2.2.6 HYDROGEN INFRASTRUCTURE SAFETY RESEARCH AND DEVELOPMENT

Technology Description

Like other commodities used as fuels in today's energy and transportation systems, hydrogen is classified as a hazardous material. Direct transport and storage of hydrogen can be achieved via pipelines, compressed gas storage vessels/cylinders, cryogenic vessels, as a hydride, or contained in a nanostructured material. Other commodities, including natural gas and methanol, also can be used as hydrogen carriers that are later reformed. Extensive hydrogen infrastructure is already in place to meet the transport needs of the petrochemical, electronics, and food industries. However, in order to meet the potential future demands for hydrogen and expand its use as a fuel, additional infrastructure and advanced storage and transport methods and technologies will need to be developed and safely, securely, and reliably integrated into the existing transportation and energy infrastructures of the United States.

System Concepts and Representative Technologies

- There are currently three primary methods of hydrogen transport and storage: pipeline, vehicular commodity transport via tube-trailer/pressure vessels and cryogenic vessels, and stationary/fixed storage and fueling infrastructure.
- Within the United States, each of the three primary methods of hydrogen transport and storage is governed by a different set of regulations established by: The U.S. Department of Transportation (DOT)/Research and Special Programs Administration (RSPA) Office of Pipeline Safety, DOT/RSPA Office of Hazardous Materials Safety, and local and state fire marshals.
- The current system for transporting natural gas and hydrogen provides a reasonable foundation and model for expanding the hydrogen infrastructure. However, the current paradigm, with the exception of motor fuels and natural gas, is for hazardous materials (HAZMAT) transport to divert or restrict the transport of these materials into urban areas and through tunnels and other vulnerable transportation infrastructure.
- Current technologies include: small diameter hydrogen pipelines; DOT-approved pressure vessels and cylinders; DOT-approved cryogenic vessels; and, for stationary applications, pressure vessels complying with the American Society of Mechanical Engineers (ASME) boiler and pressure vessel code.
- New technologies developed or being proposed include very high-pressure (13,000-15,000 psi), all-composite pressure vessels meeting both DOT and ASME requirements; advanced pipeline materials that reduce and/or catalyze permeated or leaked hydrogen; hydrides; below-ground cryogenic vessels; and nanostructured materials.
- These new technologies may be additions to or replace current transportation infrastructure, or may be integrated into the existing infrastructure.

Technology Status/Applications

- Hydrogen has been transported and stored within the United States safely, securely, and reliably, for several decades using the current conventional (under 4,500 psi) technologies.
- New technologies to increase the efficiency and reduce the cost of hydrogen transport, such as advanced carbon composite cylinders and storage, are being adapted. New technologies are being reviewed and evaluated within the framework of the appropriate and necessary Federal regulations and other codes and standards. To date, many of the technologies have not met the burden of proof to demonstrate that they can meet the necessary safety requirements for transporting hydrogen in commerce.
- Other technologies, such as carbon nanotubes and advanced pipeline materials, are still in an early research and development (R&D) phase and are not ready for commercialization.
- The DOT/RSPA Office of Hazardous Materials Safety is currently reviewing applications for exemption for several technologies, including hydrides and high-pressure composite cylinder mobile fuelers, and is working with industry and the Department of Energy (DOE) to help guide safe and successful development and deployment of these technologies.

Current Research, Development, and Demonstration
RD&D Goals • Work within the Federal government and with industry to develop, test, and approve new storage and monitoring technologies. • Continue to use the exemption and regulatory development process to keep pace with the emerging technologies and applications. • Conduct a thorough and comprehensive transportation and storage infrastructure assessment to address capacity, safety, security, reliability, operations, and environmental compliance evaluating all conceived scenarios for near-term and long-term development and implementation of hydrogen infrastructure. • Conduct risk analysis for each technology and application. • Collect data on the safety, security, reliability, and operation of new technologies and systems to guide regulatory development and future deployment. • Develop a future system that offers improved safety, security, reliability, and functionality vs. the current transportation and storage systems. **RD&D Challenges** • Gain a fundamental understanding of fatigue and failure modes of advanced composites and other storage media. • Establish effective monitoring, inspection, and recertification technologies and procedures for hydrogen transport and storage. • Adapt aging infrastructure to accommodate new demands. • Educate and train operators, regulators, and users effectively. **RD&D Activities** • The Operating Administrations of DOT, specifically RSPA and the National Highway Traffic Safety Administration (NHTSA), are actively engaged in domestic and international consensus codes and standards development. • DOT staff are supporting DOE R&D activities and committees, and the activities and committees of the various consensus codes- and standards-setting organizations. • DOT staff continues to work with the National Association of State Fire Marshals to educate and train personnel and to promote safe handling and storage practices.
Recent Progress
• DOT/RSPA Office of Hazardous Materials Safety has recently approved an exemption for hydride storage of hydrogen. • In conjunction with DOE, progress is being made in the development and revision of consensus codes and standards.