



Opening Remarks

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Engineering and
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Liquefied Natural Gas (LNG) Research and Development (R&D) Public Meeting and Forum

November 15 & 16, 2022



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

PHMSA: Your Safety is Our Mission



Good Morning & Welcome!

- We value your attendance & participation
- Together we will:
 - Collaborate on LNG facility safety risks and other challenges
 - Uncover technical gaps complementary to those currently addressed
 - Develop comprehensive research topics for future investments



PHMSA's Safety Research Program



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

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PHMSA: Your Safety is Our Mission

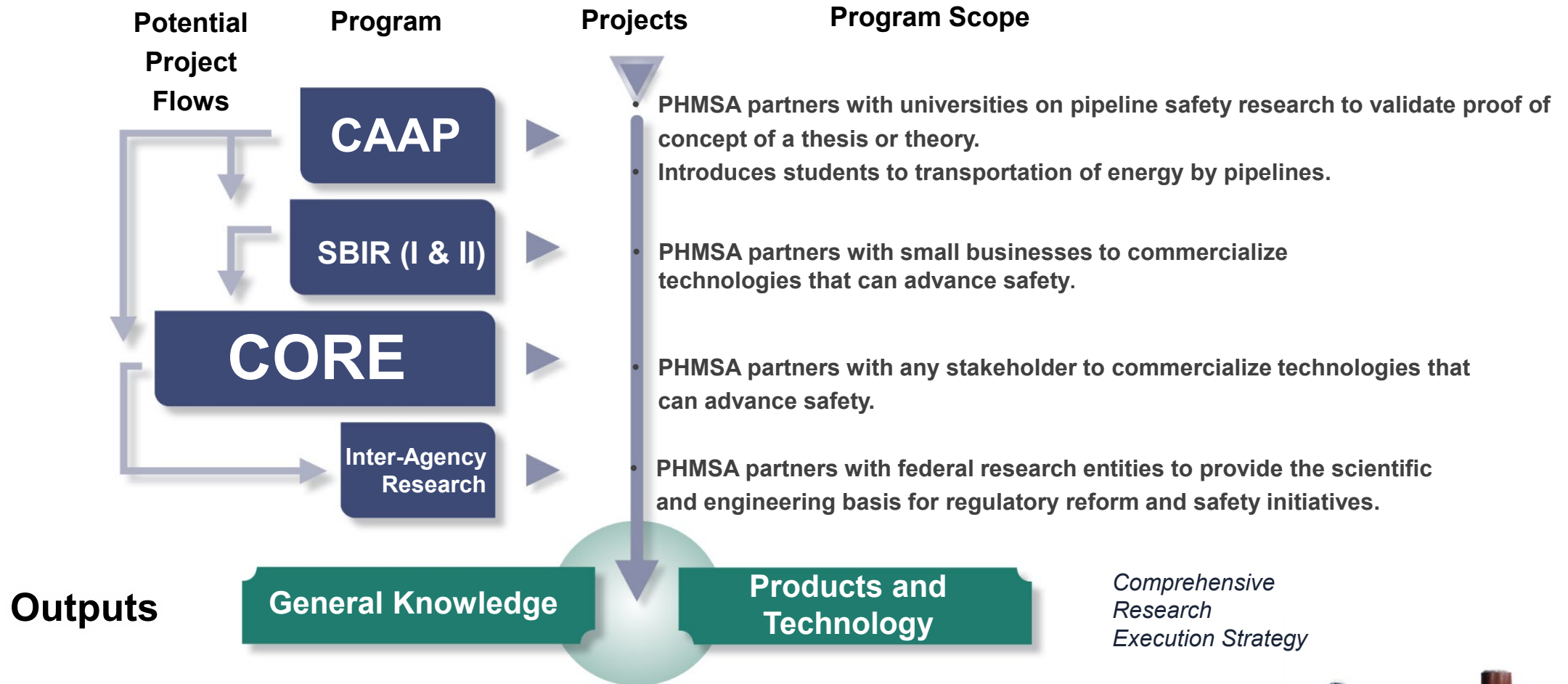


Safety Research Program Mission

To sponsor research and development projects focused on providing **near-term solutions** for the Nation's pipeline transportation system and LNG and underground natural gas storage facilities that will improve **safety**, reduce **environmental impact**, and enhance **reliability**.



