



**Pipeline and Hazardous Materials Safety Administration**  
**Office of Pipeline Safety**

**PHMSA Public Meeting**  
**PHMSA Hydrogen Pipeline Safety Regulations**

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*US DOT - PHMSA – Office of Pipeline Safety, Engineering and Research Division*

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# PHMSA's Mission

To protect people and the environment by **advancing the safe transportation of energy and other hazardous materials** that are essential to our daily lives. To do this, the agency establishes national policy, sets and enforces standards, educates, and conducts research to prevent incidents. We also prepare the public and first responders to reduce consequences if an incident does occur.

## PHMSA By the Numbers

**3.3 Million**

Miles of Regulated  
Pipelines

**1.2 Million**

Daily Shipments of  
Hazardous Materials

**16,700**

Underground Natural Gas  
Storage  
Wells

**1.6 Billion**

Tons of Hazardous  
Materials Shipped  
Annually by All Modes

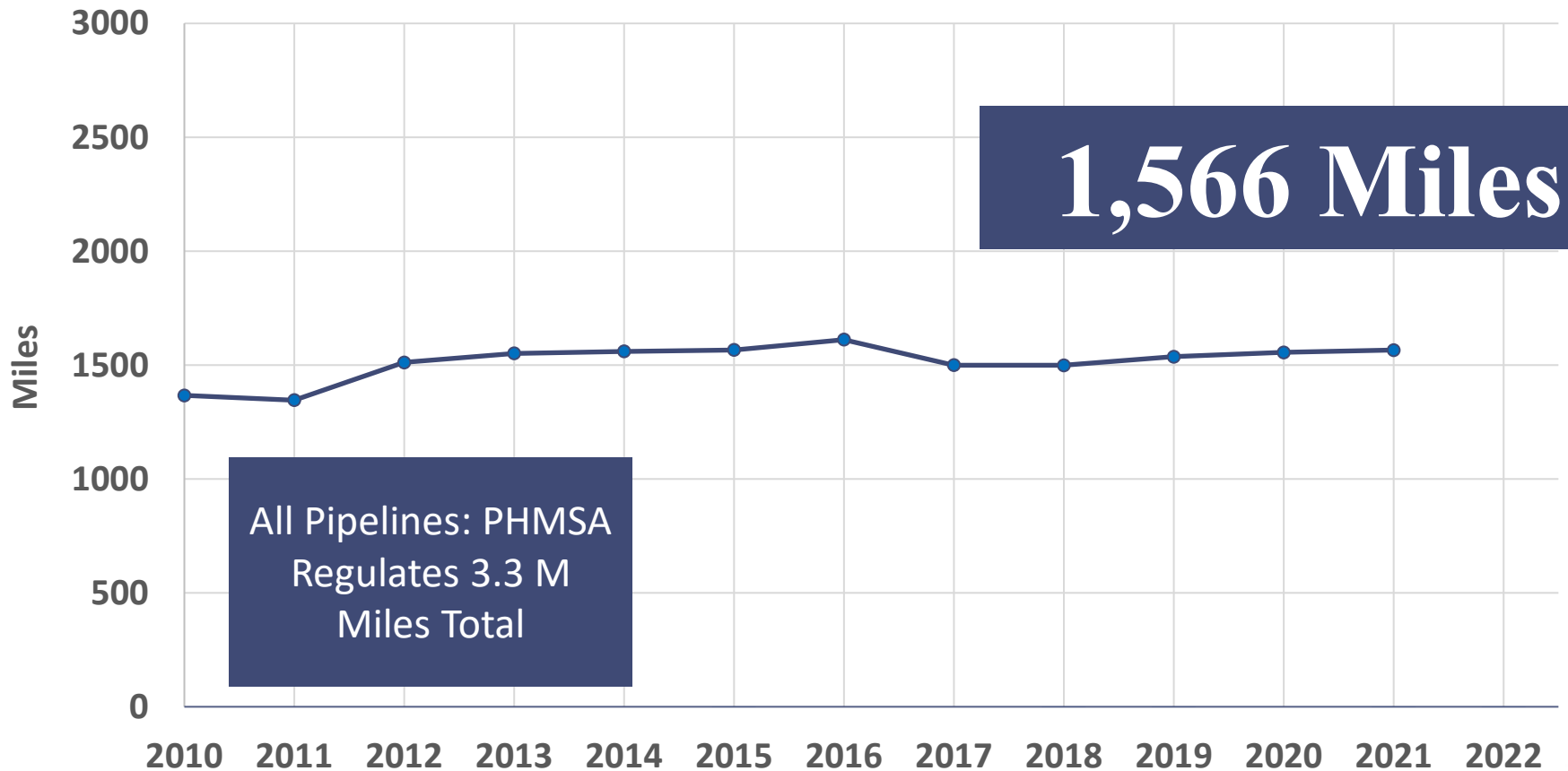
**64%**

Of U.S. Energy  
Commodities  
Transported by Pipeline



# Hydrogen Pipelines

## Regulated H<sub>2</sub> Pipeline Mileage





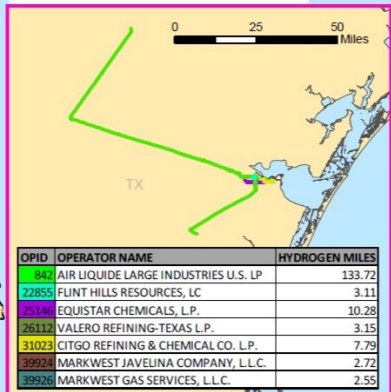
# Hydrogen Gas Transmission Pipeline Map

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

## Hydrogen Gas Transmission Pipelines National Pipeline Mapping System



FOR OFFICIAL USE ONLY



