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Item 15 of the provisional agenda
UN Regulation No. 134 (Hydrogen and Fuel Cell Vehicles)

Proposal for the 03 Series of Amendments to UN Regulation No. 134 (Hydrogen and Fuel Cell Vehicles)

Submitted by the Task Force amending UN Regulation No. 134 *

The text reproduced below was prepared by the task force involving the experts from France, Japan, the Netherlands, the European Commission, the European Association of Automotive Suppliers (CLEPA) and the International Organization of Motor Vehicle Manufacturers (OICA) as well as related industry experts on transposing amendment 1 to UN Global Technical Regulation No. 13, Phase 2 (GTR13-PH2) into the UN Regulation under the 1958 Agreement. The modifications to the existing text of the UN Regulation No. 134 are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2024 as outlined in proposed programme budget for 2024 (A/78/6 (Sect. 20), table 20.5), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraph 1, Footnote 1, amend to read:

"[1] This Regulation does not cover the electrical safety of electric power train, the material compatibility and hydrogen embrittlement of the vehicle fuel system, and the post crash fuel system integrity in the event of rear impact.

[This Regulation also does not cover supply lines for additional Thermally activated Pressure Relief Device (TPRDs) made of materials other than metal until specific requirements for such materials have been defined.]"

Paragraph 2.3., amend to read:

"2.3. "*Compressed hydrogen storage system (CHSS)"* means a system designed to store compressed hydrogen fuel for a hydrogen-fuelled vehicle and composed of a container, container attachments (if any), [**supply lines for additional Thermally activated Pressure Relief Device (TPRD) (if any),]** and all primary closure devices required to isolate the stored hydrogen from the remainder of the fuel system and the environment. "

Paragraph 5., amend to read:

"5. Part I – Specifications of the Compressed Hydrogen Storage System

This part specifies the requirements for the compressed hydrogen storage system.

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

(i) TPRD;

(ii) Check valve; and

(iii) Shut-off valve.

(b) The primary closure devices shall be mounted directly on or within each container. [**If needed, manufacturers may choose to locate additional TPRDs in alternative locations on the container. However, any high-pressure supply lines for such additional TPRDs shall have demonstrated mechanical integrity and durability as part of qualification tests for the container (verification tests for baseline metrics in paragraph 5.1., hydraulic sequential test in paragraph 5.2. excluding the drop test; see Annex 9 – Overview of applicability of tests for supply lines for additional TPRDs).**

***Note*: The post-crash fuel system integrity requirements in paragraph 7.2. also apply to supply lines for additional TPRDs.**]"

…

Paragraph 5.1.1., amend to read:

"5.1.1. Baseline initial burst pressure

Three (3) containers [**(as well as supply lines for additional TPRDs (if any) through appropriate adaptors; the same shall apply under this paragraph and paragraphs 5.1.2. to 5.2.8., 5.3.1., 5.3.4. and 5.3.5.)]** shall be hydraulically pressurized until burst in accordance with Annex 3, paragraph 2.1. 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 and are not affected by the test procedure. The manufacturer shall supply documentation (measurements and statistical analyses) that establish the midpoint burst pressure of new containers, BP*O*.

All containers tested shall have a burst pressure within ±10 per cent of BP*O* and greater than or equal to a minimum BPmin of 200 per cent NWP.

Containers having glass-fibre composite as a primary constituent shall have a minimum burst pressure greater than 350 per cent NWP."

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, or if they are all within ± 25 per cent of each other, then only~~ **o**~~**O**~~ne (1) container is tested in paragraph 5.2. ~~Otherwise, three (3) containers are tested in paragraph 5.2.~~

Unless otherwise specified, the tests in paragraph 5.2. shall be conducted on the container equipped with its container attachments (if any) **[as well as supply lines for additional TPRDs (if any) through appropriate adaptors]** that represent the CHSS without the primary closures. **[At the discretion of the Technical Service and the Type-Approval Authority, for such supply lines the worst-case approach may be applied, e.g. longest lines, largest diameter, smallest bend radius and highest number of fittings.]**"

Paragraph 5.2.2., amend to read:

"5.2.2. Drop (impact) test

[This test does not apply to supply lines for additional TPRDs.] The container with its container attachments (if any) is dropped once in one of the impact orientations specified in Annex 3, paragraph 3.2.