Research Program Execution



Performance History Since 2002

Technology

Category	Technology Projects	Technology Demonstrations	Patent Applications (U.S. + Other)	Patents Granted (U.S. + Other)	Tech-Transfer/ Commercialized Technologies	PHMSA (\$M)	Cost Share (\$M)
Threat Prevention	28	18	4	3	6	\$12.95M	\$12.89M
Leak Detection	18	12	2	1	6	\$ 9.39M	\$ 7.02M
Anomaly Detection	44	33	24	14	17	\$30.28M	\$30.87M
Anomaly Characterization	9	3	0	0	1	\$ 4.32M	\$ 2.80M
Anomaly Repair	1	0	0	0	0	\$ 0.99M	\$0.00M
Pipe Remediation/ Rehabilitation	1	0	0	0	0	\$ 0.91M	\$0.91M
Materials	9	1	2	2	1	\$10.84M	\$ 7.91M
Welding/Joining	10	7	1	1	2	\$6.27M	\$7.48M
Alternative Fuels	3	2	1	1	2	\$1.09M	\$0.56M
Underground Natural Gas Storage	2	1	0	0	0	\$0.99M	\$0.99M
Totals:	125	77	34	22	35	\$79.13M	\$72.51M

Data as of 11/1/2022



Performance History Since 2002

General Knowledge/Knowledge Dissemination

Website Metric	Measure
Total Hits	42,226,035
Average Hits/Month	180,453
Downloads Since 2008	2,163,343



Library of Knowledge



Knowledge Promotion Metric	Count
Final Reports	287
Conference or Journal Papers	284
Public Events	45

Data as of 11/1/2022



The Changing LNG Landscape

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LNG History in U.S.

- **1914:** 1st US patent for LNG handling/shipping.
- **1941:** 1st commercial LNG peak shaving pipeline storage facility in Cleveland, OH.
- **1944:** **Worst Accident in LNG History** (Cleveland) LNG tank built with substandard WWII-rationed steel ruptures, spills LNG into sewers and ignites, resulting in 130 deaths.



LNG History in U.S.

- 1940s:** 1st full scale liquefaction plant built; explosion 1944 halting most LNG for ~20 years.
- 1959:** 1st LNG ship built; Methane Pioneer.
- 1960s:** Gas shortage prompts construction of ~ 70 peak shavers.
- 1970s:** Four import facilities built; Federal regulations adopts NFPA 59A.
- 1980s:** 49 CFR 193 LNG Regulation; increased domestic production, expanded interstate pipeline, imports from Canada slows American LNG industry. By 1986 no imports of LNG. Import facilities mothballed/low utilization.
- 1990s:** LNG usage begins to exceed domestic supply.
- 2000s:** LNG import facilities reactivated.
- 2010s:** Hydraulic fracturing results in surge of domestic production of natural gas. Import terminals converting to export and design/build new LNG export facilities.



Regulatory Effectiveness

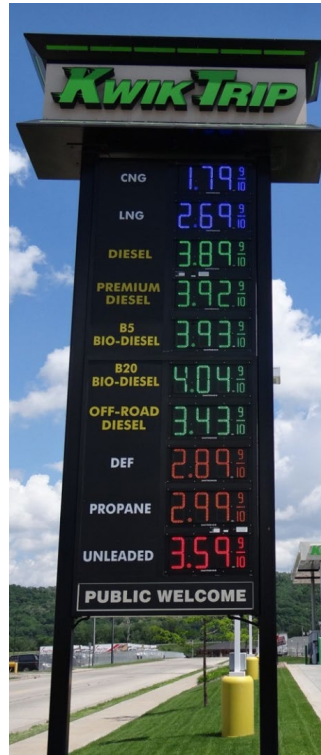


- 1980: 1st Federal LNG Safety Regulations
 - LNG peak shaving facilities
 - LNG marine import terminals
 - Mobile/Temporary facilities



Other LNG Transportation Modes

New types of LNG transportation modes driven by shale gas abundance and stricter greenhouse gas emissions regulations.



