

Proposal to replace document ECE/TRANS/WP.29/GRSP/2021/12

Proposal for Supplement 4 to the original version [and Supplement 1 to the 01 series of amendments] to UN Regulation No. 134 (Hydrogen and Fuel Cell Vehicles)

Submitted by the expert from the International Organization of Motor Vehicle Manufacturers

The text reproduced below was prepared by the expert from the International Organization of Motor Vehicle Manufacturers (OICA). The text reproduced below was prepared by the experts from the International Organization of Motor Vehicle Manufacturers (OICA), aiming to allow alternative test methods for heavy duty vehicles in order to improve applicability of the requirements to vehicles of categories M₂, M₃, N₂ and N₃. The modifications to the current text of the UN Regulation are marked in bold for new or strikethrough for deleted characters. Additional changes compared to the original text of document ECE/TRANS/WP.29/GRSP/2021/12 are indicated in **blue** and to the informal document GRSP/69 in **red**.

I. Proposal

Paragraph 2.7., amend to read:

"2.7. "Enclosed or semi-enclosed spaces" means the special volumes within the vehicle (or the vehicle outline across openings) that are external to the hydrogen system (storage system, fuel cell system and fuel flow management system) and its housings (if any) where hydrogen may accumulate (and thereby pose a hazard), ~~as it may occur in the passenger compartment, luggage compartment and space under the hood.~~"

Paragraph 5., amend to read:

"5. Part I – Specifications of the compressed hydrogen storage system

This part specifies the requirements ...

All new compressed hydrogen storage systems produced for on-road vehicle service shall have a NWP of 70 MPa or less and a service life of **1520** years **(or upon the request of the manufacturer 20 years in case of vehicles of categories M₂, M₃, N₂ and N₃ (hereinafter referred to as "20 years"))** or less, and be capable of satisfying the requirements of paragraph 5.

..."

Paragraph 5.1.2., amend to read:

"5.1.2. Baseline initial pressure cycle life.

Three (3) containers shall be hydraulically pressure cycled at the ambient temperature of 20 (±5) °C to 125 per cent NWP (+2/-0 MPa) without rupture for 22,000 cycles **for a 15-year service life or 30,000 cycles for a 20-year service life of vehicles of categories M₂, M₃, N₂ and N₃ (hereinafter referred to as "a 20-year service life")**, or until a leak occurs (Annex 3, paragraph 2.2. test procedure). ~~Upon the manufacturer's request an increase of service life for vehicles~~ **Alternatively, vehicles of categories M₂, M₃, N₂ and N₃ may be verified with the increased number of cycles in which one year of service life requires an addition of 750 cycles with the maximum of 15,000 cycles for a 20-year service life.** Leakage shall not occur within 11,000 cycles for a 15-year service life **or 15,000 cycles for a 20-year service life.** "

Paragraph 5.2., amend to read:

"5.2. Verification tests for performance durability (Hydraulic sequential tests)

If all three pressure cycle life measurements made in paragraph 5.1.2. are greater than 11,000 cycles **for a 15-year service life or 15,000 cycles for a 20-year service life**, or if they are all within ± 25 per cent of each other, then only one (1) container is tested in paragraph 5.2. Otherwise, three (3) containers are tested in paragraph 5.2.

..."

Paragraph 5.6., amend to read:

"5.6 Labelling

...

Date of removal from service shall not be more than 15 **years (or 20 years)** after the date of manufacture. "

Paragraph 7.1.1.4., amend to read:

"7.1.1.4. The fuelling receptacle shall not be mounted within the external energy absorbing elements of the vehicle (e.g. bumper) and shall ~~not~~ be installed in **such a way that access for refilling shall not be required in the passenger compartment, luggage compartment, or in any other unventilated compartment.** ~~and other places where hydrogen gas could accumulate and where ventilation is not sufficient.~~ Test procedure is by visual inspection. "

Paragraph 7.2., amend to read:

"7.2. Post-crash fuel system integrity

The vehicle fuel system shall comply with the following requirements after the vehicle crash tests in accordance with the following UN Regulations by also applying the test procedures prescribed in Annex 5 of this UN Regulation.

- (a) Frontal impact test in accordance with either UN Regulation No. 12, or UN Regulation No. 94; and
- (b) Lateral impact test in accordance with UN Regulation No. 95.

