

3. Rationale for paragraph 4 (Applicability of requirements)

39. The performance requirements in paragraph 5. address the design qualification for on-road service.

40. It is expected that all Contracting Parties will recognize vehicles that meet the full requirements of this gtr as suitable for on-road service within their jurisdictions. Contracting Parties with type approval systems may require, in addition, compliance with their requirements for conformity of production, material qualification and hydrogen embrittlement. Contracting Parties may also elect to allow alternative methods to demonstration that requirements are met, for instance on the basis of established equivalence.

F. Rationale for storage and fuel system test procedures

107. Test procedures in para. 6. replicate on-road conditions for performance requirements specified in para. 5. Most test procedures derive from test procedures specified in historical national regulations and/or industry standards.

1. Rationale for storage and fuel system integrity tests

(a) *Rationale for paragraph 6.1.1. test procedure for post-crash leak test procedure for compressed hydrogen storage systems*

000. As a general principle, the crash tests used to evaluate post-crash hydrogen leakage are those already applied by the respective contracting parties.

000. Contracting parties may permit alternative means of demonstrating that post-crash safety is ensured, notably in absence of a specific crash test for a given orientation. It concerns specifically alternative tests subjecting vehicle fuel systems to specified acceleration levels. This practise has been well established in *inter alia* UN Regulation No 67 on liquefied petroleum gases (LPG), UN Regulation No 110 on compressed natural gas (CNG) and liquefied natural gas (LNG), as well as European Union Regulation (EC) No 406/2010, implementing Regulation (EC) No 79/2009 on hydrogen safety. In this respect it is thought that its rigorous implementation has indeed contributed to a high level of safety in the field, supported by the observed absence of relevant failures in the vehicle fleet that has been subject to these particular regional requirements.

000. However, to account for technical progress, the European Commission has carried out an analysis of world-wide crash and crash test data for all respective vehicle categories¹ (acknowledged to be limited in certain cases). It was carried out with a view to review and adjust, where necessary, the specified accelerations in order to align more appropriately with the acceleration levels observed in the available crash and test data attributed to the respective vehicle categories. The relevant updated values are therefore incorporated in the regulatory text encompassed in paragraph 6.1.1.]

4. Applicability of requirements

4.1. The requirements of paragraph 5. (using test conditions and procedures in paragraph 6.) apply to all compressed hydrogen-fuelled vehicles.

4.2. Each contracting party under the UN 1998 Agreement shall maintain its existing national crash tests (frontal, side, rear and rollover) and use the limit

¹ <https://data.europa.eu/doi/10.2873/58935>

values of section paragraph 5.2.2. for compliance. In absence of any such test or as an alternative to existing tests, the acceleration tests of paragraph 6.1.1. may be applied instead, to the discretion of each contracting party.

- 4.3. The requirements of paragraph 5.3. apply to all hydrogen-fuelled vehicles using high voltage.

6. Test conditions and procedures

- 6.1. Compliance tests for fuel system integrity

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

The crash tests used to evaluate post-crash hydrogen leakage are those already applied in the jurisdictions of each contracting party.

In case that a crash test as specified above is not applicable, or as an alternative thereto, the vehicle fuel system may, instead, be subject to the relevant alternative accelerations specified below, to the discretion of each contracting party. [so that the following accelerations can be absorbed without breaking of the fixation or loosening of the container(s).] [A calculation method can be used instead of practical testing if its equivalence can be demonstrated.] [The hydrogen storage system shall in such case be installed in a position satisfying the requirements in paragraph XXX]. The accelerations shall be measured at the location where the hydrogen storage system is installed. The vehicle fuel 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.

Accelerations for vehicles of categories 1-1, 1-2 and 2 with a gross vehicle mass (GVM) of 3,500 kilograms or less

(a) [20 or 26] g in the direction of travel (forward and rearward direction);

(b) [8 or 12] g horizontally perpendicular to the direction of travel (to left and right).

Accelerations for vehicles of categories 1-1 and 1-2 with a gross vehicle mass (GVM) of at least 3,501 kilograms up to 5,000 kilograms and category 2 with a gross vehicle mass (GVM) of at least 3,501 kilograms up to 12,000 kilograms

(a) 10 g in the direction of travel (forward and rearward direction);

(b) [5 or 8] g horizontally perpendicular to the direction of travel (to left and right).

Accelerations for vehicles of categories Category 1-1 and 1-2 with a gross vehicle mass (GVM) of at least 5,001 kilograms and category 2 with a gross vehicle mass (GVM) of at least 12,001 kilograms

(a) [6.6 or 8] g in the direction of travel (forward and rearward direction);

(b) [5 or 8] g horizontally perpendicular to the direction of travel (to left and right).

コメントの追加 [BP(1): If the acceleration tests are performed instead of a real crash test, do we want to impose additional installation requirements, such as in R134.02?

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).

If this is the case, we must insert a new paragraph XXX with such requirements.

EC position is to ~~delete~~ the acceptable simple notion (in EU Regulations 79/2009 and 406/2010) that fixation or loosening of containers is the only requirements which can be demonstrated by equivalent calculation check. Instead we want to apply the post-crash leakage rate check to be fully consistent with **performance requirements in GTR**. If that is agreed, the installation limitations like the 200 mm should in our opinion also be deleted.

The storage system is then purged, if necessary, following manufacturer directions to remove impurities from the container before filling the storage system with compressed hydrogen or helium gas. Since the storage system pressure varies with temperature, the targeted fill pressure is a function of the temperature. The target pressure shall be determined from the following equation:

$$P_{\text{target}} = \text{NWP} \times (273 + T_o) / 288$$

where NWP is the nominal working pressure (MPa), T_o is the ambient temperature to which the storage system is expected to settle, and P_{target} is the targeted fill pressure after the temperature settles.

The container is filled to a minimum of 95 per cent of the targeted fill pressure and allowed to settle (stabilize) prior to conducting the crash test.

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