GTR #13 (Phase 2)

Recommendations for Test Procedures
Task Force 3 Status

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TF 3 Objectives

- To correct editorial and technical errors in the original draft
- To make modifications to the test procedures based on industry experience
- To incorporate requirements for medium and heavy duty vehicles
- To incorporate requirements for new storage technologies

Container Change of Design Table Subgroup

- Container Change of Design Table Subgroup Established
  - Concept allows for container designs that are sufficiently similar to an existing qualified design to be qualified through a reduced test program
  - The change of design table covers a wide range of possible container alterations including changes in diameter, length, fiber manufacturer, liner material, nominal working pressure, end boss design, fire protection system, etc.
  - Inclusion in the regulation will allow contracting parties to adopt it, and at the same time allow manufacturers to justify its use to their respective Safety & Compliance officers as a means of satisfying self-certification requirements.

Container Change of Design Table Subgroup

Changed Item		Required Tests
Metallic container or liner material		- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test
Plastic liner material		- Initial pressure cycle life - Sequential hydraulic tests - Sequential pneumatic tests - Fire test
Fiber material [1]		- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test
Resin material		- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test
Diameter	≤20% [2]	- Initial burst, Initial pressure cycle life
	>20% [2]	- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test
Length [3]	≤50%	- Initial burst, Initial pressure cycle life - Fire test [4]
	>50%	- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test [4]
Nominal working pressure	≤20% [2]	- Initial burst, Initial pressure cycle life
Coating		- Sequential hydraulic tests - Fire test [5]
Boss [6]	Material, geometry, opening size	- Initial burst, Initial pressure cycle life
	Sealing (liner and/or valve interface)	- Sequential pneumatic tests
Fire protection system		- Fire test
Valve change [7]		- Sequential pneumatic tests - Fire test [8]

Container Change of Design Table Subgroup

(1) Change of fiber type, e.g., glass to carbon is not applicable. Change of design applies only to changes of materials properties or manufacturer within a fiber type.
(2) Only when structural wall thickness change is proportional to diameter or pressure change.
(3) Includes change of chamber number for the case of multiple permanently interconnected chambers.
(4) Fire test is not required, provided safety relief devices or device configuration passed the required fire test on a container with equal or greater internal water volume.
(5) Fire test required if coating affects fire performance.
(6) Tests are not required if the stresses in the neck are equal to the original stresses or reduced by the design change (e.g., reducing the diameter of internal threads, or changing the boss length), the liner to boss interface is not affected, and the original materials are used for boss, liner, and seals. Boss change includes manifold change for the case of multiple permanently interconnected chambers.
(7) Alternative valve shall be approved in accordance with para. 6.2.6.2.
(8) Fire test not required if TPRD design has not been changed, and the mass of the changed valve is +/- 30% of the original valve.

- Informal Document GRSP-69-22-Rev. 2 proposed adding slightly modified change of design table to R134 – submitted to WP.29 in November 2021.

Conformable Tank Subgroup – Definitions

“Container" means the pressure-bearing component on the vehicle that stores the primary volume of hydrogen fuel in a single chamber or in multiple permanently interconnected chambers.

“Container Attachments” means non-pressure bearing parts attached to the container that provide additional support and/or protection to the container and that may be only temporarily removed for maintenance and/or inspection only with the use of tools.

"Compressed hydrogen storage system (CHSS)" means a system designed to store compressed hydrogen fuel for a hydrogen-fuelled vehicle, composed of a container, container attachments (if any), and primary closure devices, such as shut-off valve(s), check valve(s), and TPRD(s), required to isolate the stored hydrogen from the remainder of the fuel system and the environment.

Conformable Tank Subgroup

5.1 Compressed hydrogen storage system

This section specifies the requirements for a compressed hydrogen storage system (CHSS):

(a) The primary closure devices shall include the following functions, which may be combined:

(i) TPRD;

(ii) Check valve; and

(iii) Automatic Shut-off valve

(b) The CHSS shall meet the performance test requirements summarized in Table 1. The corresponding test procedures are specified in paragraph 6.

Conformable Tank Subgroup

- **Proposal of amendment to 5.1.2.1.**

5.1.2.1. Proof pressure test

The container is pressurized to ≥ 150 per cent NWP and held for at least 30 sec. (para. 6.2.3.1. test procedure). The container attachments, if any, shall also be included in this test, unless the manufacturer can demonstrate that the container attachments do not affect the test results [or are not affected by the test procedure]. The container that has undergone a proof pressure test in manufacture is exempt from this test.

Proof pressure test will be carried out during manufacturing and depending on the manufacturing process, it could be before or after the installation of the container attachments.
GTR20 sets a precedent for allowing manufacturer to demonstrate compliance.

Conformable Tank Subgroup

- **Proposal for 6.2.3.2 Drop (Impact) test (unpressurized)**

i. From a horizontal position with the bottom 1.8 m above the surface onto which it is dropped **(In case of non-axisymmetric container, the shut off valve interface location and its centre of gravity as well as the longest axis passing through the container shall be horizontally aligned).**

ii. From a vertical position with the **shut off valve interface location** upward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m **(In case of non-axisymmetric container, the shut off valve interface location and its centre of gravity shall be vertically aligned)**;

Conformable Tank Subgroup

- **Proposal for 6.2.3.2 Drop (Impact) test (unpressurized)** continued

iii. From a vertical position with the **shut off valve interface location** downward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. If the container is symmetrical (identical ends), this drop orientation is not required **(In case of non-axisymmetric container, the shut off valve interface location and its centre of gravity shall be vertically aligned)**;

iv. From a 45° angle from the vertical orientation with the **shut off valve interface location downward** and with its centre of gravity 1.8 m above the ground. However, if the bottom is closer to the ground than 0.6 m, the drop angle shall be changed to maintain a minimum height of 0.6 m and a centre of gravity of 1.8 m above the ground. (**In case of non-axisymmetric container, the line passing the shut off valve interface location and its centre of gravity shall be 45° angled from vertical orientation and the shut off valve interface location shall become the lowest).**

Additional TF 3 Open Items

- CTSG flaw generation and chemical exposure procedure, and how container attachments factor into the test
- Reduction of test container volume for pneumatic sequential test for large vessels
- HRS Risk Assessment (EIGA/Shell/WG 24)
  - Pressure ramp rate control failure could result in high flow and as a consequence, overheating of the hydrogen tank (up to 120°C liner temperature)
  - TF 3 undecided as to the validity of the failure mode
  - International CRADA proposed by Jay Keller, “Multi-lateral campaign to investigate type IV response to an HRS one-time fault”
  - Results not likely available until next phase of GTR
- Miscellaneous editorial and minor technical changes
- Next meeting July 22, 2021 (14:00 PDT)