U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Maria Cantwell
Chair, Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Chair Cantwell:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

Pursuant to 49 Code of Federal Regulations (CFR) § 1.97(a)(1), the Secretary has delegated PHMSA to submit this Report. The Report provides details on how PHMSA may operate the Center, an evaluation of potential locations to build the Center, and recommendations on the resources required for the Center to enhance safety and environmental protection in the LNG sector and in turn help maintain the United States' position as the leader and foremost expert in LNG operations.

A similar letter has been sent to the Ranking Member of the Senate Committee on Commerce, Science, and Transportation; the Chairman and Vice Chairman of the Senate Committee on Appropriations; the Chair and Ranking Member of the House Committee on Appropriations; the Chairman and Ranking Member of the House Committee on Energy and Commerce; and the Chair and Ranking Member of the House Committee on Transportation and Infrastructure.

Sincerely,

Tristan H. Brown
Deputy Administrator

Enclosure

U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Roger F. Wicker
Ranking Member, Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20510

Dear Ranking Member Wicker:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Tristan H. Brown
Deputy Administrator

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U.S. Department
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**Pipeline and Hazardous
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1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Patrick J. Leahy
Chairman, Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Chairman Leahy:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Tristan H. Brown
Deputy Administrator

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U.S. Department
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**Pipeline and Hazardous
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1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Richard C. Shelby
Vice Chairman, Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Vice Chairman Shelby:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Tristan H. Brown
Deputy Administrator

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U.S. Department
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1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

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

Dear Chair DeFazio:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Tristan H. Brown
Deputy Administrator

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U.S. Department
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1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

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

Dear Ranking Member Graves:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Sincerely,

Tristan H. Brown
Deputy Administrator

Enclosure

U.S. Department
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**Pipeline and Hazardous
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Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Rosa L. DeLauro
Chair, Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515

Dear Chair DeLauro:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Sincerely,

Tristan H. Brown
Deputy Administrator

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U.S. Department
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**Pipeline and Hazardous
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1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Kay Granger
Ranking Member, Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515

Dear Ranking Member Granger:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Sincerely,

Tristan H. Brown
Deputy Administrator

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U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

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

Dear Chairman Pallone:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Sincerely,

Tristan H. Brown
Deputy Administrator

Enclosure

U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 5, 2022

The Honorable Cathy McMorris Rodgers
Ranking Member, Committee on
Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

Dear Ranking Member Rodgers:

Enclosed is the Pipeline and Hazardous Materials Safety Administration (PHMSA) report titled *National Center of Excellence for Liquefied Natural Gas Safety* as required by Section 111 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2020" (PIPES Act of 2020; Pub. L. 116-260 at Division R), which required the U.S. Department of Transportation to submit a report to Congress detailing the resources necessary to establish a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (the Center) and ways the Center can carry out the functions therein.

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Sincerely,

Tristan H. Brown
Deputy Administrator

Enclosure

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

National Center of Excellence for Liquefied Natural Gas Safety

Report to Congress

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Cover photo courtesy of an operator

1 Executive Summary

The U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) submits this report to Congress regarding a National Center of Excellence for Liquefied Natural Gas (LNG) Safety (Center). This report is submitted in compliance with Section 111 of the Protecting our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2020 (Pub. L. 116-260). As directed in Section 111(d), the report examines how such a Center could —

> ". . . enhance the United States as the leader and foremost expert in LNG operations by—
>
> (1) furthering the expertise of the Federal Government in the operations, management, and regulatory practices of LNG facilities…
>
> (2) acting as a repository of information on best practices for the operation of LNG facilities; and
>
> (3) facilitating collaboration among LNG sector stakeholders."[1]

The report also includes a review of the current regulatory framework for U.S. LNG facilities and a discussion of the potential functions, staffing estimates, and location considerations for a Center.

PHMSA's current strategic LNG objectives include protecting the public by establishing, maintaining, and enforcing effective safety regulations and policies; strengthening collaboration and information sharing with other federal, state and local agencies; establishing an inspection and compliance team that can evaluate design, construction and operational elements of individual LNG projects that is consistent across all PHMSA regions; promoting and educating the public on PHMSA's role concerning the Nation's energy infrastructure; building coalitions with industry and other stakeholders to enhance safety regulations and practices regarding LNG infrastructure; continuing to promote research and development (R&D) through the federal grant programs that promote private/public partnerships; and collecting industry data, incident statistics, analyze trends and evaluate the efficacy of existing codes, policies, and procedures.

PHMSA also collaborates with other federal, state and local agencies involved in the review of the design, construction, operation, maintenance, and inspection of LNG facilities. PHMSA maintains coalitions with industry and other stakeholders by participating on standards committees to provide comment on practices and/or technologies; attending and participating in LNG focused technical meetings, conferences, and forums to educate industry, the public, and stakeholders about PHMSA's mission and regulations; and coordinating R&D with industry and other stakeholders to address LNG safety gaps.

While PHMSA did not request additional funding in the FY23 President's Budget for this Center, the creation of a Center could facilitate the goals in Section 111 while supporting the findings obtained through stakeholder feedback. PHMSA currently performs many of these

[1] LNG sector stakeholders are defined as Federal regulatory agencies of jurisdiction, LNG facilities operating in the United States, state governments, Indian tribes, units of local government, post-secondary educational institutions, labor organizations, and safety organizations.

functions, and this report describes how the Center could enhance current PHMSA and other stakeholder efforts.

To execute the mission of the Center, this report suggests three staffing models with up to 10 full-time personnel and provides an allotment for the role of research within the Center. This report describes core staff positions and their responsibilities as well as the flexibility within various staffing and research models. This report also provides an additional analysis of the benefits and constraints when using government employees or contractor support personnel to fulfill some roles within some of the described models.

If the path forward results in establishing a physical location for the Center, the report identifies potentially suitable locations—Texas and Louisiana—using the considerations specified in Section 111(e). These two states were identified because of their current and future LNG production capacity and proximity to LNG production facilities. Per Section 111(g), a further consideration for selecting a location may include the potential for the Center to be operated with institutions of higher education.

As required in Section 111, the report provides a cost analysis of the resources needed to establish and carry out the Center's functions (Section 8). One illustrative option for the Center includes up to $2.4 million annually for staff and up to $6.0 million annually for research (Model 3) if research is a core component of the Center. The $2.4 million is for 10 staff members, contractor support, and the necessary technology investment to establish and operate the Center if a physical location is needed. These costs represent the larger end of a range of staffing models the Center could use. Another proposed model includes reduced staff with a limited research component, and an additional proposed model (Model 1) would require an additional monetary investment of $420,000 and would reflect PHMSA continuing its current efforts to accomplish the functions established in Section 111. A potential partnership with a university and the specific location chosen for the Center, if one is needed, may also impact these costs.

2 Introduction

In response to Congress' directive in Section 111 titled, "National Center of Excellence for Liquefied Natural Gas Safety," the Secretary of Transportation (the Secretary) shall submit to the appropriate committees of Congress a report describing the resources necessary to establish the Center and how such a Center would carry out the functions described therein. The Secretary has delegated responsibility to PHMSA per Title 49, Code of Federal Regulations (49 CFR) § 1.97(a)(1).

3 PHMSA Mission

PHMSA's mission is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. The transportation of energy and other hazardous materials that PHMSA regulates is increasing in complexity and scope. In particular, the United States has experienced a significant increase in LNG exports over the last decade. According to the U.S. Energy Information Administration (EIA),

> "U.S. LNG export capacity increased from less than 1 billion cubic feet (Bcf) per day (Bcf/d) in 2015 to 10.78 Bcf/d at the end of 2020. Total peak export capacity in 2021 was about 12.98 Bcf/d. In 2015, total U.S. LNG exports were about 28 Bcf to seven countries. In 2021, U.S. LNG exports reached a record high of about 3,561 Bcf to 45 countries, and LNG exports accounted for 54% of total U.S. natural gas exports."[2]

PHMSA prioritizes collaboration with all stakeholders to leverage current data, information, and technology to create innovative solutions that improve pipeline safety, reliability, and environmental protection while simultaneously enhancing U.S. competitiveness and government efficiency.

Per Section 111(c), this report reviews and describes 1) the resources necessary to establish the Center, 2) the manner by which the chosen model could carry out its functions, and 3) an estimate of potential costs and appropriations necessary to carry out the functions. The Secretary—in consultation with LNG sector stakeholders—may establish the Center, subject to the availability of funds appropriated by Congress after the submission of this report.

4 Federal LNG Regulatory Framework

Under the Natural Gas Pipeline Safety Act[3] and as amended and codified in Title 49, United States Code (49 USC) 60103, the Secretary establishes minimum safety standards governing the location, design, construction, initial testing and inspection, operations, and maintenance of LNG facilities. The standards, which are established in 49 CFR Part 193, prescribe safety standards for LNG facilities that receive, distribute, or deliver natural gas to a pipeline subject to pipeline safety regulations outlined in 49 CFR Part 192 and 49 USC 60101, *et seq*.[4]

PHMSA, however, is not the only Federal regulatory agency with oversight of LNG facilities; other Federal agencies also have jurisdictional authority and regulate various aspects of LNG facilities. These agencies include the U.S. Department of Energy (DOE), the Federal Energy Regulatory Commission (FERC), the DOT Maritime Administration (MARAD), and the U.S. Coast Guard (USCG). **Figure 1** summarizes the LNG supply chain and the agencies responsible for regulating each aspect. Section 4.1 also provides additional details regarding each agency's regulatory responsibilities specific to LNG facilities and operations.