OPIID	OPERATOR NAME	HYDROGEN MILES
117	AIR PRODUCTS & CHEMICALS INC	539.27
842	AIR LIQUIDE LARGE INDUSTRIES U.S. LP	366.50
872	LARTITE GAS PIPELINE	5.88
4906	EXXONMOBIL PIPELINE CO	0.39
12624	EXXONMOBIL OIL CORPORATION	3.14
15485	PHILLIPS 66 COMPANY - SWEENEY REFINERY	41.09
19339	TPC GROUP, LLC	0.89
20044	LINDE	489.70
21159	SASOL CHEMICALS USA LLC	0.87
22855	FLINT HILLS RESOURCES, LC	22.18
25146	EQUISTAR CHEMICALS, L.P.	24.09
26112	VALERO REFINING TEXAS L.P.	3.15
30544	OCCIDENTAL CHEMICAL CORP	1.93
30683	WESTLAKE PETROCHEMICALS LLC	1.22
30709	HUNTSMAN PETROCHEMICAL LLC	2.13
30825	CITGO PETROLEUM CORPORATION (REFINERY)	1.32
30951	ALBEMARLE CORPORATION	2.61
30959	THE DOW CHEMICAL COMPANY	3.15
31023	CITGO REFINING & CHEMICAL CO. L.P.	7.79
31371	BUCKEYE DEVELOPMENT & LOGISTICS, LLC	4.25
31805	HOLLY REFINING & MARKETING COMPANY	4.59
32011	HOLLY ENERGY PARTNERS - OPERATING, L.P.	1.45
32401	PIONEER AMERICAS LLC DOING BUSINESS AS OLIN CHLOR ALKALI PRODUCTS	5.79
32558	NOURYON PULP AND PERFORMANCE CHEMICALS LLC	0.45
32564	VALERO REFINING-NEW ORLEANS, L.L.C.	1.57
32389	CENTAURI TECHNOLOGIES, LP	1.99
32499	SOLVAY CHEMICALS, INC.	0.09
32429	US AMINES	20.89
39976	BLUE CUBE OPERATIONS, LLC	5.84
39938	INEOS USA LLC	21.09
39583	EVONIK	0.46
39624	AIRGAS MERCHANT GAS KALAMA	2.26
39924	MARKWEST JAVELINA COMPANY, L.L.C.	2.72
39926	MARKWEST GAS SERVICES, L.L.C.	2.55
39999	MATHESON TRI-GAS, INC	11.89
88888	SOLD - PENDING NEW OPERATOR SUBMISSION	0.16



