

Proposal for amendment to global technical regulation No.13 (Hydrogen and fuel cell vehicles)

Note: The modifications to ECE/TRANS/180/Add/13 are marked in bold and strikethrough characters.

I. Proposal

Paragraph 3.3., amend to read:

“3.3. ~~“Burst disc~~~~”~~ **“Burst disc”** is the non-reclosing operating part of ...”

Paragraph 3.5., amend to read:

“3.5. ~~“Hydrogen concentration~~ **“Hydrogen concentration”** is the percentage of ...”

Paragraph 3.29., amend to read:

“3.29. ~~“Compressed hydrogen storage system (CHSS)”~~ **“Compressed hydrogen storage system (CHSS)”** ~~indicates~~ **means a system designed to store hydrogen fuel for hydrogen-fuelled vehicle and composed of** a pressurized container, pressure relief devices (PRDs) and shut off device(s) that isolate the stored hydrogen from the remainder of the fuel system and the environment.”

Paragraph 3.32., amend to read:

“3.32. ~~“Luggage compartment”~~ **“Luggage compartment”** is the space in the vehicle for luggage **and/or goods** accommodation, bounded by the roof, hood, floor, side walls, as well as by the electrical barrier and enclosure provided for protecting the **occupants** ~~power train~~ from direct contact with live parts, being separated from the passenger compartment by the front bulkhead or the rear bulkhead.”

Paragraph 3.46., amend to read:

“3.46. ~~“Rupture”~~ **“Rupture”** ~~and~~ **“burst”** both mean to come apart suddenly and violently, break open or fly into pieces due to the force of internal pressure.”

Paragraph 5.1., amend to read:

“5.1. Compressed hydrogen storage system

This section specifies the requirements for ~~the integrity of~~ the compressed hydrogen storage system. The hydrogen storage system consists of the high pressure storage container and primary closure devices for openings into the high pressure storage container. Figure 1 shows a typical compressed hydrogen storage system consisting of a pressurized container, three closure devices and their fittings. The closure devices **shall include the following functions, which may be combined:**

- (a) ~~A~~-TPRD;
- (b) ~~A~~-~~e~~Check valve that prevents reverse flow to the fill line; and
- (c) ~~An~~~~a~~Automatic shut-off valve that can close to prevent flow from the container to the fuel cell or ~~ICE~~**internal combustion** engine. Any shut-off valve, and TPRD that form the primary closure of flow from the storage container shall be mounted directly on or within each container. At least one component with a check valve function shall be mounted directly on or within each container.”

Paragraph 5.1.1.2., amend to read:

“5.1.1.2. Baseline initial pressure cycle life

Three (3) new containers randomly selected from the design qualification batch are hydraulically pressure cycled at 20(±5)°C to 125 per cent NWP (**+2/-0 MPa**) without rupture for 22,000 cycles or until a leak occurs (para. 6.2.2.2. test procedure). Leakage shall not occur within a number of Cycles, where the number of Cycles is set individually by each Contracting Party at 5,500, 7,500 or 11,000 cycles for a 15-year service life.”

Paragraph 5.1.2.1., amend to read:

“5.1.2.1. Proof pressure test

A storage container is pressurized to 150 per cent NWP (**+2/-0 MPa**) and held for **at least** 30 sec (para. 6.2.3.1. test procedure). A storage container that has undergone a proof pressure test in manufacture is exempt from this test.”

Paragraphs 5.1.2.4. thru 5.1.2.7., amend to read:

“5.1.2.4. Chemical exposure and ambient-temperature pressure cycling test

The storage container is exposed to chemicals found in the on-road environment and pressure cycled to 125 per cent NWP (**+2/-0 MPa**) at 20° (±5)°C for 60 per cent number of Cycles pressure cycles (para. 6.2.3.4. test procedure). Chemical exposure is discontinued before the last 10 cycles, which are conducted to 150 per cent NWP (**+2/-0 MPa**).

