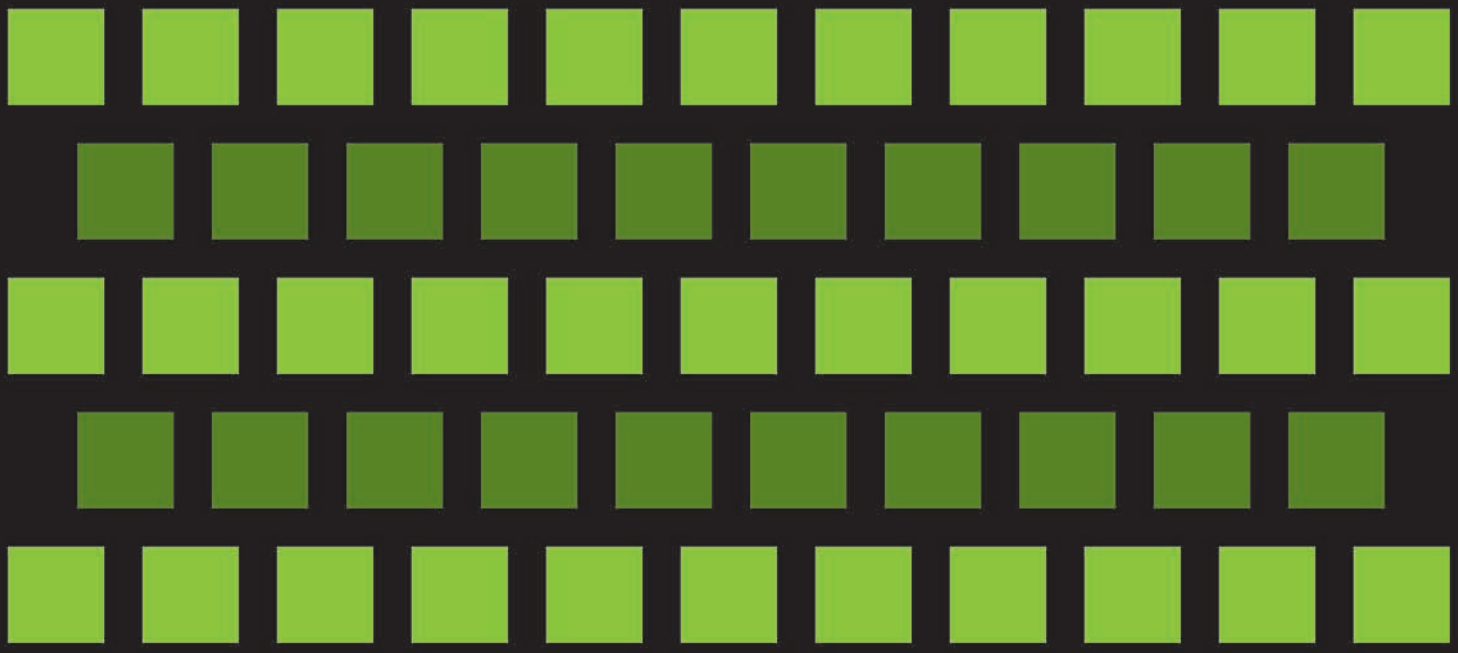
STP-PT-023

GUIDELINES FOR IN-SERVICE INSPECTION OF COMPOSITE PRESSURE VESSELS



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GUIDELINES FOR IN-SERVICE INSPECTION OF COMPOSITE PRESSURE VESSELS

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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, 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.

The ASME B&PVC Standards Committee appointed a project team to develop new Code rules 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 (103 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. This technical report has been developed in response to Project Team needs and is intended to establish data and other information supporting separate initiatives to develop ASME standards for the hydrogen infrastructure.

Established in 1880, the American Society of Mechanical Engineers (ASME) is a professional not-for-profit organization with more than 127,000 members promoting the art, science and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit www.asme.org for more information.

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ABSTRACT

This report describes the procedures and recommendations for in-service inspection of high pressure composite tanks made to ASME code requirements and used for the shipping or storage of hydrogen. For the in-service inspection of high pressure composite tanks, only external visual inspection is recommended. Internal visual inspection is optional and may be performed when it is not certain that only pure dry hydrogen has been shipped or stored in the tanks. For certain applications, safety rules or regulations may also require a hydrostatic pressure test of the tanks.

Guidelines are given for acceptable methods of visual inspection of high pressure composite tanks and for acceptance criteria for any indications that are found by the visual inspection. This report does not specify or provide guidelines for the frequency of performing the in-service inspection. The frequency of the in-service inspection is determined by the operational requirements or specified by other safety rules and regulations.

1 INTRODUCTION

This report provides recommendations for in-service inspection of composite tanks that are used to store or transport hydrogen.

The scope of this study includes the in-service inspection of both stationary (e.g., storage) tanks and transport tanks used to store or transport gaseous hydrogen at maximum allowed working pressures (MAWP) up to 15,000 psi. The recommendations made in this report cover all types of ASME composite tanks used to store or transport hydrogen. This includes tanks with metallic liners (steel or aluminum) and tanks with non-metallic liners that are constructed by filament winding with fiberglass, aramid or carbon fibers.

Composite hydrogen tanks may require periodic inspection while in service. This report does not make specific recommendations about the time interval between in-service inspections and does not make specific recommendations about the useful life of the tanks. The time interval between required in-service inspections and the total useful life of the tanks will depend on the specific tank design, use and application. Procedures for establishing the time interval between required in-service inspections and the total useful life of the tanks should be based on an overall lifetime structural integrity assessment of the tanks and should be specified in the requirements for the construction of each type of tank.

The recommendations are limited to procedures and criteria for the visual inspection of the composite tanks. Nondestructive evaluation procedures (such as ultrasonic, acoustic emission, eddy current and radiography) are not addressed in this guide

The primary requirement for the in-service inspection of hydrogen tanks is for a periodic external visual inspection of the tank to evaluate any damage or degradation. Under certain conditions it may also be desirable or required to conduct an internal visual inspection of the hydrogen tanks. Safety regulations for transport tanks may also require periodic pressure testing of the tanks.

The justification for limiting the primary method of periodic in-service inspection of composite hydrogen tanks to external visual inspection only is that any damage or degradation to the tanks that is likely to occur can readily be seen by visual inspection alone. Internal visual inspection of the hydrogen tanks is generally not required and is not recommended because it is expected that the only degradation that can occur in the interior of the tanks is corrosion. If the tanks are used only for dry hydrogen service, corrosion of the interior tank liner is not expected to occur and it is preferable to not remove the tank valve to inspect the interior of the tank. The exception to this is that if it is known or suspected from operational practices that corrosion of the interior liner of the tank may occur, an optional internal visual inspection should be conducted.

In-service hydrostatic pressure testing of the tanks is not recommended and should be done only when required by other specific safety rules or regulations. Hydrostatic pressure testing requires the removal of valves and fittings from the tanks and the introduction of water into the interior of the tank. Opening the tanks and introducing water into them can create the necessary conditions for internal tank corrosion which is not present when the tanks are filled only with pure, dry hydrogen. The in-service hydrostatic pressure test serves little purpose for evaluating the structural integrity of the tanks and the water introduced into the tanks during the hydrostatic pressure test may cause degradation due to increased corrosion.

The stationary tank in-service inspection recommendations of this guide should be the same as those applied to tanks used in transportation. However, it should be noted that some tanks used in transportation may require additional in-service inspection as specified by other standards or regulations.