# Current Transportation Regulations

## 49 CFR Part 192 Regulations Unique to Hydrogen Gas Pipelines

- PHMSA has regulated the transportation of Hydrogen gas by pipeline since 1970
- Limited regulatory differences between Hydrogen and Natural Gas pipeline transportation
- Blends are not currently defined or specifically captured in data
- § 192.625(b), when hydrogen gas is intended to be used as feedstock for a manufacturing process, it does not have the requirement to be odorized in Class 3 and 4 locations
- § 192.53 General: “Materials for pipe and components must be:” (...) “(b) Chemically compatible with any gas that they transport and with any other material in the pipeline with which they are in contact”



# Incidents – 2010 to present

- Between 2010 and today, five reported incidents involved regulated hydrogen gas pipelines:
  - None attributed to the transportation of hydrogen gas.
  - None involved blended gas.
  - No injuries or fatalities.

Calendar Year	Operator ID	Operator Business Name	System Sub Type	Commodity	Cause	Sub-cause
2015	9171	MARKWEST JAVELINA PIPELINE COMPANY, L.L.C.	GAS TRANSMISSION	HYDROGEN GAS	EQUIPMENT FAILURE	NON-THREADED CONNECTION FAILURE (BLIND FLANGE CONNECTION FAILURE ON A TEMPORARY SEPARATOR FILTER INSTALLED AT ILI RECEIVER SITE)
2018	31023	CITGO REFINING & CHEMICAL CO. L.P.	GAS TRANSMISSION	HYDROGEN GAS	CORROSION FAILURE	INTERNAL CORROSION (AT THE BOTTOM OF THE PIPE AT LOW LYING AREAS; SATURATED LIQUID HYDROCARBON DROP-OUT)
2019	20044	LINDE	GAS TRANSMISSION	HYDROGEN GAS	NATURAL FORCE DAMAGE	LIGHTNING (ANOMALY IN THE VICINITY OF A GROUNDING ROD FOR A NEARBY ELECTRICAL TRANSMISSION TOWER)
2021	15485	PHILLIPS 66 COMPANY - SWEENEY REFINERY	GAS TRANSMISSION	HYDROGEN GAS	EQUIPMENT FAILURE	OTHER EQUIPMENT FAILURE (HIGH FLOW INDUCED EROSION AT PIPELINE METER STATION)
2022	842	AIR LIQUIDE	GAS TRANSMISSION	HYDROGEN GAS	MATERIAL FAILURE OF PIPE OR WELD	DESIGN-, CONSTRUCTION-, INSTALLATION-, OR FABRICATION-RELATED (HYDROGEN INDUCED CRACKING (HIC) PIPE GIRTH WELD)



# Pipeline Transportation: Hydrogen and Emerging Fuels R&D Public Meeting and Forum

**Event Purpose:** Assist PHMSA in developing its R&D agenda for the next two years and help address one of DOT's strategic goals to develop climate solutions. The first day of the event was a public meeting and general session focusing on two objectives: (1) The current state of PHMSA's pipeline safety R&D, and (2) The environmental and infrastructure impacts of a shift to clean emerging fuels. The second day consisted of six smaller interactive working groups to develop robust R&D topics for funding consideration by PHMSA. The final day included a report out from each working group.



## Event Summary:

- Nov 30<sup>th</sup> - Dec 2<sup>nd</sup>, 2021
- Approximately 530 virtual attendees
- 25 research gap/topics identified as a priority for future research
- All presentations available from this page:

<https://primis.phmsa.dot.gov/meetings/MtgHome.mtg?mtg=153>





# Hydrogen R&D Initiative

**BACKGROUND:** Hydrogen

**ISSUE:** Pipeline and UGS integrity threats.



## Previous Research/Findings

- \$2.3M and five pipeline projects funded
- Heavy focus on materials issues and welding qualifications
- Knowledge Transfer registered to standards bodies
  - American Society of Mechanical Engineering B31.12 Standard on Hydrogen Piping and Pipeline