5.1.2.5. High temperature static pressure test.

The storage container is pressurized to 125 per cent NWP (**+2/-0 MPa**) at ≥85°C for **at least** 1,000 hr (para. 6.2.3.5. test procedure).

5.1.2.6. Extreme temperature pressure cycling.

The storage container is pressure cycled at ≤ -40°C to 80 per cent NWP (**+2/-0 MPa**) for 20 per cent number of Cycles and at ≥ +85°C and 95 per cent relative humidity to 125 per cent NWP (**+2/-0 MPa**) for 20 per cent number of Cycles (para. 6.2.2.2. test procedure).

5.1.2.7. Hydraulic residual pressure test. The storage container is pressurized to 180 per cent NWP (**+2/-0 MPa**) and held **at least** 4 minutes without burst (para. 6.2.3.1. test procedure).”

Paragraph 5.1.3.1., amend to read:

“5.1.3.1. Proof pressure test

A system is pressurized to 150 per cent NWP (**+2/-0 MPa**) for **at least** 30 seconds (para. 6.2.3.1. test procedure). A storage container that has undergone a proof pressure test in manufacture ~~is~~**may be exempted** from this test.”

Paragraph 5.1.3.2. (b), amend to read:

“(b) The first group of pressure cycling, 25 cycles are performed to 80 per cent NWP (**+2/-0 MPa**) at ≤ -40 °C, then 25 cycles to 125 per cent NWP (**+2/-0 MPa**) at $\geq +50$ °C and 95 (**± 2**) per cent relative humidity, and the remaining 200 cycles to 125 per cent NWP (**+2/-0 MPa**) at 20 (± 5) °C;

The second group of pressure cycling, 25 cycles are performed to 125 per cent NWP (**+2/-0 MPa**) at $\geq +50$ °C and 95 (**± 2**) per cent relative humidity, then 25 cycles to 80 per cent NWP (**+2/-0 MPa**) at ≤ -40 °C, and the remaining 200 cycles to 125 per cent NWP (**+2/-0 MPa**) at 20 (± 5) °C.”

Paragraph 5.1.3.4., amend to read:

“5.1.3.4. Residual proof pressure test (hydraulic)

The storage container is pressurized to 180 per cent NWP (**+2/-0 MPa**) and held **at least** 4 minutes without burst (para. 6.2.3.1. test procedure).”

Paragraph 5.1.3.5., amend to read:

“5.1.3.5. Residual strength burst test (hydraulic)

The storage container undergoes a hydraulic burst to verify that the burst pressure is ~~within 20~~**at least 80** per cent of the baseline burst pressure determined in para. 5.1.1.1. (para. 6.2.2.1. test procedure).”

Paragraph 5.1.5.2., amend to read:

“5.1.5.2. Check valve and automatic shut-off valve qualification ~~on~~ requirements

Design qualification testing shall ...”

Paragraph 5.2., amend to read:

“5.2. Vehicle fuel system

This section specifies requirements for the ~~integrity of the hydrogen vehicle fuel-delivery~~ system, which includes the **compressed** hydrogen storage system, piping, joints, and components in which hydrogen is present.”

Paragraph 5.2.1.3.1.(c), amend to read:

- “(c) Other pressure relief devices (such as a burst ~~disc~~) may be used outside the hydrogen storage system. The hydrogen gas discharge from other pressure relief devices shall not be directed:
- (i) Towards exposed electrical terminals, exposed electrical switches or other ignition sources;
 - (ii) Into or towards the vehicle passenger or ~~cargo~~ **luggage** compartments;
 - (iii) Into or towards any vehicle wheel housing;
 - (iv) Towards hydrogen gas containers.”

Paragraph 5.2.1.4.1., amend to read:

“5.2.1.4.1. Hydrogen leakage and/or permeation from the hydrogen storage system shall not directly vent into the passenger ~~or~~, luggage, ~~or cargo~~ compartments, or to any enclosed or semi-enclosed spaces within the vehicle that contains unprotected ignition sources.”