[*Note*: The manufacturer applying for approval shall provide handling procedures to ensure that the supply lines for additional TPRDs will not suffer damage during handling. It shall require the removal from service of supply lines that have unacceptable damage.]"

Paragraph 5.3., amend to read:

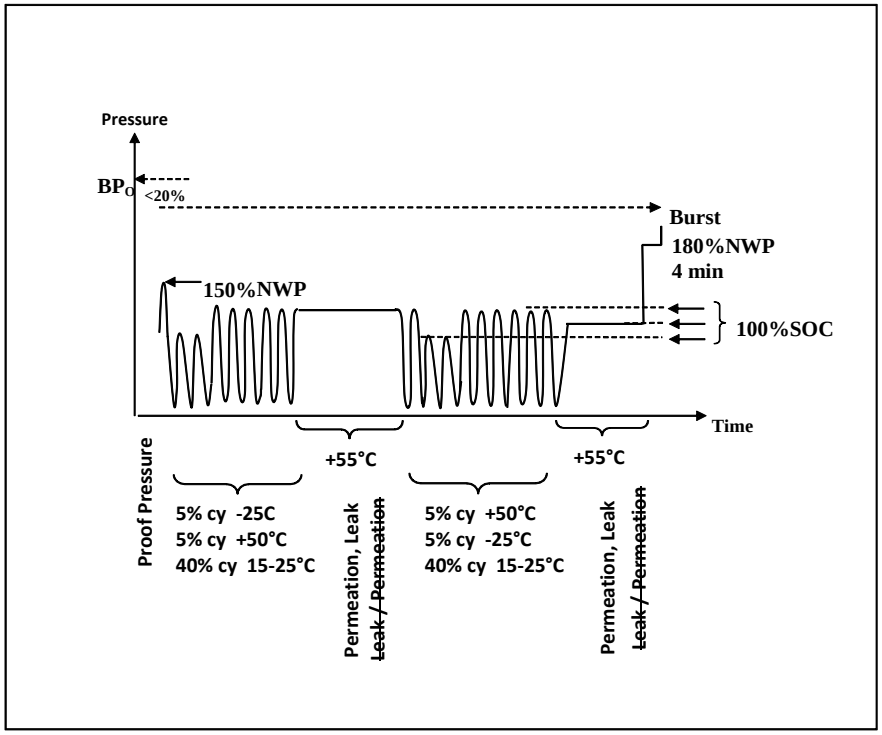
"5.3. Verification test for expected on-road performance (Pneumatic sequential tests)

A CHSS shall undergo the following sequence of tests, which are illustrated in Figure 2. Specifics of applicable test procedures for the CHSS are provided in Annex 3. **[At the discretion of the Technical Service and the Type-Approval Authority, for supply lines for additional TPRDs the worst-case approach may be applied, e.g. longest lines, largest diameter, smallest bend radius and highest number of fittings.]**"

Figure 2., amend to read:

"

Figure 2
Verification Test for Expected On-Road Performance (Pneumatic/~~hydraulic~~)



"

Paragraph 5.3.3., amend to read:

"5.3.3. Extreme temperature static ~~gas pressure leak/permeation test~~ **permeation test and localized leak test** (pneumatic).

The test shall be conducted in accordance with Annex 3, paragraphs 4.2. and 4.3.

The maximum allowable hydrogen discharge from the CHSS is 46 ml/hr/l water capacity of the CHSS. Any single point of localized external leakage measured in accordance with Annex 3, paragraph 4.3. shall not exceed 0.005 mg/sec (3.6 Nml/min)."

