic area matures.

Anticipated Program Activities: Research is expected to integrate the data obtained from materials testing and new scientific experiments to develop physics-based, fully predictive models. After validation via full-scale testing, these models will provide guidance to codes and standards bodies on underground storage issues and other national challenges. This program will also continue international collaborative research initiatives.

Expected Program Outcomes: This program will result in reducing environmental impact through identification and mitigation of technical issues currently preventing the safe underground storage of fuels. Anticipated outcomes are project reporting, patent applications, guidelines and frameworks for new operational safety procedures and inspection technology into the market that support our growing focus on LNG and underground gas storage.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. In particular, PHMSA is continuing its coordination with the Department of Energy on challenges with underground natural gas storage that may include co-sponsoring of some research. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent

re-authorizations. In addition, new authorities were provided by the PIPES Act of 2016 Sec. 12(b) 49 U.S.C. § 60141 for underground natural gas storage that research under this program will support policy development. Finally, research for LNG challenges will support PIPES Act of 2016 Sec. 27(b).

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Hazardous Materials Risk Management and Mitigation

\$1,300,000

Program Description: 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. Analyzing transport operations and transport incidents using risk management methodology, and communicating the results of the analysis, should reduce the probability of, and minimize the consequences associated with, hazardous material incidents.

Program Objective: Minimize the probability of hazardous materials transport incidents and their associated consequences by developing risk management principles that can be applied to existing hazardous materials regulations, policies, transport systems and operations.

Anticipated Program Activities: PHMSA's hazardous materials risk management and mitigation research will focus on the identification and development of risk management methods to assess hazardous materials transport. The analysis would be both of regulatory operations, and impacts, and of transport operations and systems. The research will also provide the identification of communication technologies and best practices to ensure results are communicated to the transport industry.

The program staff will serve as members of industry working groups for collaboration and coordination of research initiatives of committee meetings. Program staff will also present research results for peer review at various industry and public conferences and in technical journals.

Expected Program Outcomes: The PHMSA hazardous materials risk management program's expected outcomes are to improve public safety and protect the environment by identifying transport risks and developing mitigation strategies. This risk reduction strategy is designed to lower transport related injuries and fatalities; increase packaging and operational safety; and improve system reliability.

Outcomes for projects funded under the initiative will improve transport safety through development and application of new risk models and methodologies and it will expand our use of data analytics in hazardous materials transport research. The projects will help increase the knowledge and understanding of human, package and conveyance interfaces and reduce the potential for human errors and systematic incompatibilities.

Project outcomes will raise public confidence in regulatory agencies and incorporate stakeholder and transportation industry innovation. The projects will support the development of national and international transport and packaging standards, identify industry best practices and publicize lessons learned.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research program and on projects involving their mode. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

In addition, PHMSA will present the research and incorporate outcomes in its international regulatory program. The international authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the project is in their sphere of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

PHMSA solicits research needs statements and enters into public/private agreements with universities and private industry to generate innovation. The administration also establishes research partnerships 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.

All processes and reports are available for public download free of charge and any member of the public is invited to submit research problem statements. The program staff will present research results for peer review at various conferences and in technical journals.

In addition, DOT Order #1120.39 established the modern Office of the Assistant Secretary for Research & Technology (OST-R) RD&T Planning Team. The Order mandates the purpose of the RD&T Planning Team shall be to ensure cross-modal collaboration and coordination in the RD&T initiatives within the DOT and with external entities. Since FY 2007, the RD&T Planning Team has met monthly to collaborate, coordinate, and communicate internal RD&T activities within each DOT Administration.

How does the Program meet statutory requirements? Research will play a large role in addressing and mitigating risks associated with the international and domestic transport of hazardous materials. The research programs conducted support the mandate for R&D found in the “Fixing America’s Surface Transportation Act” or the “FAST Act” of 2015. Section 6014 of the FAST Act authorizes PHMSA to conduct research activities relating to but not limited to: emergency planning and response, including information and programs that can be readily assessed and implemented in local jurisdictions; risk analysis and 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.

How does the Program incorporate public and stakeholder input into the research planning process?

PHMSA periodically holds public research planning events that are announced in the Federal Register. These events solicit input from state officials, emergency response community, hazardous materials industry and trade association representatives, universities and federal research facilities. Input from these meetings is used in compilation of PHMSA research plans.