Paragraph 5.2.1.5., amend to read:

“5.2.1.5. Fuel system leakage

The hydrogen fuelling line (**e.g. piping, joint, etc.**) ~~and the hydrogen system(s)~~ downstream of the main shut off valve(s) **to the fuel cell system or the engine** shall not leak. Compliance shall be verified at NWP (para. 6.1.5. test procedure).”

Paragraph 5.2.1.6. (b), amend to read:

“(b) Yellow in colour if the detection system malfunctions (**e.g. circuit disconnection, short-circuit, sensor fault**). ~~and~~ It shall be red in compliance with section para. 5.2.1.4.3;”

Paragraph 5.2.1.6. (d), amend to read:

“(d) Remains illuminated when 2 ± 1.0 per cent concentration or detection ~~system malfunction~~ exists and the ignition locking system is in the "On" ("Run") position or the propulsion system is activated.”

Paragraphs 5.2.2.1. and 5.2.2.2., amend to read:

“5.2.2.1. Fuel leakage limit

The volumetric flow of hydrogen gas leakage shall not exceed an average of 118 NL per minute for **the time interval, Δt , as determined in accordance with paragraph 6.1.1.1. or 6.1.1.2. 60 minutes after the crash** (para. 6.1.1. test procedures).

5.2.2.2. Concentration limit in enclosed spaces

Hydrogen gas leakage shall not result in a hydrogen concentration in the air greater than 3 ± 1.0 per cent by volume in the passenger ~~and~~ luggage ~~and~~ ~~and~~ ~~and~~ cargo compartments (para. 6.1.2. test procedures). The requirement is satisfied if it is confirmed that the shut-off valve of the storage system has closed within 5 seconds of the crash and no leakage from the storage system.”

Paragraph 6.1.1., amend to read:

“6.1.1. Post-crash compressed hydrogen storage system leak test

....

The main stop valve and shut-off valves for hydrogen gas, located in the downstream hydrogen gas piping, are **in normal driving condition** ~~kept open~~ immediately prior to the impact.”

Deleted:

Paragraph 6.1.1.2., amend to read:

“6.1.1.2. Post-crash leak test - Compressed hydrogen storage system filled with compressed helium

...

The average helium flow rate over the time interval is therefore

$$V_{\text{He}} = (M_t - M_0) / \Delta t \times 22.41 / 4.003 \times (P_0 - P_{\text{target}} / P_0)$$

where V_{He} is the average volumetric flow rate (NL/min) over the time interval and the term $P_0 - P_{\text{target}} / P_0$ is used to”

Paragraph 6.1.2., amend to read:

“6.1.2. Post-crash concentration test for enclosed spaces

...

Prior to the crash impact, the sensors are located in the passenger ~~and~~ luggage, ~~and~~ ~~and~~ ~~and~~ cargo compartments of ...

(c) At a distance within 100 mm of the top of luggage ~~and~~ ~~and~~ ~~and~~ cargo compartments within ...

... to more than 10 per cent of the targeted criteria in the passenger ~~and~~ luggage, ~~and~~ ~~and~~ ~~and~~ cargo compartments.

...

The filtered readings from each sensor shall be below the targeted criteria of 3 ± 1.0 per cent for hydrogen ~~or~~ ~~and~~ 2.25 ± 0.75 per cent for helium at all times throughout the 60 minutes post-crash test period.”

Paragraph 6.1.3.1.2.1., amend to read:

“6.1.3.1.2.1. Preparation for the test: The test is conducted without any influence of wind **by appropriate means such as:-**

- (a) A test gas ...

Paragraph 6.1.3.2.1.3., amend to read:

- 6.1.3.2.1.3. Prior to the test the vehicle is prepared to allow remotely controllable hydrogen releases from the hydrogen system. The number, location and flow capacity of the release points downstream of the main hydrogen shutoff valve are defined by the vehicle manufacturer taking worst case leakage scenarios **under single failure condition** into account. As a minimum, the total flow of all remotely controlled releases shall be adequate to trigger demonstration of the automatic "warning" and hydrogen shut-off functions."