[2] https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php (updated as of May 19, 2022).
[3] Natural Gas Pipeline Safety Act of 1968, as amended through P.L. 96-129, Pipeline Safety Act of 1979 and subsequent Acts.
[4] LNG operators must also comply with the reporting requirements outlined in 49 CFR § 191.

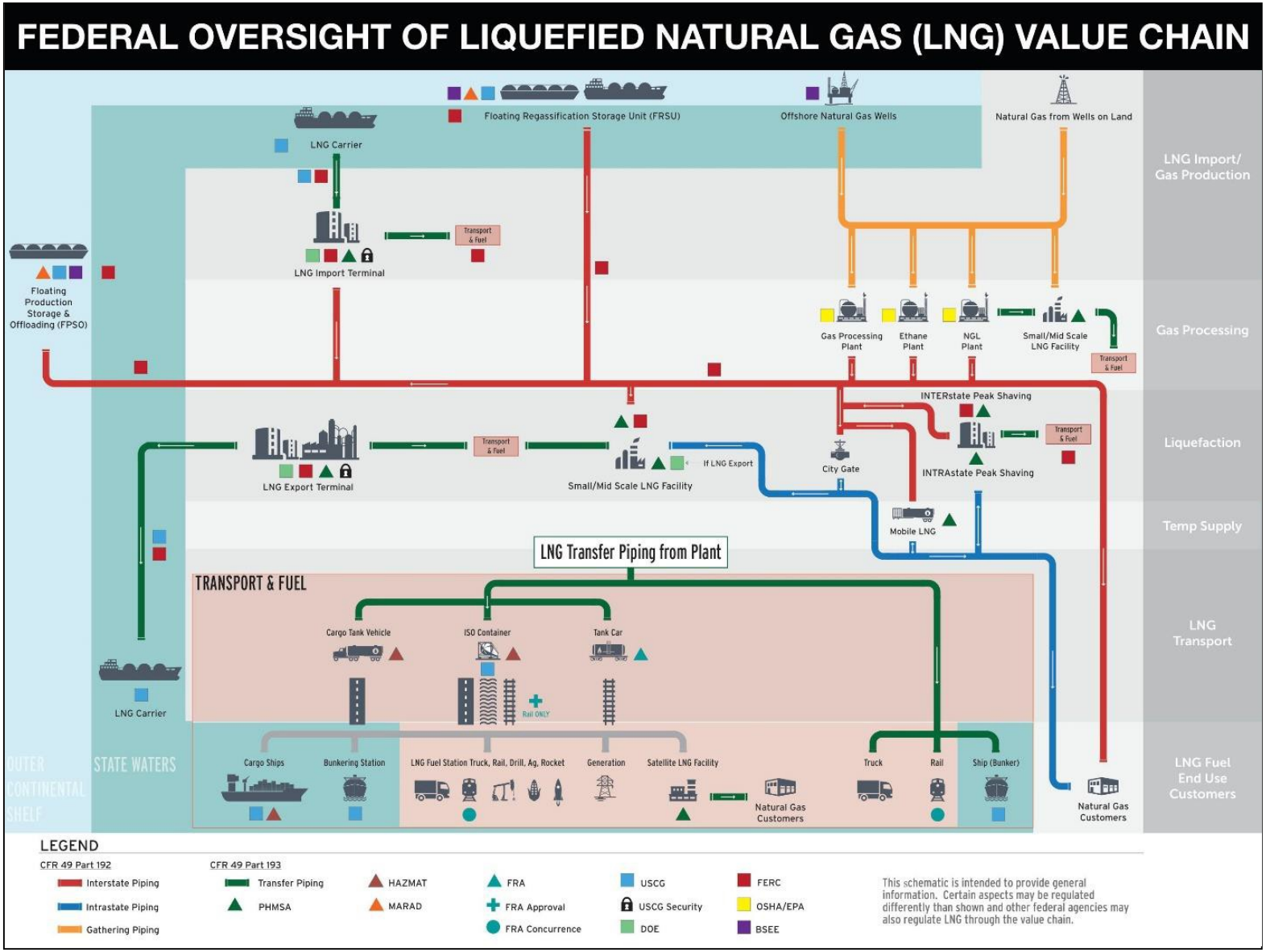

Figure 1: Federal Oversight of LNG Facilities

4.1 Regulatory Authority and Responsibilities

- PHMSA
  - Establishing effective safety regulations for LNG facilities found in 49 CFR Parts 191 and 193.
  - Administering an inspection and compliance program to evaluate the safety of existing LNG facilities and the siting, design, and construction of new facilities.
  - Expanding internal resource capabilities and expertise through hiring, training, and retention of subject matter experts (SMEs).
  - Promoting and educating the public on PHMSA's safety and environmental mitigation role with respect to our Nation's energy infrastructure.
  - Collaborating with stakeholders to enhance LNG infrastructure safety regulations and practices.
  - Continuing R&D through Federal funding programs that promote safety, environmental mitigation, and leverage public-private partnerships.
  - Collecting LNG facility performance data and analyzing trends to evaluate and improve the efficacy of regulations and policies.
  - Strengthening collaboration and information sharing with other federal, state, and local agencies involved in regulating LNG facilities.
- DOE
  - Authorizing the import or export of natural gas (including LNG, compressed natural gas, compressed gas liquids) from or to any foreign country.
  - Evaluating applications to export natural gas to countries with which the United States does not have existing free trade agreements, to determine whether such exports are in the public interest.
  - Conducting reviews under the National Environmental Policy Act for any application to export natural gas or LNG to a country with which the United States does not have an existing free trade agreement.
- FERC
  - Reviewing applications for siting, constructing, and operation of LNG facilities involved in interstate and foreign commerce for public interest determinations.
  - Preparing environmental assessments and environmental impact statements in collaboration with other Federal agencies, including recommendations to enhance the reliability and safety of proposed LNG facilities based on regulations, generally accepted good engineering practices, and performance-based approaches.
  - Authorizing the siting, construction, and operation of onshore and near-shore LNG terminal facilities.
  - Issuing certificates of public convenience and necessity for LNG facilities engaged in interstate natural gas transportation by pipeline.

- Authorizing emergency response plans and associated cost sharing plans under the Energy Policy Act of 2005 for LNG terminals and along LNG carrier routes.
- Conducting construction inspections and issuing notices to proceed with certain site preparation, construction of final design, commissioning, and commencement of service activities.
- Receiving and reviewing semiannual and incident reports that detail LNG facility modifications and abnormalities in operations, maintenance, and incidents.
- Inspecting LNG facilities involved in interstate and foreign commerce.

- MARAD
  - Licensing deepwater ports and determining the financial capability of potential licensees to construct, operate, and decommission the port.
  - Preparing the project record of decision, which includes evaluations under the nine criteria outlined in the Deepwater Port Act of 1974,[5] (as amended) and the findings in the environmental impact statement.
- USCG
  - Ensuring the safety and security of ports and waterways associated with new and existing LNG facilities through coordination with Federal and state partner agencies.
  - Coordinating with FERC and PHMSA to ensure proper siting and permitting based on regulations prescribed in 33 CFR Part 127.
  - Requiring LNG facility applicants to perform Waterway Suitability Assessments and overseeing their development to ensure the effective flow of commerce through vital waterways, continuity of port operations, and community and environmental protection.
  - Requiring LNG facilities meet the regulations prescribed in 33 CFR Parts 105 and 127 by conducting annual safety and security inspections, port coordination, and area maritime security meetings.
  - Developing and maintaining operational and construction regulations for the marine transfer area, and security at new and existing waterfront facilities.
  - Ensuring alignment with international laws and treaties.
  - Overseeing post-licensing activities associated with the development of deepwater ports, including the design, construction, and activation phases; environmental monitoring programs; operational procedures; risk assessments; security plans; safety; and inspections.
  - Conducting Certificate of Compliance examinations on foreign flagged liquefied gas carriers at least once each year and issuing a certificate valid for 24 months only after the vessel has been found in compliance with the applicable regulations, in accordance with 46 USC 3711 and 3714.

[5] 33 U.S.C. § 1501 *et seq.*

4.2 Current Interagency Agreements (IAs) for LNG Oversight

As shown in **Figure 1** and described in Section 4.1, LNG facilities may be regulated by several Federal agencies. These regulatory efforts must be well coordinated to avoid conflicting efforts or gaps. The coordination between various agencies has been established over many years of cooperative effort, much of which is described in the following agreements:

- 1986 Memorandum of Understanding (MOU) Between the USCG and the Research and Special Programs Administration (RSPA) for Regulation of Waterfront Liquefied Natural Gas Facilities[6]
- 1993 MOU Between DOT and FERC Regarding Natural Gas Transportation Facilities
- 2004 Interagency Agreement (IA) Among FERC, USCG, and RSPA for the Safety and Security of Waterfront Import/Export LNG Facilities
- 2018 MOU Between DOT and FERC Regarding LNG Transportation Facilities.