PHMSA uses research panels consisting of Subject Matter Experts from government, academia and industry to define projects/programs and evaluate progress and output. PHMSA ensures program transparency by providing the general public web-based access to program/project database and providing opportunity to submit research needs statement online.

Program and technical staff are members of domestic and international standards committees and industry working groups. Standards and products from these groups will be incorporated in research plans.

Hazardous Materials Emerging Technology

\$1,700,000

Program Description: As the U.S. energy production expands, domestic and international transport expands. This expansion has included and will continue to spawn new energy sources, new transport systems and new packaging technologies. Regulators must research and understand these emerging systems and technologies so existing levels of transport safety can be maintained or improved.

Program Objective: Identify and analyze emerging materials, processes, packaging technologies and transport operations to assess their potential risks or benefit to the existing hazardous materials transport network.

Anticipated Program Activities: The PHMSA hazardous materials research on emerging technologies and materials will focus on research and analysis of emerging energy products, including various grades of crude oil and liquefied natural gas. It will also provide research and analysis of new packaging materials and technologies, as well as transportation systems and operations that have been identified by the stakeholder and expert community for their relevance to future risk. The efforts will continue an international collaborative research initiative to study emerging technologies.

Expected Program Outcomes: The PHMSA hazardous materials emerging technology program's outcomes are designed to improve public safety and protect the environment by identifying and focusing resources on emerging risks, developing new packaging materials and new transport systems. This risk reduction strategy is designed to lower transport related injuries and fatalities through containment of the hazardous material in an incident or accident and by lowering the probability of a transport incident or accident.

Outcomes for projects funded under the initiative will demonstrate the feasibility of innovative transport systems and technologies to improve the safety of hazardous materials transport. PHMSA expects to share the successes under this program with its modal and industry partners. Project outcomes will also advance the development of new packaging materials and technologies to improve package performance. Improved package performance will reduce the number of transport related fatalities and serious injuries.

In addition, the research will support the development and improvement of packaging safety standards, transport best practices and documentation of lessons learned in safety operations.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

PHMSA presents research and incorporates outcomes in its international regulatory program. International authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the projects are in their spheres of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of

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How does the Program meet statutory requirements? Research will play a large role in addressing and mitigating risks associated with the international and domestic transport of hazardous materials. The research programs conducted support the mandate for R&D found in the “Fixing America’s Surface Transportation Act” or the “FAST Act” of 2015. Section 6014 of the FAST Act authorizes PHMSA to conduct research activities relating to but not limited to: emergency planning and response, including information and programs that can be readily assessed and implemented in local jurisdictions; risk analysis and 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.

How does the Program incorporate public and stakeholder input into the research planning process?

PHMSA periodically holds public research planning events that are announced in the Federal Register. These events solicit input from state officials, emergency response community, hazardous materials industry and trade association representatives, universities and federal research facilities. Input from these meetings is used in compilation of PHMSA research plans.

PHMSA uses research panels consisting of Subject Matter Experts from government, academia and industry to define projects/program and evaluate progress and output. PHMSA ensures program transparency by providing the general public web-based access to program/project database and providing opportunity to submit research needs statement online.

Program and technical staff are members of domestic and international standards committees and industry working groups. Standards and products from these groups are incorporated in research plans.

Hazardous Materials Packaging Integrity

\$2,056,000

Program Description: One of the primary means to ensure the safe transport of hazardous materials is to ensure they remain contained within their packaging during transport. Accordingly, research and development in packaging technologies and testing and assessment of packaging integrity is a vital safety function.

Program Objective: Evaluate and verify the suitability and effectiveness of existing packaging standards and practices; improve transport safety by developing, evaluating and testing new packaging technologies and materials.

Anticipated Program Activities: PHMSA hazardous materials packaging integrity research will focus on testing and evaluating existing packaging materials and packaging technologies. It will provide analysis, evaluation and performance evaluations of emerging packaging materials and methods. In addition, the research will focus on testing and evaluation of materials whose compositions are included as part of the overall combination packaging.

Program staff members will serve as members of industry working groups for collaboration and coordination of research initiatives of committee meetings. They will present research results for peer review at various industry and public conferences and in technical journals.