## Planned Research

### FY 2022

- Identifying/Mitigating/Preventing pipeline and UGS integrity threats
- Developing & validating leak detection sensors

### FY 2023

- Advancing additional solutions beyond that would be funded in FY 2022 to safely transport hydrogen
- Coordination with government, public, & industry

## Outputs

Knowledge/Technology project reporting about hydrogen safely in transporting/storing underground

## Outcomes

Revision of industry standards and PHMSA regulations regarding hydrogen

## Impacts on Strategic Goals

Safe transportation and UGS of hydrogen supporting the advancement of climate change timelines





# Review of Integrity Threat Characterization Resulting from Hydrogen Gas Pipeline Service

**Researcher:** Engineering Mechanics Corporation of Columbus

**Project Cost:** \$300,000 (\$240,000 PHMSA + \$60,000 cost sharing)

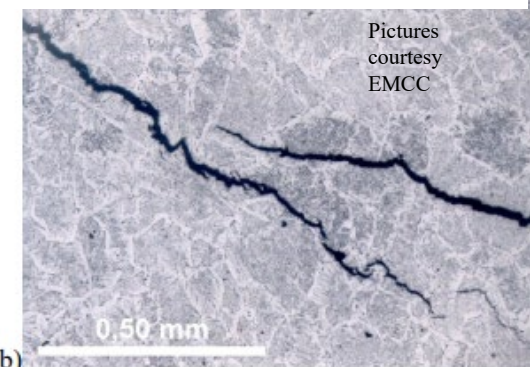
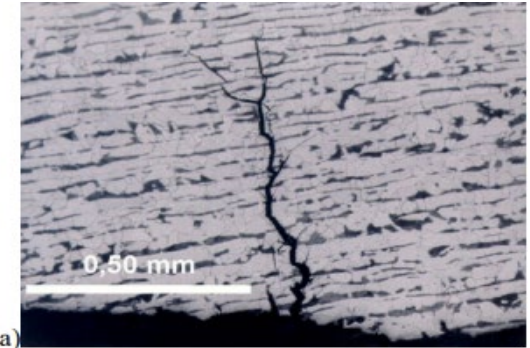
**Public Page:** <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=985>

**Project Objective:** Identify differences between existing integrity threats and potential new threats resulting from the presence of hydrogen.

- Identify possible changes to the American Society of Mechanical Engineers (ASME) Code B31.8S threat assessment process to address hydrogen or hydrogen/natural gas blend service-based threats in new and existing pipelines.

**Project End Date:** 9/29/2024

**Potential Impact on Safety:** An updated threat assessment process for pipelines in hydrogen gas service will allow for a better understanding of risks for pipeline rupture or leaks. Improved leak and burst pressure predictions are essential because over predictions suggest a false sense of low risk, while underpredictions result in excessive conservatism.



# Determining the Required Modifications to Safely Repurpose Existing Pipelines to Transport Pure Hydrogen and Hydrogen-Blends

**Researcher:** Engineering Mechanics Corporation of Columbus

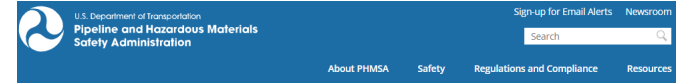
**Project Cost:** \$1,000,000 (\$800,000 PHMSA + \$200,000 cost sharing)

**Public Page:** <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=978>

**Project Objective:** Will determine practical methods for optimizing or repurposing existing pipeline networks to safely transport pure hydrogen or hydrogen blends. Provide insight into which existing gas transmission pipeline components and facilities may need modifications to safely introduce hydrogen gas or natural gas/hydrogen blends.

**Project End Date:** 9/29/2025

**Potential Impact on Safety:** Improved understanding of pipeline system limitations for hydrogen service will help pipeline integrity professionals reduce the risk for leaks or ruptures, with their associated environmental impact of gas escaping a pipeline, and hazards to the general public.