4.3 PHMSA's Safety Regulations for LNG Facilities

Part 193 of Title 49 CFR establishes PHMSA's safety standards for LNG facilities. An LNG facility is subject to 49 CFR Part 193 if the facility is connected to a pipeline used in the transportation of natural gas subject to 49 CFR Part 192.

4.3.1 Location/Siting Standards

Part 193, Subpart B, Siting Requirements, requires that each LNG container and LNG transfer system include exclusion zones[7] for thermal radiation protection and flammable vapor-gas dispersion protection. Each LNG facility also must be designed to withstand wind forces from natural disasters such as hurricanes.

Additionally, Subpart B incorporates by reference the 2001 edition of National Fire Protection Association (NFPA) Standard 59A (NFPA-59A-2001) for additional siting requirements. NFPA-59A-2001, Sections 2.1.1(c) and (d), require consideration of applicable site-specific hazards due to forces of nature and the potential releases of hazardous materials.

PHMSA reviews proposed LNG facility designs for compliance with the siting requirements outlined in Subpart B. For FERC jurisdictional LNG facilities, PHMSA provides its conclusions in a letter of determination to FERC for consideration in whether to authorize or issue a certificate of public convenience and necessity to a proposed LNG facility, as described in the 2018 MOU (Section 4.2).

4.3.2 Design, Installation, Construction, Inspection, and Testing Standards

PHMSA conducts reviews and inspections of design, construction, and initial equipment testing for LNG facilities per Part 193, Subparts C through E (Design, Construction, and Equipment). LNG facility operators are required to submit a notification of construction to PHMSA for each new, replaced, relocated, or significantly altered LNG facility per 49 CFR 191.22(c).

[6] RSPA is the predecessor to PHMSA.
[7] Areas surrounding the LNG facility in which the operator or government agency legally controls all activities to protect the public, in the event of an accident, from adverse effects of thermal radiation heat flux levels and flammable vapor-gas dispersion concentrations for as long as the facility is in operation.

To ensure that LNG facilities meet the applicable design, construction, and testing requirements outlined in Subparts C through E, PHMSA performs design reviews and conducts field inspections throughout the construction phase of an LNG project. PHMSA coordinates with FERC and state partners,[8] as needed, to conduct inspections and reviews to determine compliance with these standards.

4.3.3 Operations and Maintenance (O&M) Standards

Subparts F and G of Part 193 prescribe the requirements for operating and maintaining LNG facility components. To verify compliance with these requirements, PHMSA implements an inspection process that includes periodic field inspections at LNG facilities after commencement of service. PHMSA, FERC, and USCG coordinate and share information on their inspections and findings, as outlined in the 2004 IA and 2018 MOU (Section 4.2).

4.3.4 Personnel Qualifications and Training, Fire Protection, and Security Standards

Subparts H through J of Part 193 prescribe requirements for LNG facility staff training, fire protection, and security systems and operations.

Training requirements include written programs to achieve and maintain the qualifications and health of personnel involved in design and fabrication, construction, installation, inspection and testing, operations, maintenance, and security. Records of the required training must be maintained.

Applicable fire protection requirements in Subpart I are those specified in NFPA 59A-2001, Sections 9.1 through 9.7 and 9.9, which address equipment and procedures designed to minimize the consequences from a release of LNG, flammable refrigerants, flammable liquids, and flammable gases.

Subpart J requires LNG facility operators to prepare and follow written procedures for facility security. It also provides security requirements for protective enclosures, communications, lighting, monitoring, alternative power sources, and warning signs. PHMSA performs inspections prior to and periodically during facility operations to ensure compliance with these requirements.

5 Center of Excellence Functions

Section 111 outlines the Center's three functions as follows:

- Furthering the expertise of the Federal Government in the operations, management, and regulatory practices of LNG facilities (Section 5.1 of this report);
- Acting as a repository of information on best practices for the operations of LNG facilities (Section 5.2 of this report); and
- Facilitating collaboration among LNG stakeholders (Section 5.3 of this report).

[8] State partners are those state agencies who have certifications and agreements with PHMSA to assume the safety authority over intrastate gas and hazardous liquid pipelines. 49 U.S.C. 60105-60106.

5.1 Furthering Federal Government Expertise in LNG Operations, Management, and Regulatory Practices

Congress further outlined its vision for the Center in Section 111, with the stated goal of enhancing the United States as the leader and foremost expert in LNG operations and safety, by furthering the expertise of the Federal Government in the operations, management, and regulatory practices of LNG facilities through:

- the use of performance-based principles;
- experience and familiarity with LNG operational facilities; and
- increased communication with LNG experts to learn and support state-of-the-art operational practices.

Routine communication and collaboration occur between Federal agencies with LNG jurisdiction in accordance with the MOUs and IAs listed in Section 4.2. For example, the DOT Safety Council hosted an LNG Workshop in February 2018[9] that addressed issues across all LNG transportation modes and facilities (i.e., facilities served by pipelines and transportation by rail, truck, and marine vessel). The workshop identified that regulatory challenges and needed improvements varied by mode. Modal participants identified the following:

- Multimodal priority areas, including the following:
  - R&D;
  - Performance-based regulatory challenges; and
  - Communication, outreach, and training.
- Recommendations to address the following multimodal concerns:
  - Creation of a multimodal LNG Center of Excellence, a central repository to collect and make accessible to different agencies available LNG literature and other research information;
  - Development of data needs assessments by mode;
  - Development of risk assessment procedures across modes;
  - Study of jurisdictional gaps and overlaps; and
  - Realignment of regulations with the current and emerging LNG environment.
- Recommendations to address other priority multimodal concerns, which included the following:
  - Engagement of stakeholders to improve facility, route, and risk awareness as well as communicate emergency procedures;
  - Training for inspectors, industry personnel, regulators, and first responders;
  - Development of succession and emergency response plans; and
  - Creation of a funding mechanism to support LNG-related activities.

Additional collaboration between Federal agencies and stakeholders is accomplished formally via a Federal Advisory Committee Act committee—informally known as the Gas Pipeline

[9] U.S. DOT Safety Council LNG Workshop, "Transportation and End-user Safety Hazards of the Emerging LNG Market", February 2018.

Advisory Committee (GPAC)—that peer-reviews proposed standards and regulations related to LNG to report on their technical feasibility, reasonableness, cost-effectiveness, and practicability. Both the GPAC and the Liquid Pipeline Advisory Committee comprise members from Federal or state agencies, industry, and the public. A Center could provide additional, less formal, and more frequent means of furnishing information to government agencies and thus increase expertise related to the changing environment for LNG operations.

5.1.1 Use of Performance-Based Principles

5.1.1.1 Overview

Performance-based requirements are defined by the American Institute of Chemical Engineers as follows:

> A requirement that defines necessary results without defining the specific means to accomplish them, the 'what to do,' but not 'how to do it.' The means for producing the desired results is left up to the discretion of the facility based on an evaluation of its needs and conditions, and on industry practices.[10]

PHMSA works to address performance-based risk reduction at every type of LNG facility during site location, design, construction, operations, maintenance, and fire protection activities. The Center could enhance these efforts to bring together regulators, operators, and other stakeholders to examine how LNG safety regulations can further incorporate performance-based principles to enhance safety and environmental performance. The Center could routinely facilitate and sponsor topic-specific workshops that include the specific stakeholders identified in Section 111 and others such as university representatives, engineering firms, safety and risk consultants, and international regulators. Additionally, the Center could facilitate formal and informal discussions (i.e., roundtables, symposiums, workshops, webinars, meetings) with LNG sector stakeholders on the recommended and best practices to incorporate performance-based principles within LNG safety regulations. Stakeholders could also recommend the research required to establish performance requirements as part of this interchange. (Section 5.3 provides additional details on such workshops and discussions.) An additional benefit of these discussions would be increased transparency allowing all participants to better understand the issues and opportunities that are important to other participants.

Performance-based regulations are not a solution for all regulatory situations. For example, such regulations are considered valuable in situations where the regulated industry includes diverse technologies or is changing rapidly. They can also encourage innovative or relatively new approaches that provide demonstrably equivalent or improved safety via risk analyses. A possible disadvantage of performance-based approaches is the learning curve for both the regulated community and regulators in 1) applying such practices and 2) judging whether the results satisfy the safety objectives important to the regulatory agency and the public.

Current Federal pipeline safety regulations related to natural gas and LNG facilities include both prescriptive and performance-based regulations. For example, 49 CFR Part 193, Subpart G,

[10] https://www.aiche.org/ccps/resources/glossary/process-safety-glossary/performance-based-requirement

provides performance-based requirements for maintaining equipment while providing prescriptive testing and inspection requirements for control systems and pressure relief valves at LNG facilities. Other U.S. regulatory agencies—such as FERC and the Occupational Safety and Health Administration (OSHA)—and regulatory agencies in other countries—such as the United Kingdom and Canada—have also adopted performance-based regulatory approaches.