Expected Program Outcomes: The PHMSA hazardous materials packaging integrity program's outcomes are designed to improve public safety and protect the environment by improving bulk and non-bulk package designs, packaging standards and packaging performance test requirements. Improved package design and performance testing will lower transport related injuries and fatalities and better protect the environment because they will better contain materials and will be easier to handle and transport.

Outcomes for projects funded under the initiative will decrease transportation accidents and incidents by improving packaging integrity and package's ability to contain its contents. Project outcomes will improve containment and better prevent environmental damage resulting from hazardous materials incidents and accidents.

In addition, the project will help decrease deaths and serious injuries that result from package failure or improper use of packages and improve safety by better understanding package to package performance and package to conveyance performance. Project outcomes will decrease accidents and incidents caused by human error by improving and simplifying operating and handling instructions.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

PHMSA will present research and incorporate outcomes in its international regulatory program. The international authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the projects are in their spheres of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

PHMSA solicits research needs statements and enters into public/private agreements with universities and private industry to generate innovation. PHMSA will establish research partnerships 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.

All processes and reports are available for public download free of charge and any member of the public is invited to submit research problem statements. Program staff present research results for peer review at various conferences and in technical journals.

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PHMSA uses research panels consisting of Subject Matter Experts from government, academia and industry to define projects/program and evaluate progress and output. The administration ensures program transparency by providing the general public web-based access to program/project database and providing opportunity to submit research needs statement online.

Program and technical staff are members of domestic and international standards committees and industry working groups. Standards and products from these groups are incorporated in research plans.

Hazardous Materials Technical Analysis to Aid Risk Assessments

\$2,500,000

Program Description: Change is a constant in both the hazardous materials and the transportation industries. Our risk assessments, conceptual models and frameworks and evaluation methods used to evaluate activities, events or incidents must change if the overall level of transport safety is to be improved.

Program Objective: Identify strategies to reduce fatalities and serious injuries resulting from hazardous materials transportation.

Anticipated Program Activities: PHMSA hazardous materials risk management and mitigation research will focus on analysis of individual incidents and accidents involving hazardous materials to determine root cause. It will also provide analysis of all transport incidents and accidents involving hazardous materials to determine patterns or anomalies within packaging or systems.

In addition, the research will focus on the development of new inspection and test methods used to classify materials and to certify packaging. Research efforts will continue an international collaborative research initiative to study technical analysis of risk.

Expected Program Outcomes: The PHMSA hazardous materials technical assessment program's outcomes are to improve public safety and protect the environment by using data analytics, accident analysis, failure modelling and newly developed risk methodologies and strategies to lower accident rates and material releases.

Outcomes for projects funded under the initiative will provide the transport community the means to improve safety by applying the preventative and corrective measures, which result from the modeling, research and analysis of transport accidents and incidents. The project will provide transport community the means to take advantage of technology and integrate affordable and sustainable technology solutions that improve transport safety. Project outcomes will increase effectiveness and efficiency of hazardous materials transportation through identifying processes and methods that support continuous improvement in transportation industry, safety management and regulatory development.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

PHMSA presents research and incorporates outcomes in their international regulatory program. International authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the projects are in their spheres of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

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PHMSA uses research panels consisting of Subject Matter Experts from government, academia and pipeline failure. Preventing or reducing such damage would dramatically improve pipeline safety. Damage is most often caused by contact with the pipe during excavation activities, including operators’ and contractors’ use of backhoes, bulldozers, and even shovels but also by earth movements and river scour.

Program Objectives: Research in this area will develop new or improved tools and technology for preventing/reducing damage which may be caused by third party activity, to pipelines that will prevent/lessen releases into the environment. This is achieved with technologies making pipes intrinsically locatable, examining construction fault tree models, and others.

Anticipated Program Activities: This program will fund research, development, and demonstration of various technology types that support the program objectives and that may be deployed sub-surface, on the surface or airborne. These tools will all be used to locate and inform those performing construction activities about threats they may be posing to existing pipelines.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents. Technologies that are commercialized as a result of this collaboration will fill existing safety and technical gaps, informing construction entities not previously available. Knowledge generated from this work will be made available to the industry, allowing adoption of best practices and filling knowledge gaps.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating Administrations (OA) to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

United States Department of Transportation

Annual Modal Research Plans

Fiscal Year 2019

PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION

Preventing Pipeline Damage

Program Description: Damage to pipe by excavation and outside force continues to be a leading cause of pipeline failure. Preventing or reducing such damage would dramatically improve pipeline safety. Damage is most often caused by contact with the pipe during excavation activities, including operators' and contractors' use of backhoes, bulldozers, and even shovels but also by earth movements and river scour.