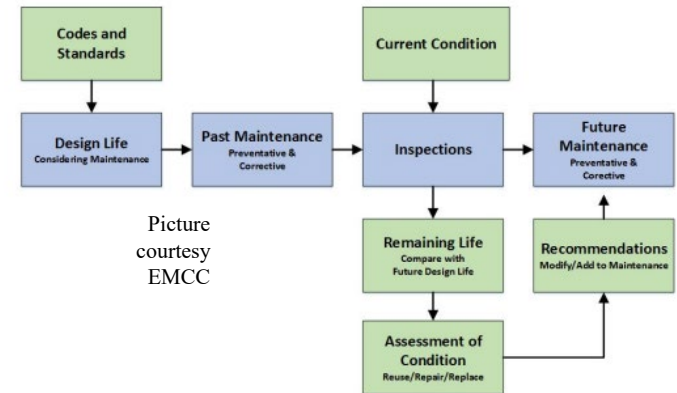
## Guidance: Pipeline Flow Reversals, Product Changes and Conversion to Service

[2014-22201.pdf](#) (193.88 KB)

PHMSA is issuing this advisory bulletin to alert operators of hazardous liquid and gas transmission pipelines of the potential significant impact flow reversals, product changes and conversion to service may have on the integrity of a pipeline. Failures on natural gas transmission and hazardous liquid pipelines have occurred after these operational changes. This advisory bulletin describes specific notification requirements and general operating and maintenance (O&M) and integrity management actions regarding flow reversals, product changes and conversion to service. This advisory bulletin also recommends additional actions operators should take when these operational changes are made including the submission of a comprehensive written plan to the appropriate PHMSA regional office regarding these changes prior to implementation.

DOT is committed to ensuring that information is available in appropriate alternative formats to meet the requirements of persons who have a disability. If you require an alternative version of files provided on this page, please contact [PHMSA-Accessibility@dot.gov](mailto:PHMSA-Accessibility@dot.gov).

Effective Date: Saturday, September 18, 2004



Picture courtesy EMCC



# Advancing Hydrogen Leak Detection and Quantification Technologies Compatible with Hydrogen Blends

**Researcher:** Gas Technology Institute

**Project Cost:** \$1,499,070 (\$749,446 PHMSA + \$749,624 cost sharing)

**Public Page:** <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=979>

## Project Objective:

- Investigate impact of hydrogen injection on leakage dynamics.
- Investigate effect of hydrogen on existing leak detection equipment.
- Resulting analysis will inform new approaches for hydrogen sensing and integration into next-generation leak detection equipment.

**Project End Date:** 9/29/2025

**Potential Impact on Safety:** The findings will advance our understanding of hydrogen and natural gas/hydrogen blend leaks, ensuring that any leaks can be detected quickly and efficiently, reducing potential safety impacts caused by undetected leaks, and most importantly minimizing misinterpreted leak detection results causing an underestimation of the size and potential safety hazard of a leak.

Example of mobile-mounted system for natural gas detection



Pictures courtesy GTI

Example of a Handheld device



Example of a fixed-point detector



# Expanding Hydrogen Storage to Porous Rock Formations: A Framework for Estimating Feasibility & Operational Considerations

**Researcher:** Gas Technology Institute

**Project Cost:** \$598,000 (\$298,000 PHMSA + \$300,000 cost sharing)

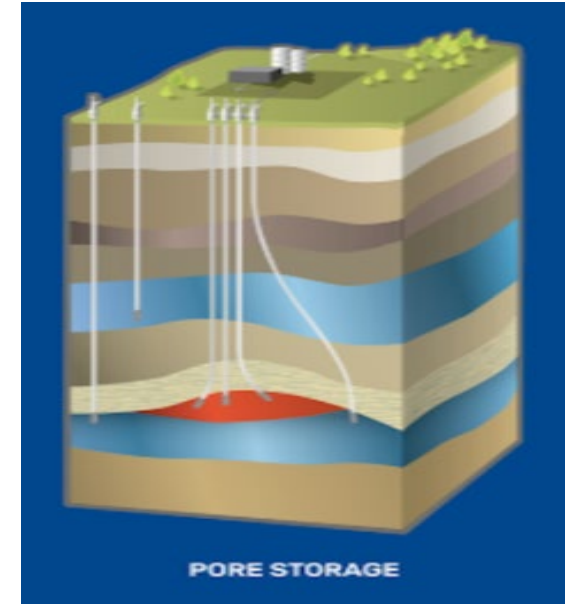
**Public Page:** <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=984>

## Project Objective:

- Develop a framework that accelerates industry expansion of underground hydrogen storage beyond salt caverns.
- Provide operational considerations for selecting suitable porous rock formations as potential storage sites.
- Establish guidelines for monitoring potential hydrogen movement or hydrogen loss resulting from geochemical reactions.

