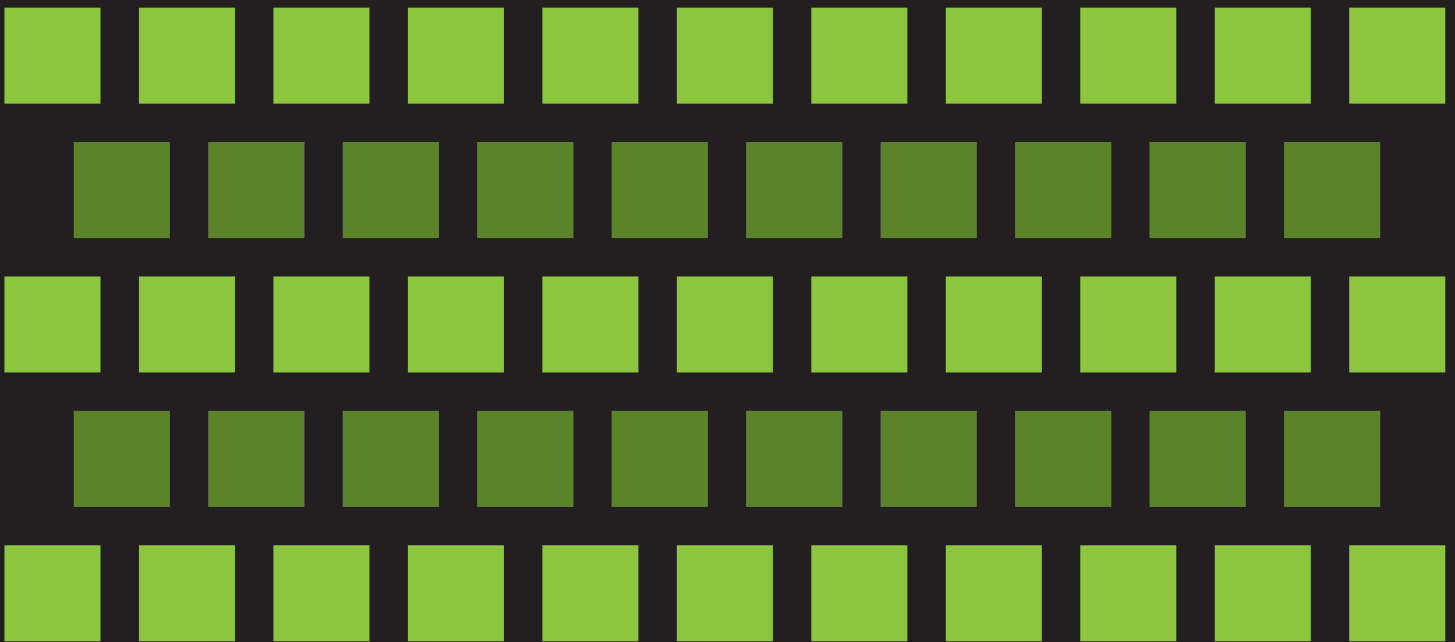


STP/PT-005

DESIGN FACTOR GUIDELINES FOR HIGH PRESSURE COMPOSITE HYDROGEN TANKS



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FOREWORD

Commercialization of hydrogen fuel cells, in particular fuel cell vehicles, will require development of an extensive hydrogen infrastructure comparable to that which exists today for petroleum. This infrastructure must include the means to safely and efficiently generate, transport, distribute, store, and use hydrogen as a fuel. Standardization of pressure retaining components, such as tanks, piping, and pipelines, will enable hydrogen infrastructure development by establishing confidence in the technical integrity of products.

Since 1884, the American Society of Mechanical Engineers (ASME) has been developing codes and standards (C&S) that protect public health and safety. The traditional approach to standards development involved writing prescriptive standards only after technology has been established and commercialized. With the push toward a hydrogen economy, government and industry have realized that they cannot afford a hydrogen-related safety incident that may undermine consumer confidence. As a result, ASME has adopted a more anticipatory approach to standardization for hydrogen infrastructure which involves writing standards with more performance based requirements in parallel with technology development and before commercialization has begun.

Today, ASME codes and standards are used for hydrogen storage, transmission, and distribution. The anticipated requirements of the hydrogen economy will require local refueling stations with the capability to fill gaseous hydrogen vehicle tanks rapidly, to pressures as high as 15,000 psig (100 MPa). Although current standards could be used to build pressure tanks, piping, and pipelines meeting these operating requirements, it is likely that the resulting components would not, as a practical matter, enable commercialization of the technology.

ASME has worked closely with the Department of Energy (DOE), national laboratories, and other standards developing organizations (SDOs) to identify lead organizations to address the need for standards for hydrogen applications. ASME was selected to lead the efforts for pressure tanks, piping, and pipelines for storage, transportation, and distribution of hydrogen. Initial work of the ASME's Hydrogen Steering Committee led to the formation of volunteer task forces under the ASME Board on Pressure Technology Codes and Standards (BPTCS) to explore the standardization requirements for storage tanks, transportation tanks, portable tanks, piping, and pipelines for hydrogen-specific applications. The task forces submitted their recommendations at the end of 2003, and these recommendations led to initiation of standards actions, formation of project teams, and commencement of supporting research.

The ASME Boiler and Pressure Vessel (BPV) Standards Committee appointed a project team to develop new Code rules in the Boiler and Pressure Vessel Code Section VIII (pressure vessels) and Section XII (transport tanks) for hydrogen storage and transport tanks to be used in the storage and transport of liquid and gaseous hydrogen and metal hydrides. Rules for gaseous storage tanks with maximum allowable working pressures (MAWPs) up to 15,000 psig (100 MPa) will be needed. Research activities are being coordinated to develop data and technical reports concurrent with standards development and have been prioritized per Project Team needs. The Project Team may identify additional needs and gaps as drafts are developed.

The Technical Reports to be developed will establish data and other information to be used to support and facilitate separate initiatives to develop ASME standards for the hydrogen infrastructure. These reports will target specific disciplines and fill the gaps identified by ASME's hydrogen task forces. An initial report, developed under the sponsorship of the National Renewable Energy Laboratory (NREL), Hydrogen Standardization Interim Report for Tanks, Piping and Pipelines was issued on May 3, 2005. This interim report addressed priority topical areas within each of the four pressure technology applications for hydrogen infrastructure development: storage (stationary) tanks, transport tanks, piping and pipelines, and vehicle fuel tanks.

The present report builds on the work of the interim report to develop specific recommendations for design factors for composite stationary tanks and transport tanks.

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ABSTRACT

This report provides recommendations to the ASME Hydrogen Project Team for design factors for composite hydrogen tanks. The scope of this study included stationary (e.g., storage) and transport tanks; it does not include vehicle fuel tanks. The report provides recommended design factors relative to short-term burst pressure and interim margins for long-term stress rupture based on a fixed 15-year design life for fully wrapped and hoop wrapped composite tanks with metal liners. These recommended margins are based on the proven experience with existing standards for composite reinforced tanks. Recommendations for further research are also provided, in particular for development of rules that would provide design life dependent design factors relative to stress rupture that would provide a means to design for longer or shorter lives than 15 years, and to provide a method for the manufacturer to determine, by testing, the stress ratio for their fiber reinforcement system.