



# Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety

**PHMSA's Research and Development Forum  
2023**

*Kandilarya Barakat – Operations Supervisor of the R&D Team  
Engineering and Research Division  
October 31, 2023*



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

**PHMSA: Your Safety is Our Mission**



# Hydrogen Pipelines

# Hydrogen Pipelines (H<sub>2</sub>)



# Past Hydrogen Pipeline Research

Project	Goals
<p><a href="#">"Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation"</a></p> <p><i>Category: Alternative Fuels</i></p>	<p>This project will address the most critical issues related to the safe and efficient transportation of hydrogen using pipelines. The impact of high pressure hydrogen on the fatigue behavior of commonly used linepipe steels will be studied systematically by conducting fatigue tests and developing a mechanistic-based analysis model/procedure to correlate and predict the test results.</p> <p><i>Researcher: Center for Reliable Energy Systems</i>      <i>PHMSA: \$659,500</i></p>
<p><a href="#">"Cost-Effective Techniques for Weld Property Measurement and Technologies for Improving Weld Hydrogen Embrittlement and Intergranular Stress Corrosion Cracking Resistance for Alternative Fuel Pipelines"</a></p> <p><i>Category: Alternative Fuels</i></p>	<p>Built upon proven technologies, this proposal research aims at (i) advancing the general knowledge related to fatigue and fracture properties of pipeline steel welds subject to high pressure hydrogen atmosphere (e.g. a pressurized hydrogen transport system) and (ii) developing technologies for weld property improvement.</p> <p><i>Researcher: University of Tennessee</i>      <i>PHMSA: \$665,211</i></p>
<p><a href="#">"The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of the Heat-Affected Zones in X52 and X70 Pipelines"</a></p> <p><i>Category: Materials</i></p>	<p>NIST and PHMSA seek to address concerns over heat-affected zones voiced by American Society of Mechanical Engineers (ASME) B31.12 committee on Hydrogen Piping and Pipelines.</p> <p><i>Researcher: National Institute of Standards and Technology</i>      <i>PHMSA: \$160,000</i></p>
<p><a href="#">"The Effect of Pressurized Hydrogen Gas on the Fatigue Properties of Welds in X52 and X70 Pipelines"</a></p> <p><i>Category: Materials</i></p>	<p>NIST's Material Measurement Laboratory (MML), Applied Chemicals and Materials Division (ACMD) is assisting PHMSA in evaluating emerging technologies and standards. NIST will be performing research and standardization activities related to effects of transporting hydrogen in today's pipelines.</p> <p><i>Researcher: National Institute of Standards and Technology</i>      <i>PHMSA: \$105,187</i></p>



# Ongoing Hydrogen Pipeline Research

Currently 11 active projects related to hydrogen pipelines with a total of \$10.6 million in PHMSA funding and an additional \$2.5 million in cost sharing.

Project	Goals
<a href="#">"Knowledge-guided Automation for Integrity Management of Aging Pipelines (KAI-MAP) for Hydrogen Transport"</a> <b>Category: Threat Prevention</b>	Develop an AI-enabled automation framework for pipeline integrity management for emerging fuels, such as hydrogen. Additionally, the researcher will develop decision support tools using AI interfacing with goal-oriented optimization and a context-driven platform to recommend potential pipeline risk mitigation measures. <i>Researcher: Arizona State University</i> <span style="float: right;"><i>PHMSA: \$844,726</i></span>
<a href="#">"Development of Compatibility Assessment Model for Existing Pipelines for Handling Hydrogen-Containing Natural Gas"</a> <b>Category: Threat Prevention</b>	Use data analytics-based modeling techniques to create a compatibility assessment model which determines the capability of existing pipelines with blended and pure hydrogen gas. Develop a publicly available software tool that operators can use to determine suitability of existing pipelines for pure hydrogen or blended gas and identify needed modifications. <i>Researcher: University of Oklahoma</i> <span style="float: right;"><i>PHMSA: \$1,000,000</i></span>
<a href="#">"Accelerating Transition towards Sustainable, Precise, Reliable Hydrogen Infrastructure (Super-H2): Holistic Risk Assessment, Mitigation Measures, and Decision Support Platforms"</a> <b>Category: Threat Prevention</b>	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. <i>Researcher: North Dakota State University</i> <span style="float: right;"><i>PHMSA: \$1,000,000</i></span>
<a href="#">"Investigate Damage Mechanisms for Hydrogen and Hydrogen/Natural Gas Blends to Determine Inspection Intervals for In-Line Inspection Tools"</a> <b>Category: Anomaly Detection &amp; Characterization</b>	Analyze failure mechanisms related to hydrogen and hydrogen/natural gas blends, develop knowledge regarding critical flaw sizes and availability and accuracy of ILI tools, and recommend changes to practices for determining reinspection intervals. <i>Researcher: Kiefner and Associates, Inc.</i> <span style="float: right;"><i>PHMSA: \$1,200,000</i></span>





# Ongoing Hydrogen Pipeline Research

Currently 11 active projects related to hydrogen pipelines with a total of \$10.6 million in PHMSA funding and an additional \$2.5 million in cost sharing.