Additional consideration of performance-based principles could be targeted by the Center. As noted earlier, considering increased implementation of performance-based regulations was part of the focus for the February 2018 DOT Safety Council LNG Workshop (Section 5.1) and was included in the recommendations from that meeting.

5.1.1.2 Furthering Expertise for Performance-Based Regulatory Activities

A focus of the Center could be to ensure that expertise regarding performance-based approaches is captured, maintained, and disseminated to stakeholders to assist with regulatory development. This knowledge could include an understanding of existing regulations, industry standards, industry guidance, and initiatives by regulatory agencies in the United States and abroad.

Additionally, LNG sector stakeholders could benefit from the Center's collaboration with LNG trade partners to provide an international perspective on safety and environmental challenges, enhancing the United States' position as a global leader in LNG operations—and enhancing both safety and environmental mitigation, globally, as well as U.S. competitiveness.

Another critical function of the Center could be ensuring that performance-based regulatory activities achieve or surpass prescriptive regulations by 1) sponsoring research that examines the outcomes of performance-based applications compared to other approaches, and 2) providing awareness and evaluations of existing and proposed performance-based regulations and best practices. These activities would require a close liaison between the Center and PHMSA's Office of Pipeline Safety (OPS) Standards and Rulemaking Division.

5.1.2 Improving Experience and Familiarity Across the Sector and Regulatory Agencies

To fulfill their roles in regulating the safe operations of LNG facilities, regulatory agencies have an ongoing need to train personnel and maintain up-to-date expertise in LNG operations, technologies, and equipment. This is especially true as the industry introduces new technologies, addresses new environmental justice and climate approaches, and proposes new LNG facility types such as small-scale facilities, marine bunkering, and other LNG applications. In working with PHMSA's existing Training and Qualifications Center in Oklahoma City, Oklahoma, the Center could provide a variety of methods for stakeholders and regulatory staff to share information, thus filling new knowledge gaps in emerging and complex technical areas and increasing transparency and collaboration (as delineated further in Section 5.3).

5.1.3 Increased Communication with LNG Experts

Transparent communication becomes increasingly important as the LNG industry adopts new design, construction, and operational practices. All LNG sector stakeholders and regulatory entities could benefit from a centralized channel for communicating with LNG experts regarding operational practices. This communication would help to maintain the United States as the leader

and foremost expert in LNG operations, specifically areas of safety, the environment, climate change, and environmental justice (as explained further in Section 5.3).

5.2 Repository of Information

Section 111 provides for the creation of an electronic repository that may benefit LNG operations, management, and regulatory practices. Such a repository of information could be vital in helping ensure the United States' status as the foremost worldwide expert in LNG facility operational efficiency, safety, and environmental practices.

Currently, there is not a repository or formal process of sharing information on best practices for the operation of LNG facilities between all potential stakeholders. PHMSA informally shares information with stakeholders through meetings, conferences, workshops, training, and correspondence.

In addition to being a Section 111 requirement, the 2018 DOT Safety Council LNG Workshop (Section 5.1) recommended the creation of a repository "for LNG research and reports for government-wide access that will build upon current resources and expand to include multi-modal parties."[11] The workshop report indicated that such a repository, which could be stored on the Center website either physically or through links maintained by other organizations, would play a crucial role in informing and coordinating standards and regulations as well as streamlining research efforts.

The repository could include works from international organizations, universities, and the Transportation Research Board. The Center would not duplicate information readily available from other organizations such as the EIA but instead would indicate how that information can be accessed.

The Center's repository could include relevant public information from international and U.S. government agencies (including state-level agencies), public interest stakeholders, universities, standards developers, the LNG industry, facilities that use LNG as a fuel, end users, and other reputable sources that LNG sector stakeholders can share in a transparent environment. The repository would be updated on an ongoing basis; both governmental and industry stakeholders would play a key role in ensuring that the repository remains pertinent.

The intent would be for the Center to define what constitutes information on best practices for LNG facility operations through a scoping process and input from relevant stakeholders. **Table 1** lists representative information categories that the repository may include, based on current knowledge.

[11] DOT Safety Council LNG Workshop, "Transportation and End-user Safety Hazards of the Emerging LNG Market," February 2018.

Table 1: Potential Document Categories to be Maintained in Center Repository

Category	Description
LNG Industry Standards and Guidance Documents (e.g., recommended practices)	Includes LNG industry documents related to design, construction, environmental consequences, operations, and maintenance of LNG facilities. If specific documents cannot be shared because of copyright or proprietary restrictions, the repository could include brief abstracts and where they can be obtained.
LNG Regulations	Includes LNG regulations from all U.S. agencies. The repository could describe regulation applicability by agency and provide links to current regulations, including both advisory and statutory standards designed to ensure the safety of LNG facilities, activities, and processes. This would help foster a more safety-centered LNG industry starting at the Federal level.
LNG Federal Goals, Roadmaps, and Progress	Provides a list of Federal, state, or otherwise nationwide LNG goals and agendas. This information would encourage more open dialogue among stakeholders and help guide the Center's events, roundtables, and conferences.
LNG-related Committees	Identifies opportunities for stakeholder awareness of and participation in pertinent LNG-related technical committees (e.g., NFPA-59A).
LNG-related Conference Schedules	Provides stakeholders with information relative to LNG conferences and encourages stakeholders to participate in conferences or keep abreast of changes in the LNG industry.
LNG Industry Leaders	Includes—but is not limited to—manufacturing, LNG production, LNG transportation, and fire protection equipment industry leaders. The goal of this list would be to provide stakeholders with additional information regarding industry leaders in areas such as tank design as well as vaporization and liquefaction equipment manufacturing.
Foreign and Domestic LNG Stakeholders and Contacts	Includes foreign and domestic government and private stakeholders. This information could be stored for reference when planning roundtables, conferences, speakers, and other Center-led events.
Conference Reports and Presentations	Includes information available from both Center-sponsored LNG conferences and outside events (when available).
Research Reports and Proceedings	Includes LNG-related research white papers, reports, and results.
LNG Facility Contacts	Make available to the Center's staff an internal document of LNG facility contacts for site tours or other familiarity activities.

The electronic storage of this information would require an information technology (IT) infrastructure to support the secure capture, storage, and dissemination of documentation or other information collected by the Center. A physical library is not required because the information collected would be used to assist with other Center functions, including collaboration with geographically dispersed LNG sector stakeholders. The Center could decide how it shares and uses collected information—considering copyright protections, security, and any other restrictions—and how stakeholders access the information.

5.3 LNG Sector Stakeholder Collaboration

As required by Section 111, this analysis identifies how the Center could facilitate collaboration among LNG stakeholders. Input gathered from interviews during the development of this study

that was conducted with LNG sector stakeholders revealed an interest in increased communication and coordination with the following entities:

- Operators that represent the broad array of LNG facility types operating in the United States, which may include import and export terminals, peak-shaving facilities, and fueling facilities (including fueling for marine, rail, and road transportation);
- States, Indian tribes, and units of local government, which may include state fire marshals, local zoning authorities, and emergency responders;
- Postsecondary education institutions;
- Labor organizations;
- Safety organizations;
- Public interest groups;
- Information Sharing and Analysis Centers; and
- Federal regulatory agencies of jurisdiction, which may include the following:
    - PHMSA
    - FERC
    - DOE
    - OSHA
    - USCG
    - MARAD.

Additional stakeholders may include the following:

- Companies that provide design, manufacturing, and construction services for LNG facilities and equipment;
- Industry associations and nonprofit institutions;
- Research entities that have performed government-sponsored LNG research, such as the Gas Research Institute and specific national laboratories;
- Sector Coordinating Councils;
- Government agencies such as the Cybersecurity and Infrastructure Security Agency, Transportation Security Administration, U.S Army Corps of Engineers, National Oceanic and Atmospheric Administration, the Environmental Protection Agency, and the Department of Interior; and
- Companies involved in any additional aspects of the LNG value chain.

As part of its function of fostering communication among stakeholders, the Center could work with each stakeholder to better understand their respective information needs and roles in advancing safety, environmental protection, efficiency, and competitiveness within the LNG sector. Additionally, the Center could establish common goals for improving LNG safety, mitigating environmental impacts, and building trust through multiple collaborative engagements which could include dedicated one-on-one meetings with individual stakeholders, roundtable

discussions[12], conferences to reach large audiences, and tours of LNG facilities and service provider/equipment manufacturer sites for regulatory and other governmental staff.

The Center also could disseminate information to relevant stakeholders and promote collaborative projects that benefit the public by addressing issues of safety, the environment, equity, and technological challenges. For example, the cooperative work between PHMSA and the LNG sector led to the development of a model evaluation protocol (MEP), which PHMSA uses to determine whether software other than that currently specified in 49 CFR Part 193 should be approved for use in performing siting evaluations. The MEP includes performance measures and procedures used by regulators to determine suitable models that ensure public safety.