**Project End Date:** 9/29/2024

**Potential Impact on Safety:** This framework will help industry identify the most viable candidates for storing and recovering hydrogen in these types of formations and will accelerate the safe operation of Underground Hydrogen Storage in the US.



Picture courtesy of cH2ange





# Development of Compatibility Assessment Model for Existing Pipelines for Handling Hydrogen-Containing Natural Gas

**Researcher:** University of Oklahoma

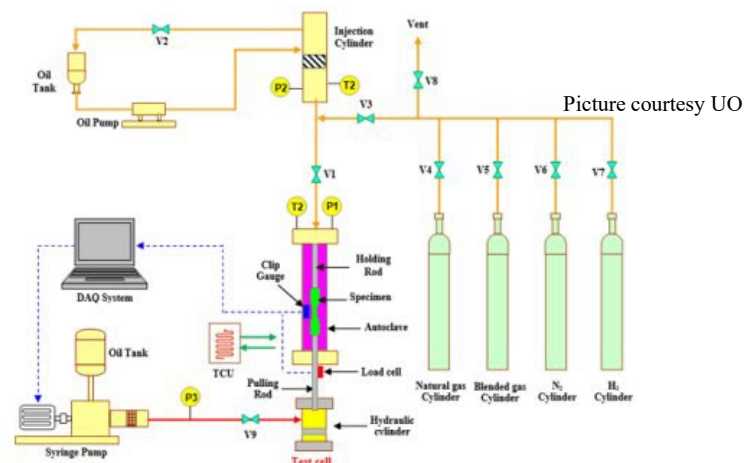
**Project Cost:** \$1,250,000 (\$1,000,000 PHMSA + \$250,000 cost sharing)

**Public Page:**

<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=916>

**Project Objective:**

- Use data analytics-based modeling techniques to create a comprehensive compatibility assessment model for determining the capability of existing pipelines to transport blended and pure hydrogen gas while accounting for hydrogen embrittlement.
- Develop a publicly available software tool that operators can use to determine which existing pipelines are suitable for pure hydrogen or blended gas and what modifications would be needed to make a pipeline suitable for hydrogen transportation.



**Project End Date:** 9/29/2025

**Potential Impact on Safety:** Produced knowledge will reduce the likelihood of existing pipeline failure in blended gas and pure hydrogen transportation.



# Accelerating Transition Toward Sustainable, Precise, and Reliable Hydrogen Infrastructure (Super-H<sub>2</sub>): Holistic Risk Assessment, Mitigation Measures, and Decision Support Platforms