In case that one or both of the vehicle crash tests specified above are not applicable to the vehicle, the ~~vehicle fuel system~~ **compressed hydrogen storage system** shall, instead, be subject to the relevant alternative accelerations specified below and the **compressed** hydrogen storage system shall be installed ~~in-comply to with a position satisfying~~ the relevant requirements in paragraphs 7.2.3. and 7.2.4. The accelerations shall be measured at the location where the **compressed** hydrogen storage system is installed. The ~~vehicle fuel system~~ **compressed hydrogen storage system** shall be mounted and fixed on the representative part of the vehicle. The mass used shall be representative for a fully equipped and filled container or container assembly.

..."

Paragraph 7.2.4.2., amend to read:

"7.2.4.2. Requirements on installation of the hydrogen storage system not subject to the lateral impact test:

The container shall be mounted in a position which is between the two vertical planes parallel to the centre line of the vehicle located 200 mm inside from the both outermost edge of the vehicle in the proximity of its container(s). ~~This requirement shall not apply to compressed hydrogen storage systems which are mounted in such a way that the lowest part of the system is higher than 1,000 mm above the ground."~~

Insert new paragraphs 7.2.4.3.-7.2.5., to read:

"7.2.4.3. **Lateral impact test on compressed hydrogen storage system as alternative to 7.2.4.2.**

Upon the manufacturer's request, for compressed hydrogen storage systems installed in vehicles to which the vehicle crash test specified in 7.2. (b) is not applicable, the additional installation requirement under 7.2.4.2. does not apply if the compressed hydrogen storage system has passed the lateral impact test specified below:

7.2.4.3.1. **Test conditions**

The compressed hydrogen storage system must be filled with hydrogen or helium. The test pressure shall be agreed by the manufacturer together with the Technical Service. Tests shall be conducted on the compressed hydrogen storage system in the position intended for the installation in the vehicle including attachments, brackets and protective structures if applicable. At the manufacturer's discretion and in agreement with the Technical Service the compressed hydrogen storage system may be fixed to a representative part of the frame or on a complete vehicle. The protective structure shall be defined by the manufacturer.

7.2.4.3.2. **Movable deformable barrier**

The movable deformable barrier (MDB) shall comply with the requirements of UN Regulation No. 95, Annex 5.

7.2.4.3.3. **Lateral impact on compressed hydrogen storage system**

The MDB speed at the moment of impact shall be 50 ± 1 km/h. However, if the test was performed at a higher impact speed and the compressed hydrogen storage system met the requirements, the test shall be considered satisfactory. The impact direction shall be in an angle of 90° to the longitudinal axis of the ~~container~~ test set-up as defined in paragraph

7.2.4.3.1. and the height of the container shall be adjusted in a way that the middle of the front plate of the barrier matches the middle of the container in the horizontal and vertical.

After this lateral impact test the compressed hydrogen storage system shall comply with the requirements in 7.2.1. – and 7.2.3.

[7.2.54.3.4. A calculation method may be used instead of practical testing if its equivalence can be demonstrated by the applicant for approval to the satisfaction of the Technical Service.]

Paragraph 8.1., amend to read:

- "8.1. Every modification to an existing type of vehicle or hydrogen storage system or specific component for hydrogen storage system shall be notified to the Type Approval Authority which approved that type. The Authority shall then, **referring to Annex 6**, either:
- (a) Decide, in consultation with the manufacturer, that a new type-approval is to be granted; or
 - (b) Apply the procedure contained in paragraph 8.1.1. (Revision) and, if applicable, the procedure contained in paragraph 8.1.2. (Extension)."

Paragraph 9.3.2.2., amend to read:

- "9.3.2.2. ...
- For the service life of 15 years, the cylinder shall not leak or rupture within the first 11,000 cycles, **or for the service life of 20 years, within the first 15,000 cycles.**

Paragraph 9.3.2.3., amend to read:

- "9.3.2.3. Relaxation provisions
- ...
- 9.3.2.3.1. One cylinder from each batch shall be pressure cycled with 11,000 cycles for the service life of 15 **years or with 15,000 cycles for the service life of 20 years** depending on the intended use of the container
- 9.3.2.3.2. On 10 sequential production batches of the same design, should none of the pressure cycled cylinders leak or rupture in less than 11,000 cycles x 1.5 for the service life of 15 years **or in less than 15,000 cycles x 1.5 for the service life of 20 years**, then the pressure cycling test can be reduced to one cylinder from every 5 batches of production.
- 9.3.2.3.3. On 10 sequential production batches of the same design, should none of the pressure cycled cylinders leak or rupture in less than 11,000 cycles x 2.0 for the service life of 15 years **or in less than 15,000 cycles x 2.0 for the service life of 20 years**, then the pressure cycling test can be reduced to one cylinder from every 10 batches of production. "

Annex 3, Paragraph 3.2., amend to read:

- "3.2. Drop (impact) test (unpressurized)
- The storage container is drop tested ...
- If more than one container is used to execute all drop specifications, then those containers shall undergo pressure cycling according to Annex 3, paragraph 2.2.

until either leakage or 22,000 cycles **for a 15-year service life or 30,000 cycles for a 20-year service life** without leakage have occurred. Leakage shall not occur within 11,000 cycles **for a 15-year service life or 15,000 cycles for a 20-year service life**.