Fuel Type	Price per Gallon
CNG	1.79
LNG	2.69
DIESEL	3.89
PREMIUM DIESEL	3.92
B5 BIO-DIESEL	3.93
B20 BIO-DIESEL	4.04
OFF-ROAD DIESEL	3.43
DEF	2.89
PROPANE	2.99
UNLEADED	3.59



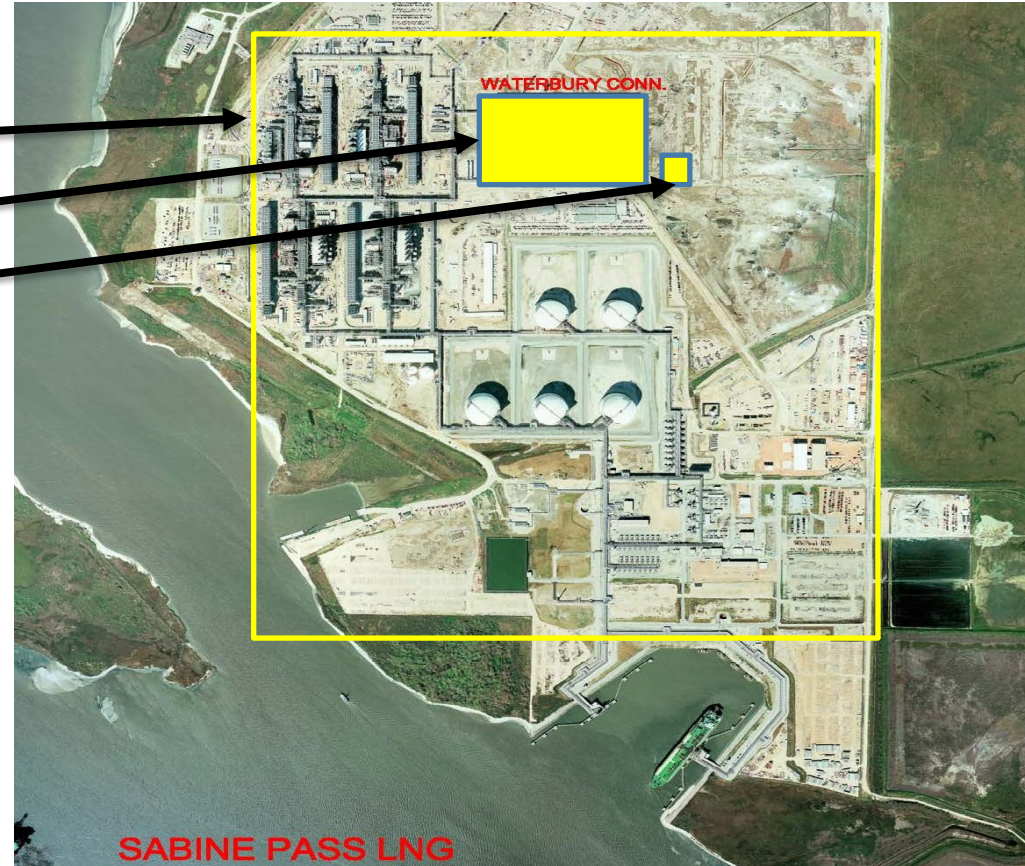