Paragraphs 9.2. to 9.2.1., amend to read:

"9.2. The production control of the compressed hydrogen storage system container [**(and supply lines for additional TPRDs (if any); the same shall apply under paragraphs 9.2.1. and 9.2.3.2.)]** shall satisfy the following additional requirements;

9.2.1. Every container or, upon agreement of the Type Approval Authority, every pressure bearing chamber, of CHSS shall be pressurized smoothly and continually with a hydraulic fluid or gas to the target pressure of ≥ 125 per cent NWP until the target test pressure level is reached and then held for ≥ 30 seconds. Temperature variation during the test shall be taken into account. The quality variability of the products shall be assessed with a method defined by the manufacturer e.g., variability of elastic expansion, etc. **[If applicable, for containers with supply lines for additional TPRDs as well as containers consisting of multiple permanently interconnected chambers, the test may be conducted separately on each pressure bearing chamber, supply line and interconnecting fuel line, as described above, not resulting in leakage. Upon agreement with the Type-Approval Authority, the test can be conducted on individual parts, or on a subsystem assembly.]**"

Paragraphs 9.2.3.1. and 9.2.3.2., amend to read:

"9.2.3.1. Burst test

The test shall be performed according to Annex 3, paragraph 2.1. (burst test). The burst pressure of each sample tested shall be at least BPmin and the average burst pressure recorded of the last ten tests shall be at or above BPo - 10 per cent. [**If applicable, for containers with supply lines for additional TPRDs as well as containers consisting of multiple permanently interconnected chambers, the test may be conducted separately on each pressure bearing chamber, supply line and interconnecting fuel line, or on any sub-assembly thereof.]**

9.2.3.2. Ambient temperature pressure cycling test in batch testing

The test shall be performed according to paragraph 2.2. (a) to (c) (hydrostatic pressure cycling test) of Annex 3, except that the temperature requirements for the fuelling fluid and the container skin, and the relative humidity requirement, do not apply. The container of the CHSS shall be pressure cycled using hydrostatic pressures ≥ 125 per cent of NWP, to 22,000 cycles in case of no leakage or until leakage occurs. The container of the CHSS shall not leak or burst within the first 11,000 cycles. **[If applicable, for containers with supply lines for additional TPRDs as well as containers consisting of multiple permanently interconnected chambers, the test may be conducted separately on each pressure bearing chamber, supply line and interconnecting fuel line, or on any sub-assembly thereof.]**"

Insert new paragraph 13.8. to 13.11., amend to read:

"**[13.8. As from the official date of entry into force of the 03 series of amendments, no Contracting Party applying this UN Regulation shall refuse to grant or refuse to accept UN type approvals under this UN Regulation as amended by the 03 series of amendments.**

13.9. As from 1 September [2028], Contracting Parties applying this Regulation shall not be obliged to accept type approvals to the preceding series of amendments, first issued after 1 September [2028].

13.10. Contracting Parties applying this UN Regulation shall continue to accept type approvals issued according to any of the preceding series of amendments to this Regulation first issued before 1 September [2028], provided the transitional provisions in these respective previous series of amendments foresee this possibility.]

[13.11. Until 1 September [2029], Contracting Parties applying this Regulation shall accept type approvals to the preceding series of amendments, first issued before 1 September [2028].

13.12. As from 1 September [2029], Contracting Parties applying this Regulation shall not be obliged to accept type approvals issued to the preceding series of amendments to this Regulation.]

[13.11. Notwithstanding paragraph 13.10., Contracting Parties applying this Regulation shall continue to accept type approvals issued according to the preceding series of amendments to this Regulation, for the vehicles, vehicle systems and parts which are not affected by the changes introduced by the 03 series of amendments.]"

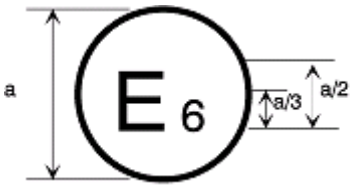
Paragraphs 13.8. and 13.9. (former), renumber as paragraphs 13.12. and 13.13.