5.3.1 Coordination With PHMSA Training and Qualifications (TQ) Division

The PHMSA TQ Division in Oklahoma City, Oklahoma, 1) provides training courses for federal and state pipeline safety inspectors; 2) promotes the uniform application of safety regulations through classroom instruction, laboratory training, and field exercises; and 3) conducts seminars for states and industry representatives on pipeline safety regulations. The TQ site is comprised of classroom facilities and an outdoor laboratory area. TQ instructors offer both virtual instruction, classroom, and hands-on training through field scenarios. Section 111 states that the Center should coordinate with the TQ Division "to facilitate knowledge sharing among, and enhanced training opportunities for, Federal and State pipeline inspectors and investigators."

The Center may gain a substantial understanding of changing training needs within the LNG industry through its interactions with stakeholders and regular and recurring discussions of LNG curriculum, industry trends, and technological updates. To help the Center and the TQ Division accomplish their respective objectives, the Center would be required to 1) inform the TQ Division of emerging training needs based on industry trends and 2) coordinate with the TQ Division to create, modify, and deliver any LNG-related training.

Furthermore, as the demand for LNG increases around the world, the Center and the TQ Division could be well situated to educate stakeholders on emerging LNG-related safety issues through virtual or in-person training. This could serve the dual benefit of helping 1) reduce greenhouse gas emissions globally and 2) promote environmental best practices for adoption by foreign LNG operators, as well as U.S. operators who are required by Federal statute to minimize methane emissions per Section 114 of the PIPES Act of 2020.

5.3.2 Coordination With Educational Institutions

Section 111 states that the Center may be operated with an educational institution. University partnerships could contribute to the Center's activities via research, collaboration, and existing relationships with stakeholders as well as toward staffing, facilities, and administrative services. Because of the Center location considerations outlined in Section 111, this report focuses on universities near the Gulf of Mexico which 1) are near existing and developing LNG export terminals and 2) have programs that focus on LNG-related areas of study. Other institutions may ultimately be considered, particularly if a multi-university approach is selected.

[12] Organized conversations in which a topic is presented and each participant is provided an equal opportunity to voice opinions

The following universities have provided input on potential involvement with the Center as well as indicated a willingness and ability to submit a proposal for supporting joint operation of the Center.

- Louisiana State University (LSU), Baton Rouge, Louisiana. Point of contact (POC): Dr. David Dismukes, Executive Director, Center for Energy Studies
- McNeese State University, Lake Charles, Louisiana. POC: Dr. Tim Hall, Dean of Science, Engineering, and Mathematics
- Rice University, Houston, Texas. POC: Dr. Kenneth B Medlock III, Senior Director, Center for Energy Studies
- Texas A&M University, College Station and Galveston, Texas. POC: Jeff Spath, Director, Crisman Institute for Petroleum Research
- University of Houston (UH), Houston and Sugarland, Texas. POC: Dr. Ramanan Krishnamoorti, Chief Energy Officer

Each institution offers a variety of experiences, indicated a willingness to collaborate with the Center, has existing relevant research centers, and possesses a demonstrated history of LNG-related collaboration with industry and government. Representative examples of such research centers include the following:

- LSU
    - Center for Energy Studies
    - Center for Coastal Resiliency
    - Center for Innovations in Structural Integrity Assurance
    - Coastal Marine Institute
- McNeese State University
    - U.S. Department of Labor-funded LNG Center of Excellence
    - Energy Institute of Louisiana (via collaboration with the University of Louisiana Lafayette)
- Rice University
    - Center for Energy Studies
    - Subsea Systems Institute (in collaboration with UH and the National Aeronautics and Space Administration (NASA))
- Texas A&M University
    - Homeland Security National Emergency Response and Recovery Training Center
    - LNG Safety Research at the Mary Kay O'Connor Process Safety Center and Texas A&M Engineering Experiment Station (TEES)
    - Management of the Ocean Energy Safety Institute (OESI) for Bureau of Safety and Environmental Enforcement (BSEE)
- UH
    - UH Energy Center Programs and Symposia
    - Subsea Systems Institute (in collaboration with Rice University and NASA)
    - Development of "LNG 101" video series with LNG industry

6 Center of Excellence Staffing

Section 111 notes that only after submitting this report to Congress—and subject to the availability of funds appropriated by Congress—the Secretary, in consultation with LNG sector stakeholders, may establish a center to be known as the National Center of Excellence for Liquefied Natural Gas Safety.

PHMSA currently performs the functions listed in Section 111 and described in Section 5 of this report to a degree and in a variety of ways. Existing staff is constantly enhancing its knowledge of the LNG industry through collaboration and training and the application of performance-based principles in LNG safety regulations. PHMSA staff also maintain internal repositories of information, including those related to LNG operations and safety. As previously noted, PHMSA coordinates with LNG sector stakeholders through workshops, IAs, and MOUs. With additional resources, however, the extent to which PHMSA could execute these functions would change.

The staffing requirements of a potential Center may be dependent on the following elements:

- The degree to which the functions are centralized.
- The extent to which PHMSA performs the functions listed in Section 111.
- The role of research in the Center.

The Center could use expertise from research partnerships and academia to inform existing research activities; however, no dedicated research staff would be required to perform this advisory and educational role. In another approach, research could be incorporated as a fundamental component of the three functions of the Center, which would thus require research staff. One example of an organization set up to conduct safety research for government agencies is OESI—the functions, responsibilities, and activities of which are described in Appendix A. OESI—which is a consortium of industry, national laboratories, nongovernmental organizations, and academia—was created to develop the technology and workforce needed for increased energy production that is safer, more sustainable, and more cost effective.

Within these elements, a range of options impact the staffing resources necessary to execute the functions of a Center. Sections 6.1 through 6.4 of this report include the following, respectively: 1) a description of three potential staffing models, 2) a comparison of the three staffing models, 3) a high-level overview of possible positions and duties required to effectively accomplish the Center's mission, and 4) additional considerations for addressing staffing needs.

6.1 Center Models

This section presents three viable models for how the Center could be structured across a range of staffing, cost, and involvement levels and the degree to which PHMSA performs the functions described in Section 111. These are not the only possible models, but rather are illustrative of the range of options.

6.1.1 Model 1—Existing Investment Level

In this model, PHMSA would use existing personnel and processes to execute the functions of a Center. This model requires minimal additional investments in personnel. Any resources would

be dedicated to creating and managing the repository of information, as well as establishing more frequent and routine collaboration and engagement with LNG stakeholders on regulatory and programmatic initiatives. This model would require existing PHMSA personnel to perform part-time duties for the additional activities needed to execute the functions described in Section 111.

Since 2002, PHMSA's Pipeline Safety Research Program has funded approximately $7.8 million in LNG research. These research investments have addressed safety risks and operational challenges from LNG facilities as well as fostered the development of new technologies and alternative designs for LNG storage and piping systems. PHMSA staff and contractor support personnel are managing Fiscal Year (FY) 2022 LNG investments of $2.5 million and planned FY 2023 investments of $2.5 million.

6.1.2 Model 2—Increased Investment in Existing PHMSA LNG Activities

In this model, PHMSA would provide dedicated staff whose primary responsibility would be to execute the Center's functions. This could include the personnel deemed most critical from the positions described in Section 6.3 of this report. In addition, this model assumes that the Center would be located at an existing PHMSA facility.

This model provides the flexibility to customize the number and composition of the Center's staff according to desired outcomes. In this example, up to an additional eight full-time PHMSA employees could be devoted solely to executing the functions of the Center outlined in Section 111.

In addition to the $2.5 million in LNG research that PHMSA currently manages, this model illustrates $3.5 million in additional LNG research activities, for a total of $6 million in LNG research. This model assumes that this research would not be conducted through the Center and that all LNG research would continue as part of the existing Pipeline Safety Research and Development Program.

6.1.3 Model 3—Adding a Separate Center of Excellence at a New Location

This model assumes that the Center would be established in a new location, separate from an existing PHMSA facility. In this model, additional staff comprising 10 full-time PHMSA employees would execute the core functions of the Center. Additionally, the staff would include all necessary expertise to incorporate best practices and related elements within the Center's functions.

Similar to Model 2, this model illustrates LNG research activities totaling $6 million, which includes the $2.5 million in LNG research that PHMSA currently manages, as well as $3.5 million in additional LNG research investment. This model, however, assumes that the Center would be administering these LNG research activities.

6.2 Staffing Model Comparison

Table 2 compares the research models PHMSA could use—each based on the extent to which PHMSA is tasked with executing the functions of the Center and the role of research in the Center, should it be established. These models represent three points along a continuum of possible staffing options; the number of personnel and their specific roles are flexible. The

resources necessary to perform the functions of the Center would increase along with the number of personnel and amount of desired research; Section 8 provides a detailed cost analysis of each model.