The orientation of the container being dropped in accordance with the requirement of paragraph 5.2.2. shall be identified as follows:

- (a) If a single container was subjected to all four drop orientations, then the container being dropped in accordance with the requirement of paragraph 5.2.2. shall be dropped in all four orientations;
- (b) If more than one container is used to execute the four drop orientations, and if all containers reach 22,000 cycles **for a 15-year service life or 30,000 cycles for a 20-year service life** without leakage, then the orientation of the container being dropped in accordance with the requirement paragraph 5.2.2. is the 45° orientation (iv), and that container shall then undergo further testing as specified in paragraph 5.2.;
- (c) If more than one container is used to execute the four drop orientations and if any container does not reach 22,000 cycles **for a 15-year service life or 30,000 cycles for a 20-year service life** without leakage, then the new container shall be subjected to the drop orientation(s) that resulted in the lowest number of cycles to leakage and then will undergo further testing as specified in paragraph 5.2. "

Annex 4, Paragraph 1.1., amend to read:

"1.1. Pressure cycling test.

Five TPRD units undergo 11,000 internal pressure cycles **for a 15-year service life or 15,000 internal pressure cycles for a 20-year service life** with hydrogen gas having gas quality compliant with ISO 14687-2/SAE J2719. The first five pressure cycles are between 2 (±1) MPa and 150 per cent NWP (±1 MPa); the remaining cycles are between 2 (±1) MPa and 125 per cent NWP (±1 MPa). The first 1,500 pressure cycles are conducted at a TPRD temperature of 85 °C or higher. The remaining cycles are conducted at a TPRD temperature of 55 (±5) °C. The maximum pressure cycling rate is ten cycles per minute. Following this test, the pressure relief device shall comply the requirements of Leak test (Annex 4, paragraph 1.8.), Flow rate test (Annex 4, paragraph 1.10.) and Bench top activation test (Annex 4 paragraph 1.9.). "

Paragraph 2.3., amend to read:

"2.3. Extreme temperature pressure cycling test

- (a) The total number of operational cycles is 11,000 **for a 15-year service life or 15,000 operational cycles for a 20-year service life** for the check valve and 50,000 **for a 15-year service life or 67,000 operational cycles for a 20-year service life** for the shut-off valve. The valve unit are installed in a test fixture corresponding to the manufacturer's specifications for installation. The operation of the unit is continuously repeated using hydrogen gas at all specified pressures.
- (b) ...
- (c) **Check valve chatter flow test: Following 11,000 operational cycles for a 15-year service life or 15,000 operational cycles for a 20-year service life and leak tests in Annex 4, paragraph 2.3.(b), the check valve is subjected to 24 hours of chatter flow at a flow rate that causes the most**

chatter (valve flutter). At the completion of the test the check valve shall comply with the ambient temperature leak test (Annex 4, paragraph 2.2.) and the strength test (Annex 4, paragraph 2.1.)."

Annex 5, Paragraph 3.2.1.3. amend to read:

"3.2.1.3. Prior to the test the vehicle is prepared to **simulate** remotely controllable hydrogen releases from the hydrogen system. **Hydrogen releases may be demonstrated by using external fuel supply without modification of the test vehicle fuel lines.** 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 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. "

Insert new Annex 6, to read:

"Annex 6

Approval testing for CHSS modifications

1. Modifications to an existing type approval of CHSS may be approved in accordance with the reduced test programme specified in Table 1 below.
2. For modifications not specified in Table 1, the necessary test programme shall be identified by the Technical Service taking account of the similarities of the intended modification to the items specified in the Table 1.