Paragraph 6.1.4.3., amend to read:

- "6.1.4.3. The measuring section of the measuring device is placed on the centre line of the exhaust gas flow within 100 mm from the exhaust **point of discharge** ~~gas outlet~~ external to the vehicle."

Paragraph 6.1.5.2., amend to read:

- "6.1.5.2. Hydrogen leakage is evaluated at accessible sections of the fuel lines from the high-pressure section to the fuel cell stack (or the engine), using a gas **leak** detector or ~~a~~ leak detecting liquid, such as soap solution."

Paragraph 6.2.3.2., amend to read:

- "6.2.3.2. Drop (impact) test (unpressurized)

...

No attempt shall be made to prevent the bouncing of containers, but the containers may be prevented from falling over during the vertical drop test described ~~in b)~~ above.

If more than one container is used to execute all ~~three~~ drop specifications, then those containers shall ... "

Paragraph 6.2.3.3. (b), amend to read:

- "(b) Pendulum impacts: After 12 hours preconditioning at - 40 **(+0/-2)** °C in an environmental chamber, the centre of"

Paragraph 6.2.3.4., amend to read:

- "6.2.3.4. Chemical exposure and ambient temperature pressure cycling test

Each of the 5 areas of the unpressurized container preconditioned by pendulum impact (paragraph ~~6.4.3.3.2.5.2.-)~~ is exposed to ...

The exposure of the container with the glass wool is maintained for 48 hrs with the container held at 125 per cent NWP **(+2/-0 MPa)** (applied hydraulically) and 20 (±5) °C before ..."

Paragraph 6.2.4., amend to read:

- “6.2.4. Test procedures for expected on-road performance (para. 5.1.3.)
(Pneumatic test procedures are provided; hydraulic test elements are described in para. ~~6.2.2.1.6.3.2.~~)”

Paragraph 6.2.4.2., amend to read:

- “6.2.4.2. Gas permeation test (pneumatic)
A storage system is fully filled with hydrogen gas at 115 per cent NWP (**+2/-0 MPa**) (full fill density equivalent to 100 per cent NWP at +15 °C is 113 per cent NWP at +55 °C) and held ...”

Paragraphs 6.2.5.1. thru 6.2.5.2., renumber and amend to read:

- “6.2.5.1. Fire test
...
Either one of the following two methods are used to identify the position of the system over the initial (localized) fire source:
~~6.2.5.1.1.~~ (a) Method 1: Qualification for a generic (non-Specific) vehicle installation
...
~~6.2.5.1.2.~~ (b) Method 2: Qualification for a specific vehicle installation
... fires originating from the direction of the passenger compartment, ~~earr~~ cargo/luggage compartment, wheel wells or ground-pooled gasoline.
6.2.5.1.1. The container may ...
6.2.5.1.2. The following test requirements apply whether Method 1 or 2 (above) is used:
(a) The container assembly is filled with compressed hydrogen gas at 100 per cent of NWP (**+2/-0 MPa**). The container ...
(b) Localized portion of the fire test
(ib) The localized fire exposure area is ...
(iie) ... within the localized fire **exposure** area, and at least ...
(iiid) Wind shields are ...
(ive) ... under the localized **fire** exposure area of ...
(vff) ... in the localized fire **exposure** area has increased continuously to at least The temperature in the localized fire **exposure** area shall not exceed
(c) Engulfing portion of the fire test
...
(d) Documenting results of the fire test
....

6.2.5.2. Engulfing fire test:

The test unit is the compressed hydrogen storage system. The storage system is filled with compressed hydrogen gas at 100 per cent NWP (**+2/-0 MPa**).
....”

Paragraph 6.2.6.1.2., amend to read:

“6.2.6.1.2. Accelerated life test.

... and five at an accelerated life temperature, $T_{life} = 9.1 \times T_{act}^{0.503}$ ~~0.513~~.
The TPRD is placed in The three TPRDs tested at ~~Tact~~ shall activate in less than ...”

Paragraph 6.2.6.1.10., amend to read:

“6.2.6.1.10. Flow rate test

- (a) Eight TPRD units are tested for flow capacity. The eight units consist of three new TPRD units and one ~~TPRD~~ unit from ...”