Project	Goals
<p><a href="#">"Determining Steel Weld Qualification and Performance for Hydrogen Pipelines"</a></p> <p><b>Category: Materials</b></p>	<p>Review current codes and standards for gaps in qualification requirements for welds in pipelines intended for hydrogen transportation and provide the following: weld qualification requirements for new steel pipeline assets; performance evaluations for varying modern steel grades; and assessment parameters for evaluating the integrity of existing and vintage (pre-Code) assets.</p> <p><i>Researcher: National Institute of Standards and Technology PHMSA: \$2,060,000</i></p>
<p><a href="#">"Investigating the Integrity Impacts of Hydrogen Gas on Composite/Multi-Layered Pipe"</a></p> <p><b>Category: Materials</b></p>	<p>Investigate the impact to the integrity of composite pipe when used to transport pressurized hydrogen gas. Identify and address safety hazards to the pipeline facilities, people, and the surrounding environment. Identify required design, material and construction specifications, maintenance procedures, and a roadmap for using alternative-steel and non-steel composite systems for composite pipelines.</p> <p><i>Researcher: Edison Welding Institute, Inc. PHMSA: \$450,078</i></p>
<p><a href="#">"Advancing Hydrogen Leak Detection and Quantification Technologies Compatible with Hydrogen Blends"</a></p> <p><b>Category: Leak Detection</b></p>	<p>Investigate the impact of hydrogen on leakage dynamics and existing leak detection equipment. This will inform new approaches for hydrogen sensing and integration into next-generation leak detection equipment.</p> <p><i>Researcher: Gas Technology Institute PHMSA: \$749,446</i></p>
<p><a href="#">"Determining the Required Modifications to Safely Repurpose Existing Pipelines to Transport Pure Hydrogen and Hydrogen-Blends"</a></p> <p><b>Category: Climate Change</b></p>	<p>Determine practical methods for repurposing existing pipeline networks for the safe transport of hydrogen or hydrogen blends; and identify which existing gas transmission pipeline components may need modifications to safely introduce hydrogen gas or natural gas/hydrogen blends.</p> <p><i>Researcher: Engineering Mechanics Corporation of Columbus PHMSA: \$800,000</i></p>



# Ongoing Hydrogen Pipeline Research

Currently 11 active projects related to hydrogen pipelines with a total of \$10.6 million in PHMSA funding and an additional \$2.5 million in cost sharing.

Project	Goals
<p><a href="#">"Review of Integrity Threat Characterization Resulting from Hydrogen Gas Pipeline Service"</a></p> <p><i>Category: Climate Change</i></p>	<p>Identify differences between existing integrity threats and possible new threats resulting from the presence of hydrogen. Define a list of possible changes to the ASME threat assessment process to address hydrogen, or hydrogen blended service-based threats in new or existing pipelines.</p> <p><i>Researcher: Engineering Mechanics Corporation of Columbus PHMSA: \$240,000</i></p>
<p><a href="#">"Expanding Hydrogen Storage to Porous Rock Formations: A Framework for Estimating Feasibility &amp; Operational Considerations"</a></p> <p><i>Category: Underground Natural Gas Storage</i></p>	<p>Develop a framework to expand underground hydrogen storage beyond salt caverns to other formation types. Provide a set of operational considerations for selecting suitable porous rock formations. Establish guidelines for monitoring potential hydrogen movement or loss from geochemical reactions or multiphase hydrogen flow with formation fluids.</p> <p><i>Researcher: Gas Technology Institute PHMSA: \$298,000</i></p>
<p><a href="#">"Establishing the Technical Basis for Enabling Safe and Reliable Underground Hydrogen Storage Operations"</a></p> <p><i>Category: Underground Natural Gas Storage</i></p>	<p>Identify and understand existing PHMSA regulatory functions and needs as they relate to characterizing, permitting, and assessing underground natural gas storage (UGS) operations within the subsurface in order to define appropriate metrics relevant to UHS. Quantify the suitability of existing UGS facilities (which includes the well and subsurface geologic system) for storing pure and blended hydrogen. Characterize operational expectations with emphasis on quantifying risk for H2 resource loss processes, UGS asset degradation, and estimating transient behavior based on geologic and operational conditions.</p> <p><i>Researcher: Fossil Energy and Carbon Management PHMSA: \$2,000,000</i></p>