Table 2: Illustrative Staffing Model Comparison

Category	Model 1—Existing Investment Level	Model 2—Increased Investment in Existing PHMSA LNG Activities	Model 3—Adding a Separate Center of Excellence at a New Location
Administrative	Part-time duties delegated to existing staff in the Program Development Division	Director Program Analyst Operations Coordinator Knowledge Management Specialist	Director Program Analyst Operations Coordinator Knowledge Management Specialist
Training and Outreach	Part-time duties delegated to existing staff in the Engineering and Research Division	Outreach Program Coordinator Engagement Specialist	Outreach Program Coordinator Engagement Specialist
Technical	Part-time duties delegated to existing staff in the Standards and Rulemaking Division	Regulatory Specialist Environmental Specialist	Regulatory Specialist Environmental Specialist Security Coordinator Economist
Research	Research managed by current PHMSA staff	Research managed by current PHMSA staff	Research managed by Center personnel Academic Fellows (ad hoc by topic)

7 Center of Excellence Location

If a new physical location for a Center is deemed necessary, the requirements outlined in Section 111 will inform the initial consideration for the Center's potential location. Section 111(e)(1) states,

> "The Center shall be located in close proximity to critical LNG transportation infrastructure on, and connecting to, the Gulf of Mexico, as determined by the Secretary."

Additionally, Section 111(e)(2) provides "Considerations" for determining the location of the Center, including that the Secretary must—

> "(A) take into account the strategic value of locating resources in close proximity to LNG facilities; and
>
> "(B) locate the Center in the State with the largest LNG production capacity ..... "

PHMSA discusses the aforementioned considerations in the following sections. To ensure a comprehensive analysis, PHMSA reviewed the states with the largest and second-largest LNG production capacity in its consideration of the strategic value of locating a Center near LNG facilities and stakeholders.

7.1 LNG Terminals Along the Gulf of Mexico

LNG export terminals are the primary LNG facility type located along the Gulf of Mexico. **Figure 2** shows the location of operational facilities throughout the southeastern United States,

including FERC-approved LNG export terminals[13] along the Gulf of Mexico authorized as of December 27, 2020—the date of Section 111 enactment. Texas, Louisiana, and Mississippi each have at least one terminal.[14]

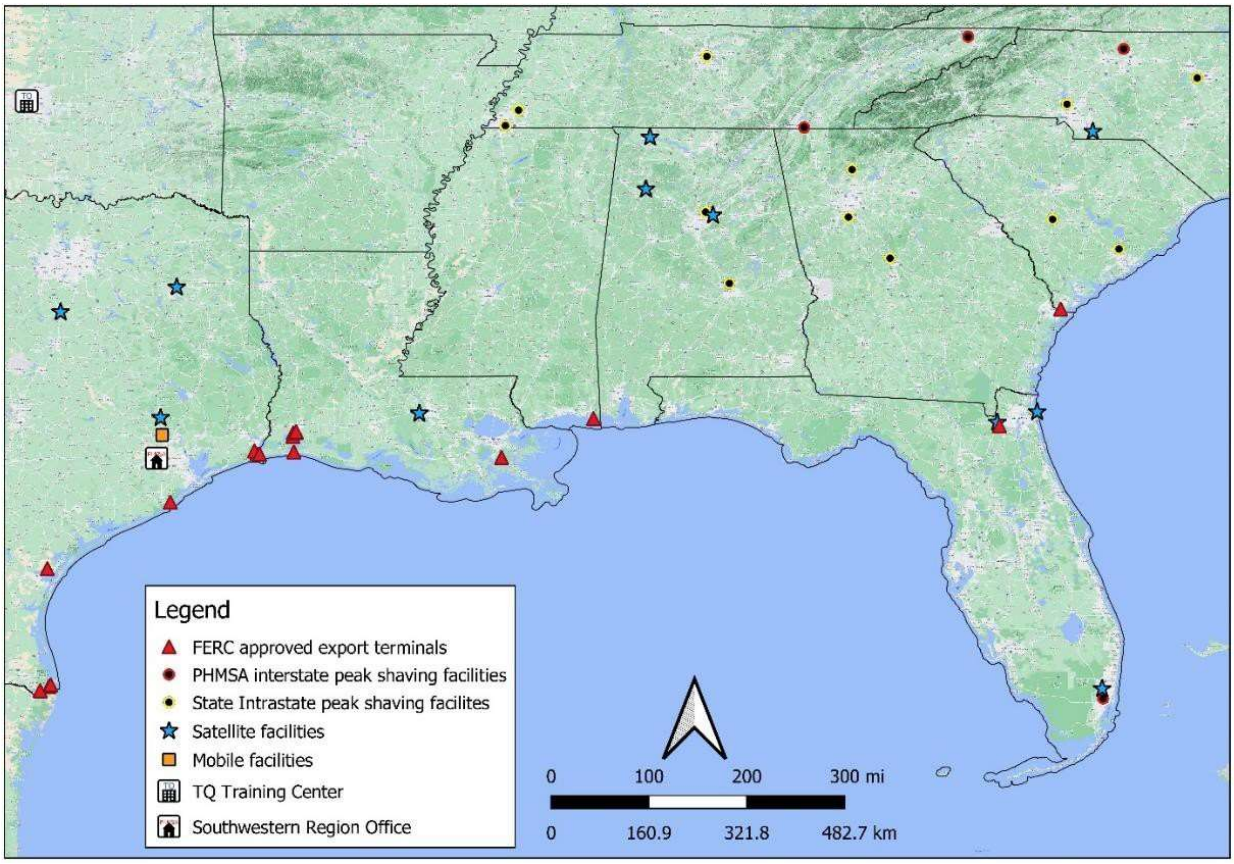

Figure 2: LNG Facilities in the Southeastern United States

7.2 LNG Production Capacities by State

Table 3 provides the total U.S. LNG export terminal capacities by state; this includes all FERC-approved export facilities as of December 27, 2020.[15] When production was expressed as million metric tons per annum (MTPA) in FERC documents, 0.13 was used as the conversion factor.[16] Based on this analysis, Louisiana is the largest producing state, followed closely by Texas. Mississippi, the only other state with a terminal on the Gulf, has much smaller, single-facility production capacity.

[13] LNG export terminals authorized as of the date of Section 111 enactment (December 27, 2020).
[14] FERC eLibrary, Order Granting Authorization Under Section 3 of the Natural Gas Act. Washington (DC): Federal Energy Regulatory Commission. Retrieved December 2, 2021, from https://elibrary.ferc.gov/eLibrary/search.
[15] Since December 27, 2020, FERC authorized increasing the annualized LNG production capacity for the Golden Pass LNG Export Project (CP20-459-000), Freeport LNG Export Terminal (CP20-532-000), Corpus Christi Export Terminal (CP19-514-000), and Sabine Pass Export Terminal (CP19-515-000). These approvals do not change the daily LNG production capacity of the export terminals, with the exception of the Golden Pass LNG Export Project (an increased daily LNG production of approximately 0.5 Bcf/d).
[16] Specifically, the MTPA must be multiplied by 0.131584156 to calculate Bcf/d, as noted by the North American Cooperation on Energy Information. This conversion factor can vary depending on gas composition assumptions for each facility

Table 3: Production Capacities by State

State	Total Production (Bcf/d)	FERC-Approved Export Facilities
Louisiana	21.2	Cameron LNG, Limited Liability Company (LLC) Driftwood LNG, LLC Magnolia LNG, LLC Venture Global Calcasieu Pass, LLC Venture Global Plaquemines LNG, LLC Sabine Pass Liquefaction, LLC Lake Charles LNG Export Company, LLC
Texas	16.3	Corpus Christi Liquefaction, LLC Freeport LNG Development, Limited Partnership Golden Pass Products, LLC Port Arthur LNG, LLC Rio Grande LNG, LLC Texas LNG Brownsville, LLC Annova LNG Brownsville
Mississippi	1.5	Gulf LNG Liquefaction Company, LLC

7.3 Location Considerations

Currently, PHMSA strategically co-locates its offices with other federal agencies to achieve efficiency and cost savings. As required by Section 111, this report also considers the potential strategic value of locating the Center near LNG facilities and LNG sector stakeholders. Using guidance and input from LNG sector stakeholders, PHMSA considered the following factors for the Center's location:

- Proximity to the Gulf of Mexico;
- Proximity to LNG export terminal corporate offices and facilities;
- Proximity to Federal and LNG sector stakeholders;
- Proximity to an international airport; and
- Local resources for recruiting and retaining employees to staff the Center, including:
    - Educational institutions (with relevant energy programs that might host the Center);
    - Housing and schools; and
    - Medical facilities.

Louisiana and Texas possess the aforementioned attributes that help make them suitable locations for the Center. These criteria favor larger metropolitan areas; smaller metropolitan areas may be less attractive from a recruiting standpoint and would make transportation to and from the Center more difficult. **Figure 3** shows the potential proximity to LNG corporate offices and facilities, industry stakeholders, international airports, and the educational institutions outlined in Section 5.3.2. Overall, Louisiana and Texas offer multiple locations that provide strategic value.