**Researcher:** North Dakota State University

**Project Cost:** \$1,250,000 (\$1,000,000 PHMSA + \$250,000 cost sharing)

**Public Page:**

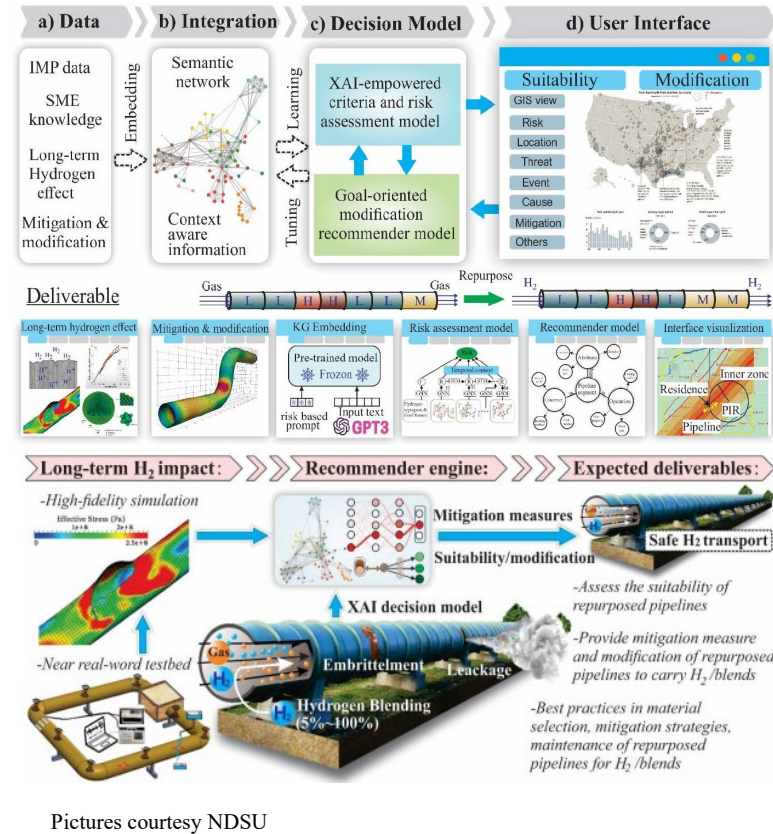
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=916>

**Project Objective:** Develop and implement a holistic framework for an AI-powered, platform-forward software tool that will accelerate the transition of existing gas pipelines for hydrogen transport.

- Develop decision support tools using AI interfacing with goal-oriented optimization and a context-driven recommender engine for potential pipeline mitigation measures.

**Project End Date:** 9/29/2025

**Potential Impact on Safety:** Produced knowledge will reduce the likelihood of existing pipeline failure in blended gas and pure hydrogen transportation.



# Determining Steel Weld Qualification and Performance for Hydrogen Pipelines

**Researcher:** National Institute of Standards and Technology – Inter-Agency Agreement

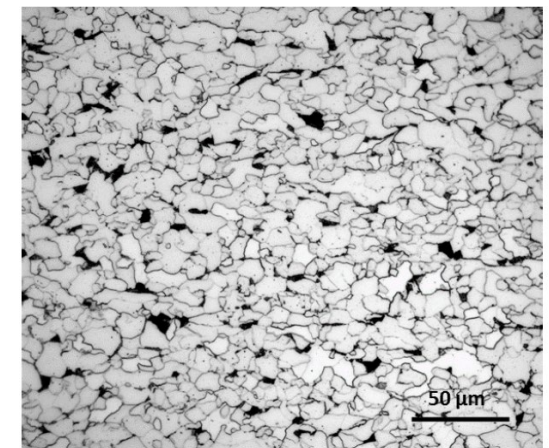
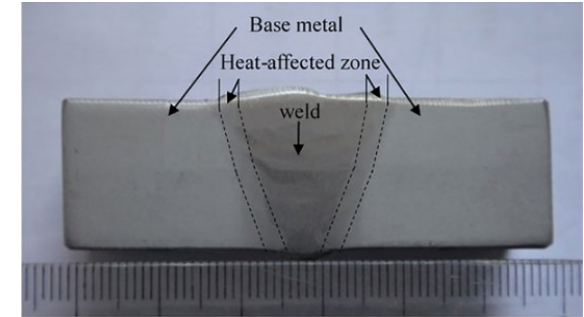
**Project Cost:** \$2,060,000

**Public Page:** <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=976>

**Project Objective:** To review current codes and standards for gaps in qualification requirements for welds in pipelines intended for hydrogen transportation and to provide: (1) weld qualification requirements for new steel pipeline assets, including seam, girth, and repair welds; (2) performance evaluations for varying modern steel grades; and (3) assessment parameters for evaluating the integrity of existing and vintage (pre-Code) assets.

**Project End Date:** 9/29/2024

**Potential Impact on Safety:** An effective weld qualification procedure will support safe operation and design limits for hydrogen pipeline construction and operation.



# 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

## Questions?

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