Changing Risk Profile of New Facilities

1. Shrinking Lot Size

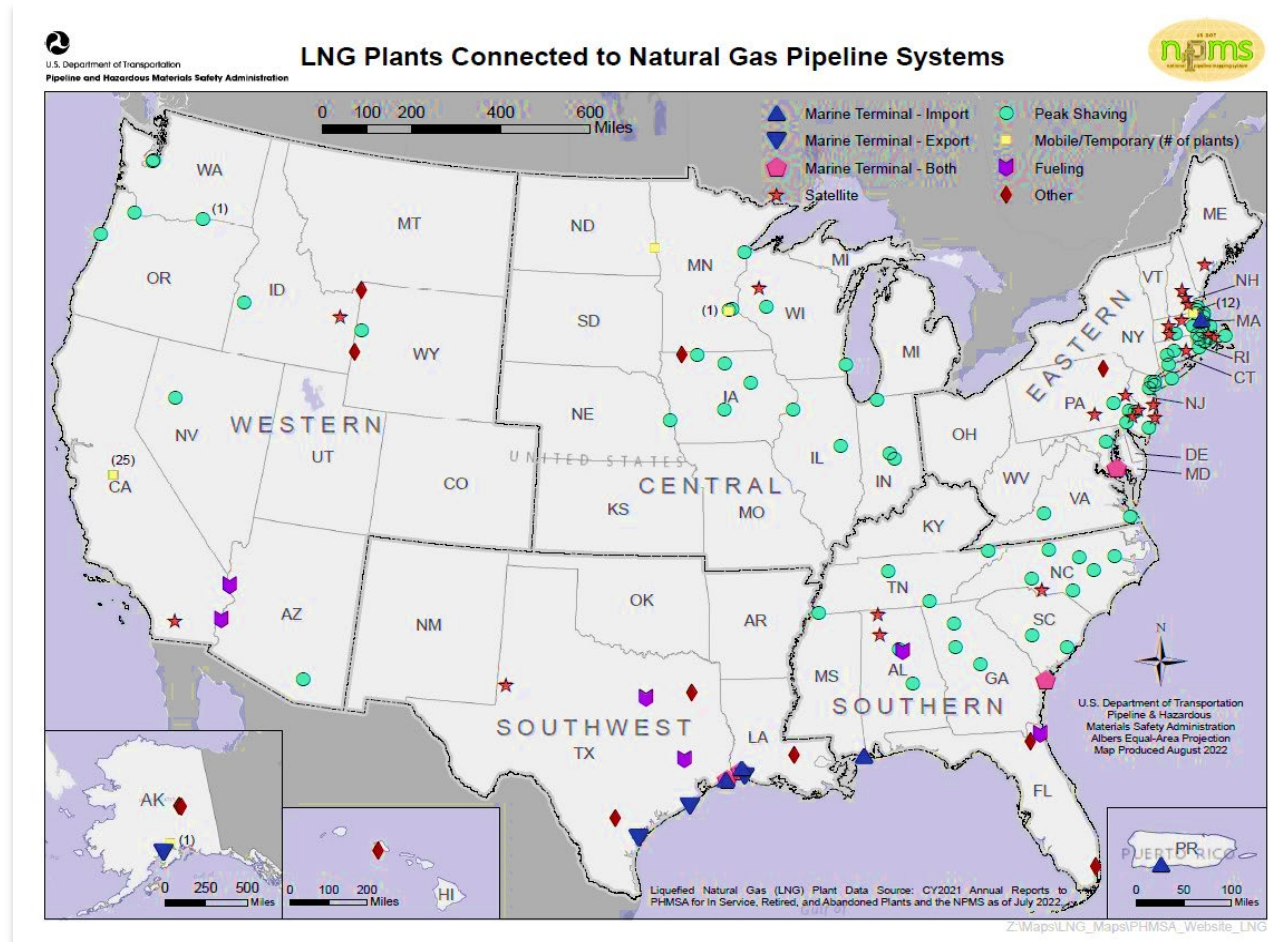
- 1000 acres: Marine Export
- 100 acres: Peak Shaving
- 15 acres: Small-Scale