Program Objectives: Research in this area will develop new or improved tools and technology for preventing/reducing damage which may be caused by third party activity, to pipelines that will prevent/lessen releases into the environment. This is achieved with technologies making pipes intrinsically locatable, examining construction fault tree models, and others.

Anticipated Program Activities: This program will fund research, development, and demonstration of various technology types that support the program objectives and that may be deployed sub-surface, on the surface or airborne. These tools will all be used to locate and inform those performing construction activities about threats they may be posing to existing pipelines.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents. Technologies that are commercialized as a result of this collaboration will fill existing safety and technical gaps, informing construction entities not previously available. Knowledge generated from this work will be made available to the industry, allowing adoption of best practices and filling knowledge gaps.

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Improving Pipeline Leak Detection Systems

Program Description: Leak detection continues to be a challenge, particularly in pipelines with very small hazardous liquid leaks. Ecological and drinking water resources can be impacted by pipelines with small hazardous liquid leaks that are not quickly or easily detected. Standardization of performance metrics of natural gas detection sensors also remains as an outstanding gap.

Program Objectives: Research in this area will develop new or improved technology solutions to reduce the volume of product released into the environment and to identify leaks before they lead to catastrophic ruptures.

Anticipated Program Activities: This program will fund research, development, and demonstration of various types of leak detection technology for both natural gas and hazardous liquid research. Such systems can be deployed internally, externally or airborne. In addition, assessment frameworks may be developed to assist in standardizing the performance of such systems.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents by raising the level of liquid leak detection capabilities, thereby better informing pipeline operators when an incident is occurring. This knowledge can then be used to minimize liquid leak impacts.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating Administrations (OA) to first disseminate our subject activities and to then build possible synergies with other OA programs.

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Improving Pipeline Anomaly Detection & Characterization

Program Description: Detecting and characterizing anomalies in pipelines require solutions having people, processes, and technology as part of a comprehensive program. The ability to detect must progress past simple corrosion to complex anomalies having a mixture of dents, gouges and corrosion characteristics. Solutions for complex defects and coming from a variety of threats are a key goal. Handheld tools for in-the-ditch or above-ground inspection, improvements to traditional and robotic in-line inspection are a focus as well as for cast iron systems.

Project Objectives: Research in this area will develop new or improved technology and assessment processes to identify and locate critical pipeline defects and to improve the capability to characterize the severity of such defects identified in pipeline systems. Such capabilities could be to detect stresses in pipelines, inspecting traditionally difficult-to-inspect pipelines, or further developing nascent characterization technologies.

Anticipated Project Activities: This program will fund research, development, and demonstration of inspection technology for use on metallic and non-metallic pipeline material types that either matches or exceeds the current capabilities of Probability of Detection and Probability of Identification. This technology will have functionality and/or performance requirements for the identification and characterization of pipeline defects—particularly cracks—with a focus on wide ranging pipeline diameters.

Expected Project Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents, and could be disseminated with reports or recommended practices.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating Administrations (OA) to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968 (P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the

natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Improving Pipeline Anomaly Remediation, Repair, Rehabilitation, or Replacement Options

Program Description: Reliable methods to repair damaged pipelines are of paramount importance in regards to bringing pipeline systems back online. Research in this area will improve the repair process by bringing automation to the market and raising standards and best practices for operators and contractors.

Program Objectives: Research in this area will enhance repair materials, techniques or processes, repair tools and technology for quickly bringing pipeline systems back on line and serving the Nation.

Anticipated Program Activities: This program will fund research, development, and demonstration of repair/replacement considerations for vintage/pre-regulation and newer onshore liquid or natural gas pipelines. These considerations could be technologies enhancing the strength of existing pipe, repairing inservice pipe, or methodologies for ranking at-risk vintage pipe.