Annex 2, amend to read:

"**Annex 2**

Arrangements of the Approval Marks

Model A
(See paragraphs 4.4. to 4.4.2. of this Regulation)

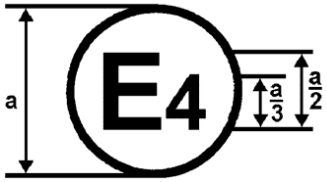


134R - 02~~2~~**3**185 a/3

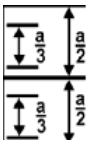
a = 8 mm min

The above approval mark affixed to a vehicle/ storage system/specific component shows that the vehicle/storage system/specific component type concerned has been approved in Belgium (E 6) for its the safety-related performance of hydrogen-fuelled vehicles pursuant to Regulation No. 134. The first two digits of the approval number indicate that the approval already contained the 02~~2~~**3** series of amendments at the time of approval.

Model B
(See paragraph 4.5. of this Regulation)



100	02 2492
134	02~~2~~**3** 1628



a = 8 mm min.

The above approval mark affixed to a vehicle shows that the road vehicle concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. 134 and 100.* The approval number indicates that, at the dates when the respective approvals were granted, Regulation No. 100 was amended by the 02 series of amendments and Regulation No. 134 was amended by the 02~~2~~**3** series of amendments. "

Annex 3, Paragraph 2.1., amend to read:

"2.1. Burst test (hydraulic)

The burst test is conducted at the ambient temperature using a hydraulic fluid. The rate of pressurization is less than or equal to 1.4 MPa/sec for pressures higher than 150 per cent of the nominal working pressure. If the rate exceeds 0.35 MPa/sec at pressures higher than 150 per cent NWP, then either the container **(as well as supply lines for additional TPRDs (if any) through appropriate adaptors; the same shall apply under this paragraph, paragraphs 2.2., 3.1., 3.2., 3.6. and 5.1.)** is placed in series between the pressure source and the pressure measurement device, or the time at the pressure above a target burst pressure exceeds 5 seconds. The burst pressure of the container shall be recorded."

Annex 3, Paragraph 3.2., amend to read:

"3.2. Drop (impact) test (unpressurized)

* The latter number is given only as an example.

The container and its container attachments (if any) is drop tested without internal pressurization[**,** ~~or~~] attached valves [**or supply lines for additional TPRDs]**. The surface onto which the test article is dropped shall be a smooth, horizontal concrete pad or other flooring type with equivalent hardness. No attempt shall be made to prevent the test article from bouncing or falling over during a drop test, but the test article shall be prevented from falling over during the vertical drop test.

…"

Annex 3, paragraphs 4.2. and 4.3., amend to read:

"4.2. ~~Gas~~ **P**ermeation test (pneumatic)

This test is performed after each group of 250 pneumatic pressure cycles conducted in accordance with Table 5a in Annex 3, paragraph 4.

…

4.3. Localized ~~gas~~ leak test (pneumatic)

This test is performed after each permeation test conducted in accordance with Table 5a in Annex 3, paragraph 4.

A bubble test may be used to fulfil this requirement. The following procedure is used when conducting the bubble test:

(a) The exhaust of the shut-off valve (and other internal connections to hydrogen systems) shall be capped for this test (as the test is focused on external leakage).

At the discretion of the Technical Service, the test article may be immersed in the leak-test fluid or leak-test fluid applied to the test article when resting in open air. Bubbles can vary greatly in size, depending on conditions. The tester estimates the gas leakage based on the size and rate of bubble formation.

(b) For a localized rate of 0.005 mg/sec (3.6 Nml/min), the resultant allowable rate of bubble generation is about 2,030 bubbles per minute for a typical bubble size of 1.5 mm in diameter. Even if much larger bubbles are formed, the leak shall be readily detectable. For an unusually large bubble size of 6 mm in diameter, the allowable bubble rate would be approximately 32 bubbles per minute.