2. Near High Population

3. Vehicle Fuel Transfer



Map of LNG Facilities



LNG Facility Research



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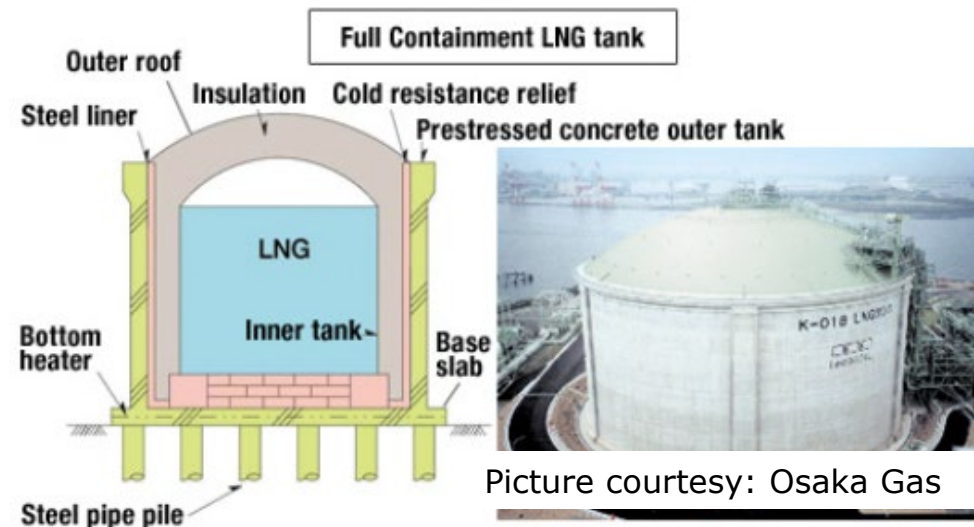
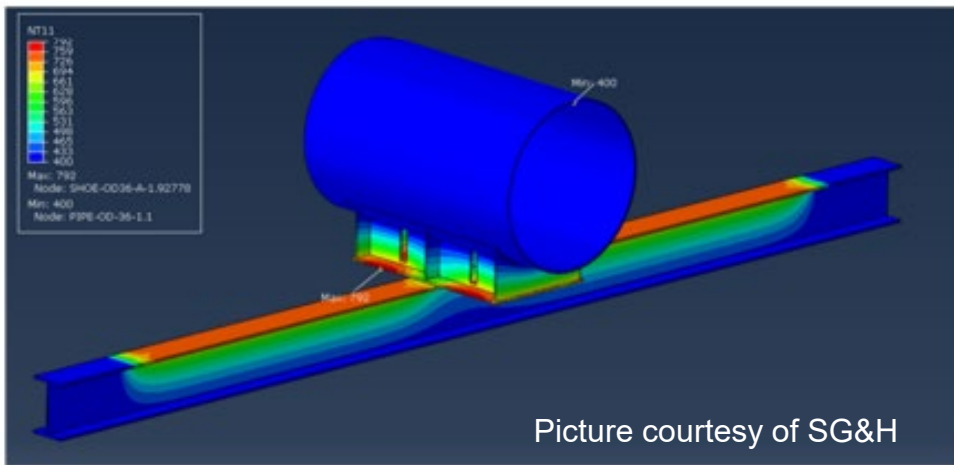
Research Portfolio (\$5.7 M)

Pri #	Project ID and Title	Status	Contractor	PHMSA
1.	<u>150</u> DTRS56-04-T-0005, Modeling and Assessing a Spectrum of Accidental Fires and Risks in a LNG Facility	Closed	Technology & Management Systems, Inc.	\$213,030.00
2.	<u>640</u> DTPH5615T00005L, Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools	Closed	CH-IV International	\$217,810.00
3.	<u>642</u> DTPH5615T00008L, Statistical Review and Gap Analysis of LNG Failure Rate Table	Closed	Gas Technology Institute	\$418,058.00
4.	<u>731</u> 693JK31810006, Consistency Review of Methodologies for Quantitative Risk Assessment	Closed	Gas Technology Institute	\$858,587.00
5.	<u>732</u> 693JK31810007, Performance Gap Comparison of Process Safety Management Consensus Standards and Regulatory Requirements for LNG Facilities	Closed	Gas Technology Institute	\$295,529.00
6.	<u>847</u> 693JK31910003POTA, Evaluation of the Efficacy and Treatment of Hazard Mitigation Measures for LNG Facilities	Closed	Gas Technology Institute	\$319,707.00
7.	<u>852</u> 693JK31910008POTA, Develop a Risk-Based Approach and Criteria for Hazard Detection Layout	Closed	Blue Engineering and Consulting Company	\$310,544.00
8.	<u>854</u> 693JK31910009POTA, Develop an Evaluation Protocol for Non-LNG Release Hazards - Modeling	Active	Blue Engineering and Consulting Company	\$485,344.00
9.	<u>922</u> 693JK32010004POTA, Vapor Cloud Explosion at Nil Wind	Closed	Blue Engineering and Consulting Company	\$134,704.00
10.	<u>923</u> 693JK32010012POTA, Development of Guidance on Potential Cascading Effects from Flammable Vapor Cloud Explosions	Active	DNV GL USA, Inc	\$1,231,520.00
11.	<u>947</u> 693JK32110004POTA, Developing Performance Criteria for External Loading Factors on External Steel Shell Tanks	Active	Simpson Gumpertz & Heger	\$424,429.00
12.	<u>948</u> 693JK32110005POTA, Liquefied Natural Gas Tanks Without Bottom Fill	Active	Blue Engineering and Consulting Company	\$331,760.00
13.	<u>949</u> 693JK32110006POTA, Developing Periodic External/Internal Inspection Requirements to Assess Low Temperature and Cryogenic Storage Tanks	Active	PEMY Consulting	\$165,000.00
14.	<u>980</u> 693JK32210005POTA, Determine the Maximum Permissible Temperature Drops for Steel when Exposed to Cryogenic Liquid	Active	Simpson Gumpertz & Heger	\$350,574.00

