9 September 2022

Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 133 – UN Regulation No. 134

Amendment 5

Supplement 4 to the original series of amendments – Date of entry into force: 22 June 2022

Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of Hydrogen-Fuelled Vehicles (HFCV)

This document is meant purely as documentation tool. The authentic and legal binding text is: ECE/TRANS/WP.29/2021/123

UNITED NATIONS

* Former titles of the Agreement:
Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958 (original version);
Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

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)."

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 15 years (or upon the request of the manufacturer 20 years in case of vehicles of categories M_2, M_3, N_2 and N_3 (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 M_2, M_3, N_2 and N_3 (hereinafter referred to as "a 20-year service life"), or until a leak occurs (Annex 3, paragraph 2.2. test procedure). 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 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. 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 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 compressed hydrogen storage system shall, instead, be subject to the relevant alternative accelerations specified below and the compressed hydrogen storage system shall comply with 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 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)."

Insert new paragraphs 7.2.4.3. to 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 test set-up as defined in paragraph 7.2.4.3.1. and 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.

7.2.4.3.4. 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 and in agreement with the type-approval authority."

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 a new Annex 6, to read:

"Annex 6

Approval testing for compressed hydrogen storage system (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

Changed Item		*Required Tests*
		- Fire test [3]
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]

Notes:

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 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 per cent of the original valve."