If the measured permeation rate during the permeation test under paragraph 4.2 is less than or equal to 0.005 mg/sec (3.6Nml/min), the localized leak test is deemed to be fulfilled."

Annex 5, paragraph 5., amend to read:

"5. Compliance test for fuel line leakage

5.1. The power system of the test vehicle (e.g. fuel cell stack or engine) is warmed up and operating at its normal operating temperature with the operating pressure applied to fuel lines.

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. [**Any single point of localized external leakage shall not exceed 0.005 mg/sec (3.6Nml/min) (measured according to test procedure in Annex 3, paragraph 4.3. (b)).]**

5.3. Hydrogen leak detection is performed primarily at joints.

5.4. When a gas leak detector is used, detection is performed by operating the leak detector for at least 10 seconds at locations as close to fuel lines as possible.

5.5. When a leak detecting liquid is used, hydrogen gas leak detection is performed immediately after applying the liquid. In addition, visual checks are performed

a few minutes after the application of liquid to check for bubbles caused by trace leaks. "

Annex 7, Table 1 and Notes, amend to read:

"[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]
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]
Container attachment	Material, geometry	- Sequential hydraulic tests - Fire test [7]
Supply lines for additional TPRDs	**Changed location of additional**	**Fire test[8]**

Changed Item		*Required Tests*
	TPRD and flow resistance	
	Length, diameter, bend radius	**Sequential hydraulic test[8]**
	Number of fittings	**Pneumatic sequential test[8]**

…

8. Fire test, hydraulic and pneumatic sequential tests are not required if the parameters of the supply lines are covered by the tested worst-case configuration.]"

Insert new Annex 9:

" [Annex 9

Overview of the Applicability of Tests for Supply Lines for Additional Thermally Activated Pressure Relief Device

Test no.	*Test title*	*CHSS*	*Container with attachments (if any)*	*Primary closure devices*	*Supply lines*	*Notes*
5.1.	**Verification test for baseline metrics**					
5.1.1.	**Baseline initial burst pressure**		**x**		**x[1]**	
5.1.2.	**Baseline initial pressure cycle life**		**x**		**x[1]**	
5.2.	**Verification tests for performance durability (Hydraulic sequential tests)**					**At the discretion of the Technical Service and the Type-Approval Authority, for supply lines the worst-case approach may be applied, e.g. longest lines, largest diameter, smallest bend radius and highest number of fittings. The tests shall be conducted for each material separately.**
5.2.1.	**Proof pressure test**		**x**		**x[1]**	
5.2.2.	**Drop (impact) test**		**x**			**The manufacturer applying for approval shall provide handling procedures to ensure that the supply lines for additional TPRDs will not suffer damage during handling. It shall require the removal from service of supply lines that have unacceptable damage.**
5.2.3.	**Surface damage test**		**x**			**Not applicable to metallic supply lines for additional TPRDs**
5.2.4.	**Chemical exposure and ambient-temperature pressure cycling test**		**x**		**x[1]**	
5.2.5.	**High temperature static pressure test**		**x**		**x[1]**	
5.2.6.	**Extreme temperature pressure cycling test**		**x**		**x[1]**	

Test no.	*Test title*	*CHSS*	*Container with attachments (if any)*	*Primary closure devices*	*Supply lines*	*Notes*
5.2.7.	**Residual proof pressure test**		**x**		**x[1]**	
5.2.8.	**Residual strength burst test**		**x**		**x[1]**	
5.3.	**Verification test for expected on-road performance (Pneumatic sequential tests)**					**At the discretion of the Technical Service and the Type-Approval Authority, for such supply lines the worst-case approach may be applied, e.g. longest lines, largest diameter, smallest bend radius and highest number of fittings. The tests shall be conducted for each material separately.**
5.3.1.	**Proof pressure test**	**x**	**x**	**x**	**x**	
5.3.2.	**Ambient and extreme temperature gas pressure cycling test (pneumatic)**	**x**	**x**	**x**	**x**	
5.3.3.	**Extreme temperature static gas pressure leak or permeation test (pneumatic)**	**x**	**x**	**x**	**x**	
5.3.4.	**Residual proof pressure test (hydraulic)**	**x**	**x**	**x**	**x**	
5.3.5.	**Residual strength burst test (hydraulic)**	**x**	**x**	**x**	**x**	
5.4.	**Verification test for service terminating performance in fire**	**x**	**x**	**x**	**x**	