Paragraph 6.2.6.2.4. (a), amend to read:

- “(a) The component ~~must now~~ **shall not** show signs of ...”

Paragraph 6.3.1.2.2.3.4., amend to read:

“6.3.1.2.2.3.4. Fourth step

If V1 is greater than or equal to V2, ...

The resulting R_i , which is the electrical isolation resistance value (in Ω), is divided by the working voltage of the high voltage bus in volt (V):

$$R_i \Omega / V = R_i \Omega / \text{Working voltage (V)}$$

...

If V2 is greater than V1, ...

The resulting R_i , which is the electrical isolation resistance value (in Ω), is divided by the working voltage of the high voltage bus in volts (V):

$$R_i \Omega / V = R_i \Omega / \text{Working voltage}$$

...”

In Table 3, the reference to the figure, amend to read:

“~~See Fig. 1 for full dimensions~~ **See Fig. 11 for full dimensions**”

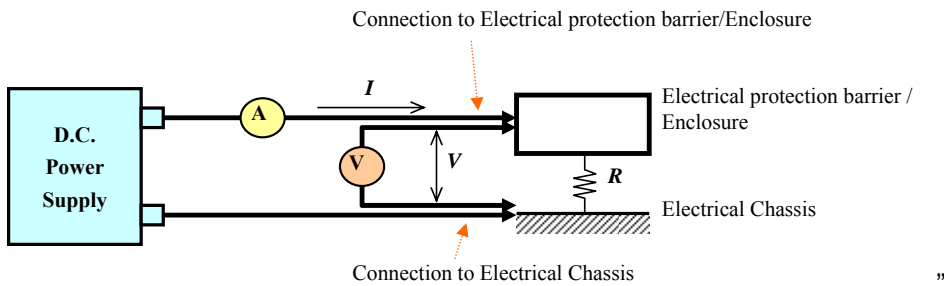
In Figure 11, the dimensions of the toe of the joint test finger, amend to read:

“~~R2=0.05 cylindrical~~ **R2±0.05 cylindrical**

~~R4=0.06 spherical~~ **R4±0.05 spherical**”

Figure 12, amend the title and replace the figure with:

“Figure 12 Example of the test method using D.C. power supply, voltmeter and ammeter



Paragraph 7.2.4.2., amend to read:

“7.2.4.2. Shut-off valves qualification requirements
 ... The ~~valve~~ **shut-off devices** shall meet ...”

Paragraph 7.3., amend to read:

“7.3. LHSS fuel system integrity
 ... with the exception of para. 5.2.1.1.1. The fuelling receptacle label shall ...”

Paragraph 7.4.1.2., amend to read:

“7.4.1.2. Baseline initial burst pressure
 if at least one of the two passing criteria described in para. ~~7.2.1.2.5.2.1.2.~~
 is fulfilled. ...”

Paragraph 7.4.2.3., amend to read:

“7.4.2.3. Vacuum loss test
 ...
 (d) The line downstream the first ~~safety~~ **pressure** relief device is blocked and ...
 ... For steel containers the second part of the test is passed if the **secondary** pressure relief device does not open below 110 per cent of the set pressure of the first ~~safety~~ **pressure** relief device and limits the pressure in the container to a maximum 136 per cent of the MAWP if a safety valve is used, or, 150 per cent of the MAWP if a burst disk is used as the **secondary safety pressure** relief device. For other container materials, an equivalent level of safety shall be demonstrated.”

Paragraph 7.5.1., amend to read:

“7.5.1. Post-crash leak test for the liquefied hydrogen storage systems

...

... Exhaust from the venting of the pressure controls or the PRDs shall not be vented to the passenger ~~or~~ luggage, ~~or~~ cargo compartments during ...”

II. Justification

Several clerical errors, inconsistencies and deficiencies have been recognised in the part II the global technical regulation No. 13 and this proposal is to clear up such issues. It is not intended to amend any content of the technical requirements of the gtr No.13.