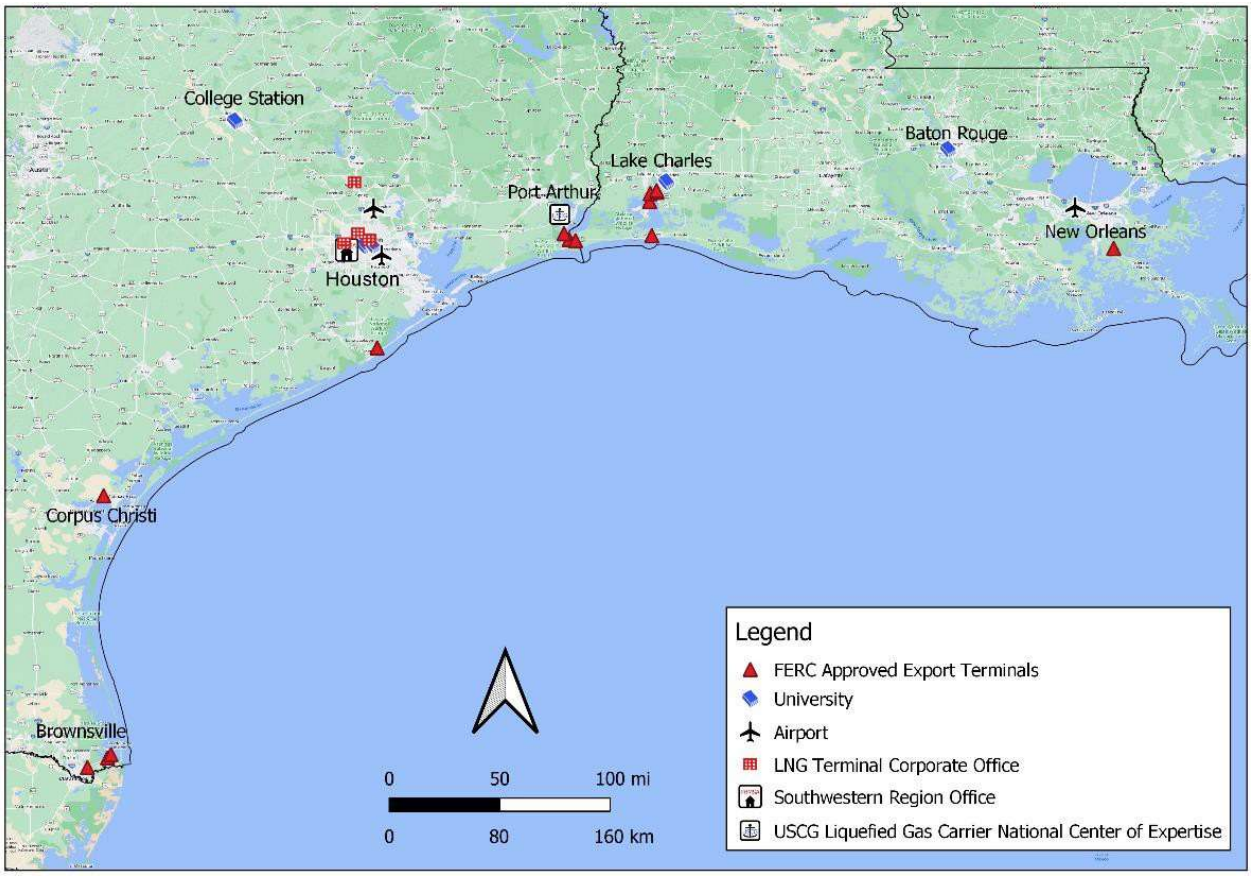

Figure 3: Texas and Louisiana LNG Facilities and Their Proximity to Resources

8 Cost Analysis

Section 111 requires that this report account for "the resources necessary to establish the Center." The previous sections detailed the Center's functions and how they could be executed. The primary cost considerations include the following:

- Staff—salaries and benefits;
- Facilities—office space, communication and facilities, supplies, and equipment;
- Travel—ability to attend site visits, roundtables, conferences, and meetings; and
- Services—establishment of technical products such as website or intranet capabilities.

To estimate the FY 2023 costs listed in **Table 4**, PHMSA used a GS-13, Step 5 pay grade with Washington, D.C., locality pay; this estimation was based on the three staffing models listed in **Table 2**. To account for physical location costs, PHMSA added standard General Services Administration (GSA) rent, equipment, and supplies—and the utilities and communications for shared services—then estimated $12,000 for annual travel per person. The research program estimate fully encompasses all elements of the role of research in the Center. The $6 million research program subtotal includes the salaries and benefits of all academic fellows and the cost of research funded through the Center.

The three models listed in **Table 4** represent three points along a continuum of funding possibilities for a Center. These are not the only possible options; rather they are illustrative potential approaches.

For example, even though Model 2 uses eight employees and provides no research function, it could easily be adapted to use four employees and provide some research activities. The intent is to provide a range of options to meet the need and an estimated rate of investment for each option. To calculate the investment estimate for an adaptation of any model, apply the average salaries, benefits, and other calculated costs to the number of staff chosen and the level of research to be conducted.

Table 4: PHMSA LNG Center of Excellence Annual Cost Estimate

Pipeline Safety Account	Model 1—Existing Investment Level	Range of Investment Model 2—Increased Investment in Existing PHMSA LNG Activities	Model 3—Adding a Separate Center of Excellence at a New Location
PERSONNEL RESOURCES			
Full-Time Employees*	0	8	10
Part Time Employees and Interns (0.5FTE each)	2	0	0
Operations			
Salaries and Benefits	148,000	1,184,000	1,480,000
Travel	12,000	96,000	120,000
GSA Rent	13,000	104,000	130,000
Communications & Utilities	38,000	304,000	380,000
Shared Services			
Supplies	4,500	36,000	45,000
Equipment	4,500	36,000	45,000
Operations Subtotal	**$ 220,000**	**$ 1,760,000**	**$ 2,200,000**
Research Program**			
Current LNG Research	2,500,000	2,500,000	2,500,000
Potential Additional LNG Research		3,500,000	3,500,000
Research Program Subtotal	**$ 2,500,000**	**$ 6,000,000**	**$ 6,000,000**
Contractor Support			
IT Collaboration Site	200,000	200,000	200,000
Admin Support			
Technical Support			
Contractor Support Subtotal	**$ 200,000**	**$ 200,000**	**$ 200,000**
TOTAL	**$ 2,920,000**	**$ 7,960,000**	**$ 8,400,000**

*These positions could be filled by a combination of full-time remote and employees reporting to a PHMSA office.

**If research funds are appropriated for LNG, the cost estimate will be modified accordingly. Model 1 and Model 2 do not assume that research would be conducted through the Center and instead PHMSA staff would continue to manage LNG research investments for the Pipeline Safety R&D Program. The amounts of additional research funding shown are illustrative, but models could be adjusted to reflect different levels of research investment.

9 Conclusion

PHMSA's strategic objectives include protecting the public by establishing, maintaining, and enforcing effective safety regulations and policies; strengthening collaboration and information sharing with other federal, state and local agencies; establishing an inspection and compliance team that can evaluate design, construction and operational elements of individual LNG projects that is consistent across all PHMSA regions; promoting and educating the public on PHMSA's role concerning the nation's energy infrastructure; building coalitions with industry and other stakeholders to enhance safety regulations and practices regarding LNG infrastructure; continuing to promote R&D through the federal grant programs that promote private/public partnerships; and collecting industry data, incident statistics, analyze trends and evaluate the efficacy of existing codes, policies, and procedures.

PHMSA collaborates with other federal, state and local agencies in the review of the design, construction, operation, maintenance, and inspection of LNG facilities. PHMSA maintains coalitions with industry and other stakeholders by participating on industry standards committees to provide comment on practices and/or technologies; attending and participating in LNG focused technical meetings, conferences, and forums to educate industry, the public, and stakeholders about PHMSA's mission and regulations; and coordinating R&D with industry and other stakeholders address LNG safety gaps.

The Center suggested by Section 111 involves more than just a research focus, therefore, it may be helpful to examine the organization and operations of additional Centers of Excellence when considering whether to establish a Center and how it would operate. The BSEE-sponsored OESI (described in Appendix A) provides an example approach for a collaborative, research-based Center.

This report provides a thorough analysis of how a Center could perform the three functions outlined in Section 111: furthering the expertise of the Federal Government in the operations, management, and regulatory practices of LNG facilities; acting as a repository of information on best practices for the operation of LNG facilities; and facilitating collaboration among LNG sector stakeholders. It also provides an analysis for a possible Center location that meets the criteria outlined in the Section 111, which include taking into account the strategic value of locating resources in close proximity to LNG facilities; and locating the Center in the State with the largest LNG production capacity. Based on these criteria, PHMSA has determined that Louisiana and Texas possess the aforementioned attributes that help make them suitable locations for the Center. Finally, it provides an estimate of the potential costs necessary to carry out the functions as outlined in Section 111. In determining these estimates PHMSA considered costs related to staffing, facilities, travel, and other services, such as the establishment of a website or intranet capabilities. PHMSA has provided three models representing three points along a continuum of funding possibilities for a Center. These are not the only possible options; rather they are illustrative potential approaches.