Project pages via <https://primis.phmsa.dot.gov/matrix/>

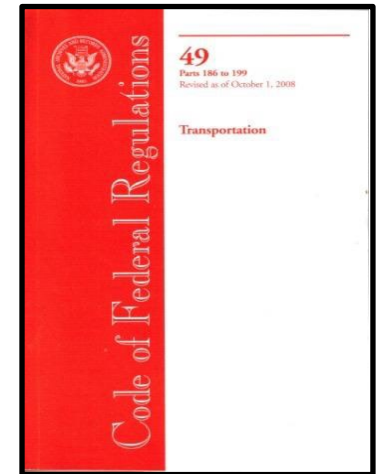
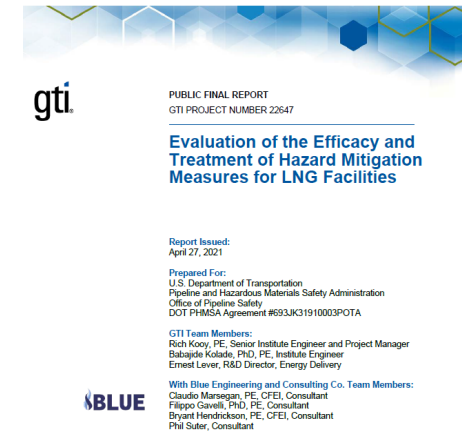


LNG Current Research Focus



Research Outputs/Outcomes/Impacts

- **Outputs:**
 - Growing portfolio of informative project reporting
- **Outcomes**
 - Knowledge driven into policy development, rulemaking and standard revision
- **Impacts:**
 - Contribution along with other PHMSA programs toward improved safety performance.



R&D Links

[About Research and Development](#)

[Congressional Mandates](#)

[Meeting and Events](#)

[Program Performance](#)

[Technology Success Stories](#)

[University Partnerships](#)

[Submit Research Ideas](#)

[Contact Us](#)

About Pipeline Research & Development

The mission of PHMSA's Pipeline Safety Research & Development Program is to sponsor projects focused on providing technical solutions that will improve pipeline safety, reduce the environmental impact of failures, and enhance the reliability of the Nation's pipeline transportation system.

The research program has the following objectives:

- Employ a coordinated and collaborative approach to address mutual pipeline challenges with a wide set of pipeline stakeholders
- Help remove technical and sometimes regulatory barriers on a given challenge
- Tell the research story by measuring our research results, outputs, and impacts
- Promote transparency by posting online R&D program/project actions and products.

R&D Program Website: <https://www.phmsa.dot.gov/research-and-development/pipeline/about-pipeline-research-development>

R&D program awards and sortable features: <https://primis.phmsa.dot.gov/matrix/>

Submit a research gap suggestion: <https://primis.phmsa.dot.gov/rd/gapsuggestions.htm>

Join the R&D Program Alerts Distribution List: <https://service.govdelivery.com/accounts/USDOTPHMSA/subscriber/new>



Thank You

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