



COMPRESSED GAS ASSOCIATION, INC.

POSITION STATEMENT

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THE USE OF CARBON FIBER, FULLY WRAPPED COMPOSITE STORAGE VESSELS PERMANENTLY INSTALLED IN STATIONARY GASEOUS HYDROGEN FUELING SYSTEMS

Background

Over the past 5 years, the U.S. Department of Transportation (DOT) has approved several carbon fiber, fully wrapped composite storage vessel designs with metallic and polymer liners. These designs used technology from aerospace applications and were developed for vehicle fuel tanks for passenger cars and buses fueling at 3625 psig (25 MPa).

Currently North American, European, and Asian automotive manufacturers are deploying third and fourth generation hydrogen-powered vehicle fleets fueling at 5075 psig (35 MPa), and all of these vehicles use carbon fiber, fully wrapped composite storage vessels.

Over the past 2 years, automobile manufacturers and others developing gaseous hydrogen-powered applications have been testing new fuel system components including ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels designed for 10 150 (70 MPa).

In many jurisdictions, various recognized codes and standards including NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, require that applicable pressure vessels used for hydrogen storage in the United States be ASME-coded pressure vessels as a condition for approved installation and operation [1]. At the present time, the ASME *Boiler & Pressure Vessel Code* does not include any standards for the construction of carbon fiber, fully wrapped pressure vessels [2].

NFPA 52, *Vehicular Fuel Systems Code*, permits composite pressure vessels that are approved for use as vehicle fuel tanks to be used as stationary storage tanks at compressed natural gas (CNG) vehicle fueling stations [3]. In addition, NFPA 52 recognizes CSA B51, *Boiler, Pressure Vessel, and Pressure Piping Code*, which allows the use of ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels as stationary storage at gaseous hydrogen fueling stations in Canada [4].

Although there is a lack of harmony in current NFPA codes and other standards, there are some local authorities having jurisdiction in North America that have approved the use of ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels as stationary storage at gaseous hydrogen fueling stations.

This position statement provides further guidelines for the installation and operation of these vessels in hydrogen vehicle fueling stations.

Question

Can ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels be used as stationary compressed hydrogen storage in addition to or in place of ASME-coded pressure vessels for gaseous hydrogen fueling stations?

Answer

Yes, when approved by the local authority having jurisdiction, ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels are suitable for use as storage systems permanently installed in gaseous hydrogen fueling stations provided all of the following conditions are met:

- The operating pressure of permanently installed storage systems is monitored and recorded (see Table 1). This data is maintained by the operator so records of pressure vessel service conditions can be correlated with the service life recommendations of the vessel manufacturers;
- Any vessel permanently installed in stationary applications for hydrogen storage is removed from service when:
 - the number of pressure cycles equal to the service life recommendation of the manufacturer is reached (see Table 1) or
 - there is any other recommendation of the manufacturer related to removal of the vessel from service;
- Any vessel so removed from service is not restored to service until it is recertified by the manufacturer or an approved recertifying entity;
- Any carbon fiber, fully wrapped composite storage vessel permanently installed in a stationary storage system is protected by a pressure relief device (PRD). The PRD shall be set at the maximum allowable working pressure in accordance with the ASME Code, Section VIII, Div 1, which is less than or equal to the original service (design) pressure in accordance with the ANSI/CSA NGV2, *Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers*, and designed in accordance with ASME Code, Section VIII, Div 1 [2, 5];
- Carbon fiber, fully wrapped composite storage vessels are installed in accordance with the manufacturer's recommendations for operational (e.g., hydrogen service) and environmental considerations; and
- Such vessels and their appurtenances are monitored annually (at a minimum) for hydrogen leakage and, in the event of such leakage, appropriate measures are taken to ensure the safety of the public and integrity of the hydrogen fueling station.

Table 1—Recommended composite cylinder life in stationary storage

Cylinder life (cycles)	Pressure cycles	Stationary storage pressure cycle – Δ psig (Δ MPa)	
		Service pressure 5075 psig (35 MPa)	Service pressure 10 150 psig (70 MPa)
300 000	< 20%	$\Delta P < 1015$ ($\Delta P < 7$)	$\Delta P < 2030$ ($\Delta P < 14$)
150 000	20% to 40%	$1015 < \Delta P < 2030$ ($7 < \Delta P < 14$)	$2030 < \Delta P < 4060$ ($14 < \Delta P < 28$)
75 000	40% to 60%	$2030 < \Delta P < 3045$ ($14 < \Delta P < 21$)	$4060 < \Delta P < 6090$ ($28 < \Delta P < 42$)
30 000	60% to 80%	$3045 < \Delta P < 4060$ ($21 < \Delta P < 28$)	$6090 < \Delta P < 8120$ ($42 < \Delta P < 56$)
15 000	> 80%	$4060 < \Delta P$ ($28 < \Delta P$)	$8120 < \Delta P$ ($56 < \Delta P$)
NOTE—NGV2 vessels are cycled from 10% to 125% of service pressure for 15 000 cycles.			

This position statement is intended to assist authorities having jurisdiction in setting conditions under which they will approve these types of ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels permanently installed in ground storage applications. CGA plans to retire this position statement once codes and standards are developed for the manufacturing and installation of ANSI NGV2 Type 3 and Type 4 carbon fiber, fully wrapped composite storage vessels for gaseous hydrogen.