Appendix A OESI Model

One example of an organization set up to conduct safety research for government agencies is the Ocean Energy Safety Institute (OESI), which is a consortium of industry, national laboratories, nongovernmental organizations, and academia created to develop the technology and workforce needed for increased energy production that is safer, more sustainable, and more cost effective.

OESI is operated and funded by Texas A&M Engineering Extension Service (TEES) under a cooperative agreement with Bureau of Safety and Environmental Enforcement (BSEE) and Department of the Energy (DOE), which is completed through a funding opportunity announcement that established the OESI. BSEE and DOE work together under an MOU that establishes BSEE as the administering party of the cooperative agreement which uses a joint steering committee (JSC) to provide oversight of OESI. Although the JSC is not part of OESI, it approves OESI research. The JSC consists of three members each from BSEE and DOE.

The original OESI included the specific functions highlighted in **Table A-1**.[17] The OESI 2.0 Objective, as listed in the funding opportunity number S21AS00165 on www.grants.gov, is to "build a World Class Center of Excellence for Ocean Energy Safety and Development that brings together the interests of DOI/BSEE and DOE/Office of Oil and Natural Gas, and DOE/Office of Energy Efficiency and Renewable Energy for mutual benefit."

Table A-1: Original OESI Functions

Function	Summary
Research	Develop a program of research, technical assistance, and education that serves as a center of expertise in oil and gas exploration, development, and production technology, including technology specific to deepwater and Arctic exploration and development
Best Available and Safest Technology	Provide recommendations and technical assistance to BSEE and Bureau of Ocean Energy Management (the Federal agencies) related to the determination of the best available and safest technology and environmentally sound oil and gas development practices for the Outer Continental Shelf (OCS)
Recommendations for OCS Exploration and Development	Provide recommendations and technical assistance related to geological and geophysical sciences relevant to understanding the technical challenges of OCS exploration and development, such as reservoir characteristics, geohazards, and worst-case discharge analyses
Equipment Failure Reporting and Database System	Develop and maintain a domestic and international equipment failure reporting system and database of critical OCS equipment failures related to control of the well. That will allow OESI to identify reliability issues and industry trends and issue safety alerts when appropriate. This system should engage both the user and manufacturer of the equipment
Contribute to Federal Employee Expertise	Engage employees of the Federal agencies to participate in research and training to enable the employees to remain current on state-of-the-art technology associated with offshore oil and gas development
Standards Collaboration	Promote collaboration among Federal agencies, industry, standards organizations, academia, and the National Academy of Sciences
Reporting	Provide BSEE with reports on all OESI activities on a quarterly basis and at an annual in-person meeting

[17] https://www.schoolitgrants.info/GrantDetails.aspx?gid=35131. Retrieved on May 27, 2022.

Under this model, BSEE and DOE each approve research and provide up to $20 million ($40 million total) over a 5-year period to fund the research. TEES, however, is responsible for independently managing OESI under the expertise, direction, and oversight of the JSC. Additional information regarding this successful research model is available on the TEES OESI website at https://oesi.tamu.edu/.

Key tasks of the organization responsible for managing OESI (currently TEES) include, but are not limited to, the following:

- Developing and submitting draft technology roadmaps for research leading to improved safety and environmental protection for offshore oil and gas, wind, and marine and hydrokinetic (MHK) development and operations. Development activities are expected to include establishing the strategic direction, providing leadership, and managing intellectual property and data.
- Developing—in collaboration with the JSC—and submitting annual plans for activities pursuant to JSC-approved roadmaps.
- Administering a world-class R&D program—per the aforementioned approved roadmaps and annual plans—that includes offshore safety, oil and gas production, oil spill prevention and response, and offshore safety and environmental protection research as well as the following wind- and MHK power-related monitoring approaches in accordance with appropriate authorities and in conjunction with relevant Federal resource agencies:
    - R&D program administration that includes competitive and/or noncompetitive solicitations, proposal evaluations, selections, and award negotiation, for specific research projects pursuant to approved roadmaps.
    - Administrative costs comprising less than 10 percent of funds for OESI management to maximize R&D funding.
- Executing technology transfer of research results and insights to industry and other stakeholders.
- Identifying research needs and gaps and recommending new research topics.
- Developing its workforce via the application of innovative and advanced technologies used for offshore oil and gas operations as well as offshore wind and MHK.
- Collecting, analyzing, and disseminating health, safety, and environmental compliance data to highlight key issues, identify trends, and communicate technology gaps.
- Identifying and developing 1) partners willing to provide nonfederal R&D investment funding and 2) other relationships with the broader research community and stakeholders, as necessary, to complete and disseminate the research as well as prevent duplication of effort with ongoing related research projects.

Specific technical areas of interest include the following:

- Oil and gas
    - Research for offshore oil and gas production and oil spill prevention across all technology readiness levels (TRLs) in the following areas:
        - Geohazards identification, including lower-cost, real-time data capture and processing as well as more localized geological characterization related to slumping potential, earthquake potential, and zones of anomalous hydrostatic pressure.
        - Maintenance of well control over its lifecycle, including drilling, completion, production operations, workovers, final plugging, and abandonment. This includes wellbore construction (pipe and cement) as well as wellbore integrity and stability assessments and predictions, early kick detection, high-pressure/high-temperature materials for zonal isolation, and transmission of data from ahead of the bit to surface.
        - Subsea automation and reliability, including sensors, subsea power generation, enhanced oil recovery injection systems, drilling from the seafloor, robotics, fiber optics corrosion treatment/prevention, materials for extreme conditions, prevention of cyber failure, reliable flow assurance and control, and produced water treatment and handling.
        - Surface systems and umbilicals, including met-ocean effects associated with normal and extreme conditions, predictions of effects on platforms at small scale, and cumulative fatigue analyses that inform facility design and predictive equipment maintenance capabilities over the facility lifecycle. These comprise engineered systems extending from the ocean floor up to and including the production platform.
    - Research for oil and gas production across all TRLs, with special emphasis on TRL 5 and above in the following areas:
        - Production operations and facilities.
        - Wellbore integrity.
        - Reservoir stimulation technologies, including enhanced oil recovery.
    - The manual mining and review of safety incident reports created prior to 2019 to identify selected data points that demonstrate skill in identifying trends.
- Offshore wind
    - R&D on technologies to improve installation and O&M safety and widen associated weather windows—such as operations-focused met-ocean monitoring, modeling and simulation tools, and improved access and transfer methods for technicians, tooling, and supplies—especially in high-sea conditions where safe operations are currently not possible.

- R&D on technologies that reduce the need for hazardous operations, such as the following:
  - Improved remote monitoring and management of wind plants.
  - The automation of installation operations and O&M, such as through autonomous (e.g., drone-based) inspection and repair, prognostic health monitoring and management, and technologies that monitor and reduce worker fatigue and strain.
- R&D on technologies to improve environmental protection in offshore wind development and operations, such as through improved construction noise mitigation techniques and marine mammal monitoring technologies.
- Research that improves the prevention of spills (such as of drivetrain and other lubricants, dielectric transformer oils) and the management of offshore wind operations.
- Research that informs domestic workforce development associated with safe offshore wind operations, such as gap analysis of existing worker safety standards and training as well as the synthesis of best practices from more mature offshore wind markets.

- MHK
  - R&D and deployment of MHK-powered environmental monitoring devices, such as MHK recharging stations for autonomous underwater vehicles and/or aerial drones.
  - Certification of MHK-powered monitoring devices.
  - Gathering of lessons learned for safe and environmentally sustainable offshore operations for future MHK installations.

Appendix B Acronyms and Abbreviations

49 CFR	Title 49, Code of Federal Regulations
49 USC	Title 49, United States Code
Bcf	Billion Cubic Feet
Bcf/d	Bcf per Day
BSEE	Bureau of Safety and Environmental Enforcement
CBO	Congressional Budget Office
CPI	Consumer Price Index
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIA	U.S. Energy Information Administration
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
GPAC	Gas Pipeline Advisory Committee
GS	General Schedule
GSA	General Services Administration
HR	Human Resources
IA	Interagency Agreement
IT	Information Technology
JSC	Joint Steering Committee
LLC	Limited Liability Company
LNG	Liquefied Natural Gas
LSU	Louisiana State University
MARAD	DOT Maritime Administration
MEP	Model Evaluation Protocol
MHK	Marine and Hydrokinetic

MOU	Memorandum of Understanding
MTPA	Metric Tons per Annum
NASA	National Aeronautics and Space Administration
NFPA	National Fire Protection Association
OCS	Outer Continental Shelf
OESI	Ocean Energy Safety Institute
O&M	Operations and Maintenance
OPS	Office of Pipeline Safety (PHMSA)
OSHA	Occupational Safety and Health Administration
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIPES	Protecting Our Infrastructure of Pipelines and Enhancing Safety (Act of 2020)
POC	Point of Contact
R&D	Research and Development
RSPA	Research and Special Programs Administration
SME	Subject Matter Expert
TEES	Texas A&M Engineering Extension Service
TQ	Training and Qualifications (Division of PHMSA)
TRL	Technology Readiness Level
UH	University of Houston
USCG	U.S. Coast Guard