***Notes*:**

1. Supply lines for additional TPRDs (if any) through appropriate adaptors]"

II. Justification

1. Additional TPRDs and supply lines, test procedures:

   Additional TPRDs and their supply lines are not excluded from the 02 series of amendments. No clear requirements were defined though, leading to differing interpretations among Technical Services and Type-Approval Authorities. This proposal clarifies the requirements in alignment with UN GTR No.13, amendment 1.

The limitation to metallic material for supply lines is based on the lack of appropriate test procedures for other materials, e.g. composites.

For a better understanding of the applicability of test procedures an Annex was introduced with an overview of parts and systems to be subjected to specific tests.

2. Permeation and leak test:

This proposal clarifies the order of the permeation and leak test in Figure 2 in alignment with the text and, in addition, streamlines the wording for headlines and text regarding these tests. There is no change to the technical requirements.

3. Localized leak test:

The leak test is not required if the permeation rate in test 4.2. fulfils the requirements of 4.3.

4. Compliance test for fuel line leakage for the fuel system:

The text does not specify a leakage threshold. The proposal clarifies that here the same limits apply as for any other localized external leakage as specified in Annex 3 paragraph 4.3. (b). There is no change to the technical requirements.

5. Conformity of Production – Rationale for allowance of different proof pressure test options for interconnecting fuel lines and supply lines of additional TPRDs:

As already introduced in the 02 Series of UN Regulation No. 134, it is permitted to test individual chambers of a container separately as an alternative to testing the assembled container. This was introduced to make hydraulic pressure testing practical and, in particular, to take account of the subsequent drying process that is necessary for containers consisting of more than one chamber and their interconnecting lines. Since, in such a case, the interconnecting lines of multi-chamber containers and the supply pipes to additional TPRDs (if any) are not tested, one contracting party requested that these lines should also be required to undergo a proof pressure test.. However, applying this in practice is highly dependent on the CHSS design, line size and connection type, and it largely dependent on the manufacturer’s assembly process as to how it is best to apply such pressure test. Hence, it is essential to allow manufacturers a high degree of flexibility in applying this requirement and to focus the regulatory requirements essentially on ensuring that the pressure test is conducted before the product is placed on the market. Therefore, it is left to the CHSS manufacturer to define:

(a) If the test should be conducted separately on each pressure bearing chamber and interconnecting line, separately on container and line sub-assemblies prior to final assembly of the container, the container assembly, or the vehicle fuel system assembly; and

(b) If the tests are performed in-house by the CHSS manufacturer, by suppliers of subcomponents or by the vehicle manufacturer by use of appropriate contractual agreements.

In comparison to industry applications, the quality control of pressure lines is well known and has been safely applied over decades. In standards that include a 100 per cent proof pressure (at least as one option of quality control), practical considerations are recognized and flexibility is introduced, so that different ways of conducting the proof test can be applied. One example to be mentioned in Europe is the Pressure Equipment Directive (EU 2014/68) that can be fulfilled by the harmonized standards EN 13480 for pressure lines (see EU 2019/1616):

(a) It requires proof pressure testing on the "finished piping system" after final installation and inspection "where practicable";

(b) However, in practice testing after final installation and inspection of "the finished piping system is not practicable", either due to:

(i) Issues of getting the hydraulic test fluid out of the system; or

(ii) Safety considerations when performing the test with gas.

(c) In such cases the standard is open to apply the proof pressure test on subsystems or components.

As industry standards also allow such flexibility, it is reasonable and essential for the automotive industry to also allow this for automotive applications.