Table 1, Change of Design

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 ⁽²⁾	≤20%	- Initial burst, Initial pressure cycle life
	>20%	- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test
Length	≤50%	- Initial burst, Initial pressure cycle life - Fire test ⁽³⁾
	>50%	- Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test ⁽³⁾
Nominal working pressure ⁽²⁾	≤20%	- Initial burst, Initial pressure cycle life
Coating		- Sequential hydraulic tests - Fire test ⁽⁴⁾
Boss ⁽⁵⁾	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 ⁽⁶⁾		- Sequential pneumatic tests - Fire test ⁽⁷⁾

- (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 thickness change is proportional to diameter ~~or pressure~~ change.
- (3) 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.
- (4) Fire test required if coating affects fire performance.
- (5) 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.
- (6) Alternative valve shall be approved in accordance with part II.
- (7) Fire test not required if TPRD design has not been changed, and the mass of the changed valve is +/- 30% of the original valve.

Justification:

II. Justification

The objective of this Regulation was the transposition of GTR 13 Phase 1. Contrary to this Regulation, the scope of GTR 13 Phase 1 does not cover heavy-duty vehicle requirements. Being aware of the ongoing work of GTR 13 Phase 2, this proposal aims to solve practicality issues for the application to heavy-duty vehicles that is urgently needed, as the approval to this Regulation will become mandatory in the European Union as of July 2022. **As this only reflects an intermediate solution until the discussions within the IWG GTR 13 phase 2 are finalized, the alternatives proposed in this document are not intended to set a new crash standard for vehicles of categories M2, M3, N2 and N3.**

1. Paragraphs 2.7. and 7.1.1.4.: Since not all vehicles have luggage compartment or space under hood, these examples may be misleading and should therefore be deleted.
2. Paragraphs 5. , 9.3.2.2 and 9.3.2.3.: The service lives of heavy-duty vehicles are in general much longer than 15 years. A service life of up to 20 years decreases the total cost of ownership, which is one of the key challenges to make hydrogen buses and trucks a viable alternative to diesel vehicles. The calculation of 750 cycles per year to increase the service life is based on the ISO 19881 and GTR 13 Phase 1.
3. Paragraph 7.2.: Is intended to clarify the requirements of the acceleration test for practical application to heavy-duty vehicles.
4. Paragraph 7.2.4.: ~~Hydrogen storage systems that are installed higher than 1,000 mm above the ground (behind the cab or on the roof of the vehicle) are not at risk of being impacted in a lateral crash.~~ As an alternative to the dimensional requirement of paragraph 7.2.4.2. a component-based lateral impact test is being proposed to demonstrate the adequate protection. **The IWG GTR 13 phase 2 is asked to further review the necessity of other alternatives to installation restrictions. It may develop appropriate proposals which will be transposed into UN regulation no. 134.**
5. Paragraph 7.2.~~54~~**3.4.**: Where practical tests are very common for passenger vehicles the heavy-duty vehicle industry has provided reliable results when showing compliance by calculation methods. **The manufacturer can correlate the calculations / simulations on the basis of a physical test in one installation situation and then assess the other situations by calculation / simulation.**
6. Annex 5 Paragraph 3.2.1.3. : “3.2. Hydrogen releases from the hydrogen system” requires alteration of the test vehicle. A test method without modification of fuel lines also should be provided. This is being discussed in IWG GTR 13 Phase 2 as well.
7. Additional changes were made to address questions raised by various Contracting Parties:
 - 7.1 The test procedure proposed in paragraph 7.2.4.3. of ECE/TRANS/WP.29/GRSP/2021/12 is component based test. Therefore, the assessments of paragraph 7.2.2. "Concentration limit in enclosed spaces" is not reasonable to apply. For this test configuration, the assessment for 7.2.2. is not possible because the body structure that may configure the enclosed space will not be included and the shut-off valve will be closed from the beginning. The assessment for paragraph 7.2.1. "Fuel leakage limit" in this component based test will ensure the CHSS will exhibit the sufficient safety performance as the alternative requirement of the dimensional requirement in paragraph 7.2.4.2.
 - 7.2 Test provisions for the CHSS in case of a change of design are part of European legislation ((EC) No 79/2009), which has been repealed by (EU) 2019/2144. The proposal intends to maintain the process for design changes established by (EC) 79/2009. The table was discussed and agreed in Taskforce 3 of the Informal Working Group on GTR13 phase 2. This amendment further clarifies the type approval procedure on basis of decisions made in the IWG on GTR13 phase 2.

7.3 The provisions on stress rupture (High temperature static pressure test) included in GTR 13 phase 1 (5.1.2.5.) and in UN-Regulation 134 (5.2.5.) already reflect a service life of 25 years and therefore do not need to be adjusted for the extension of service life to 20 years. The basis for the test considered glass fibre composite as a worst case material but did not exclude resin material.