Expected Program Outcomes: Anticipated outcomes are project reporting, patent applications and the introduction of technology improvements into the marketplace. These outcomes support the reduction of pipeline incidents. The 20-year trend for pipeline incidents have been an increase in the annual costs associated with them; this research is positioned to address a tremendous challenge facing pipeline operators.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT Operating OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Enhancing Pipeline Design, Materials, and Welding/Joining

Program Description: Operators in frontier areas, such as Alaska and offshore platforms, are pushing for pipeline material improvements that will safely allow for increased operating pressures, thereby maximizing throughput. The welding of these improved systems will require automation and inspection capabilities that safely enhance the efficiency of construction activities. There is also demand for construction-related quality improvements directed toward reducing the likelihood of girth weld failures shortly after welding, during lowering-in, during hydrostatic testing, and in subsequent service.

Program Objectives: Research in this area will improve industry's ability to design and construct safe, long-lasting pipelines using the most appropriate materials and welding/joining procedures for a given operating environment.

Anticipated Program Activities: This program will investigate the essential variables required to ensure property consistency and update modern materials and welding standards that cover qualification procedures for modern welding techniques. The program will also continue an international collaborative research initiative designed to improve pipeline design, materials, and welding/joining issues.

Expected Program Outcomes: This program will develop and demonstrate a comprehensive set of testing methods for modern, high-strength steel types, and their mechanical strength properties. The results of this project are expected to enhance industry's use of modern materials, fabrication standards, and procedures while ensuring property consistency throughout their product.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. PHMSA periodically enters into an interagency agreement with the National Institute of Standards and Technology to address technical challenges within this program area. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations.

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Investigating the Impact on Pipelines from Underground Storage and Other National Challenges

Program Description: It is critical to remove integrity threats and generate new knowledge for use in industry best practices/consensus standards in order to enable the safe pipeline transportation of fuels to and from underground storage. Sometimes emerging issues for LNG, risk management and human factors require broad studies to understand how they impact the other pipeline safety research activities described in this document. The underground natural gas storage topic area will conduct general knowledge research and studies as needed when these emerging issues materialize. As this is a new research area to the program, developing a body of knowledge will inform the direction for future research

Program Objectives: Research in the area of safety/reducing environmental impact will facilitate the identification and mitigation of technical issues preventing the safe transportation of fuels to and from underground storage, as well as addressing other emerging technological or policy issues on a national scale, which will be informed by research conducted and stakeholders as this topic area matures.

Anticipated Program Activities: Research is expected to integrate the data obtained from materials testing and new scientific experiments to develop physics-based, fully predictive models. After validation via full-scale testing, these models will provide guidance to codes and standards bodies on underground storage issues and other national challenges. This program will also continue international collaborative research initiatives.

Expected Program Outcomes: This program will result in reducing environmental impact through identification and mitigation of technical issues currently preventing the safe underground storage of fuels. Anticipated outcomes are project reporting, patent applications, guidelines and frameworks for new operational safety procedures and inspection technology into the market that support our growing focus on LNG and underground gas storage.

Collaboration Partners: PHMSA will enter into public/private partnerships including with universities to generate innovation. This historically involves other Federal and State agencies, trade organizations (energy & water sectors) and pipeline operators. In particular, PHMSA is continuing its coordination with the Department of Energy on challenges with underground natural gas storage that may include co-sponsoring of some research. PHMSA participates at monthly coordination meetings managed by the Office of the Secretary of Transportation which provides PHMSA an opportunity to engage other DOT OAs to first disseminate our subject activities and to then build possible synergies with other OA programs.

How Does the Program Meet Statutory Requirements? Research will play a large role in finding the technical solutions to national, regional, and local pipeline operational safety and environmental challenges. The technical solutions support the safety policy authority under the Natural Gas Pipeline Safety Act of 1968(P.L. 90-481) the Hazardous Liquid Pipeline Act of 1979 (P.L. 96-129) and subsequent re-authorizations. In addition, new authorities were provided by the PIPES Act of 2016 Sec. 12(b) 49

U.S.C. § 60141 for underground natural gas storage that research under this program will support policy development. Finally, research for LNG challenges will support PIPES Act of 2016 Sec. 27(b).

How Does the Program Incorporate Public and Stakeholder Input into the Research Planning Process? Section 12, Paragraph 2 of the Pipeline Safety and Improvement Act of 2002, as amended by P.L. 112-90, requires that, DOT seek a very wide range of government and private pipeline stakeholders into the research planning process. PHMSA periodically holds public research planning events (R&D Forums) that are announced in the Federal Register and provide input from representatives of the natural gas, crude oil, and petroleum product pipeline industries, utilities, 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.

Hazardous Materials Risk Management and Mitigation

Program Description: 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. Analyzing transport operations and transport incidents using risk management methodology, and communicating the results of the analysis, should reduce the probability of, and minimize the consequences associated with, hazardous material incidents.

Program Objective: Minimize the probability of hazardous materials transport incidents and their associated consequences by developing risk management principles that can be applied to existing hazardous materials regulations, policies, transport systems and operations.

Anticipated Program Activities: PHMSA's hazardous materials risk management and mitigation research will focus on the identification and development of risk management methods to assess hazardous materials transport. The analysis would be both of regulatory operations, and impacts, and of transport operations and systems. The research will also provide the identification of communication technologies and best practices to ensure results are communicated to the transport industry.

The program staff will serve as members of industry working groups for collaboration and coordination of research initiatives of committee meetings. Program staff will also present research results for peer review at various industry and public conferences and in technical journals.

Expected Program Outcomes: The PHMSA hazardous materials risk management program's expected outcomes are to improve public safety and protect the environment by identifying transport risks and developing mitigation strategies. This risk reduction strategy is designed to lower transport related injuries and fatalities; increase packaging and operational safety; and improve system reliability.

Outcomes for projects funded under the initiative will improve transport safety through development and application of new risk models and methodologies and it will expand our use of data analytics in hazardous materials transport research. The projects will help increase the knowledge and understanding of human, package and conveyance interfaces and reduce the potential for human errors and systematic incompatibilities.

Project outcomes will raise public confidence in regulatory agencies and incorporate stakeholder and transportation industry innovation. The projects will support the development of national and international transport and packaging standards, identify industry best practices and publicize lessons learned.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research program and on projects involving their mode. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

In addition, PHMSA will present the research and incorporate outcomes in its international regulatory program. The international authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete

research program and are consulted on individual projects when the project is in their sphere of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

PHMSA solicits research needs statements and enters into public/private agreements with universities and private industry to generate innovation. The administration also establishes research partnerships 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.

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How does the Program meet statutory requirements? Research will play a large role in addressing and mitigating risks associated with the international and domestic transport of hazardous materials. The research programs conducted support the mandate for R&D found in the “Fixing America’s Surface Transportation Act” or the “FAST Act” of 2015. Section 6014 of the FAST Act authorizes PHMSA to conduct research activities relating to but not limited to: emergency planning and response, including information and programs that can be readily assessed and implemented in local jurisdictions; risk analysis and 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.

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Hazardous Materials Emerging Technology

Program Description: As the U.S. energy production expands, domestic and international transport expands. This expansion has included and will continue to spawn new energy sources, new transport systems and new packaging technologies. Regulators must research and understand these emerging systems and technologies so existing levels of transport safety can be maintained or improved.

Program Objective: Identify and analyze emerging materials, processes, packaging technologies and transport operations to assess their potential risks or benefit to the existing hazardous materials transport network.

Anticipated Program Activities: The PHMSA hazardous materials research on emerging technologies and materials will focus on research and analysis of emerging energy products, including various grades of crude oil and liquefied natural gas. It will also provide research and analysis of new packaging materials and technologies, as well as transportation systems and operations that have been identified by the stakeholder and expert community for their relevance to future risk. The efforts will continue an international collaborative research initiative to study emerging technologies.

Expected Program Outcomes: The PHMSA hazardous materials emerging technology program's outcomes are designed to improve public safety and protect the environment by identifying and focusing resources on emerging risks, developing new packaging materials and new transport systems. This risk reduction strategy is designed to lower transport related injuries and fatalities through containment of the hazardous material in an incident or accident and by lowering the probability of a transport incident or accident.

Outcomes for projects funded under the initiative will demonstrate the feasibility of innovative transport systems and technologies to improve the safety of hazardous materials transport. PHMSA expects to share the successes under this program with its modal and industry partners. Project outcomes will also advance the development of new packaging materials and technologies to improve package performance. Improved package performance will reduce the number of transport related fatalities and serious injuries.

In addition, the research will support the development and improvement of packaging safety standards, transport best practices and documentation of lessons learned in safety operations.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

PHMSA presents research and incorporates outcomes in its international regulatory program. International authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the projects are in their spheres of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

PHMSA solicits research needs statements and will enter into public/private agreements with universities and private industry to generate innovation. PHMSA establishes research partnerships 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.

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Hazardous Materials Packaging Integrity

Program Description: One of the primary means to ensure the safe transport of hazardous materials is to ensure they remain contained within their packaging during transport. Accordingly, research and development in packaging technologies and testing and assessment of packaging integrity is a vital safety function.

Program Objective: Evaluate and verify the suitability and effectiveness of existing packaging standards and practices; improve transport safety by developing, evaluating and testing new packaging technologies and materials.

Anticipated Program Activities: PHMSA hazardous materials packaging integrity research will focus on testing and evaluating existing packaging materials and packaging technologies. It will provide analysis, evaluation and performance evaluations of emerging packaging materials and methods. In addition, the research will focus on testing and evaluation of materials whose compositions are included as part of the overall combination packaging.

Program staff members will serve as members of industry working groups for collaboration and coordination of research initiatives of committee meetings. They will present research results for peer review at various industry and public conferences and in technical journals.

Expected Program Outcomes: The PHMSA hazardous materials packaging integrity program's outcomes are designed to improve public safety and protect the environment by improving bulk and non-bulk package designs, packaging standards and packaging performance test requirements. Improved package design and performance testing will lower transport related injuries and fatalities and better protect the environment because they will better contain materials and will be easier to handle and transport.

Outcomes for projects funded under the initiative will decrease transportation accidents and incidents by improving packaging integrity and package's ability to contain its contents. Project outcomes will improve containment and better prevent environmental damage resulting from hazardous materials incidents and accidents.

In addition, the project will help decrease deaths and serious injuries that result from package failure or improper use of packages and improve safety by better understanding package to package performance and package to conveyance performance. Project outcomes will decrease accidents and incidents caused by human error by improving and simplifying operating and handling instructions.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. For example, U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

PHMSA will present research and incorporate outcomes in its international regulatory program. The international authorities involved in these efforts include: United Nations, International Maritime Organization, International Civil Aviation Organization and International Atomic Energy Agency.

Trade associations and the general hazardous materials industry are briefed annually on the complete research program and are consulted on individual projects when the projects are in their spheres of expertise. These interested parties include Dangerous Goods Advisory Council; Institute of Makers of Explosives; American Chemistry Council; American Trucking Association; National Tank Truck Carriers; Association of American Railroads; and Compressed Gas Association.

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Hazardous Materials Technical Analysis to Aid Risk Assessments

Program Description: Change is a constant in both the hazardous materials and the transportation industries. Our risk assessments, conceptual models and frameworks and evaluation methods used to evaluate activities, events or incidents must change if the overall level of transport safety is to be improved.

Program Objective: Identify strategies to reduce fatalities and serious injuries resulting from hazardous materials transportation.

Anticipated Program Activities: PHMSA hazardous materials risk management and mitigation research will focus on analysis of individual incidents and accidents involving hazardous materials to determine root cause. It will also provide analysis of all transport incidents and accidents involving hazardous materials to determine patterns or anomalies within packaging or systems.

In addition, the research will focus on the development of new inspection and test methods used to classify materials and to certify packaging. Research efforts will continue an international collaborative research initiative to study technical analysis of risk.

Expected Program Outcomes: The PHMSA hazardous materials technical assessment program's outcomes are to improve public safety and protect the environment by using data analytics, accident analysis, failure modelling and newly developed risk methodologies and strategies to lower accident rates and material releases.

Outcomes for projects funded under the initiative will provide the transport community the means to improve safety by applying the preventative and corrective measures, which result from the modeling, research and analysis of transport accidents and incidents. The project will provide transport community the means to take advantage of technology and integrate affordable and sustainable technology solutions that improve transport safety. Project outcomes will increase effectiveness and efficiency of hazardous materials transportation through identifying processes and methods that support continuous improvement in transportation industry, safety management and regulatory development.

Collaboration Partners: PHMSA coordinates and collaborates its research with a broad range of stakeholders. U.S. modal authorities (FRA, FAA, FMCSA and USCG) are consulted and briefed on overall research programs and on projects involving their modes. This collaboration is intended to eliminate redundant research and foster collaborative, co-funded research.

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