Submitted by the TF on UN-R 134

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Provisional agenda item 15

Proposal for the 03 Series of Amendments to the 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 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. This document amends working document GRSP/2024/26. The changes are highlighted in red and blue.

** 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 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 2.5., amend to read:

"2.5. "Container Attachments" mean non-pressure bearing parts attached to the container that provide additional support and/or protection to the container and that may be only temporarily removed for maintenance and/or inspection only with the use of tools.

Note: The non-pressure bearing parts attached to the container that provide additional support and/or protection to additional TPRDs and supply lines are also considered as container attachments."

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 component and system tests for supply lines for additional TPRDs).**

(c) The CHSS shall meet the performance test requirements **specified in paragraphs 5.1. to 5.5.** summarized in Table 2. The corresponding test procedures are specified in Annex 3 ~~and Annex 4~~;

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

…

Table 2, amend to read:

Table 2

Overview of performance requirements

Requirement section	*Test article*
5.1. Verification tests for baseline metrics	Container or container plus container attachments, **and supply lines for additional TPRDs [4],** as applicable
5.2. Verification test for performance durability	Container or container plus container attachments **and supply lines for additional TPRDs [4],** as applicable
5.3. Verification test for expected on-road performance	CHSS
5.4. Verification test for service terminating performance in fire	CHSS
5.5. Verification test for closure durability	Primary closure devices

"

…

Add footnote, to read:

[4] For detailed requirements on supply lines for additional TPRDs see Annex 9 – Overview of applicability of component and system tests for 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

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

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

Paragraph 5.3., amend to read:

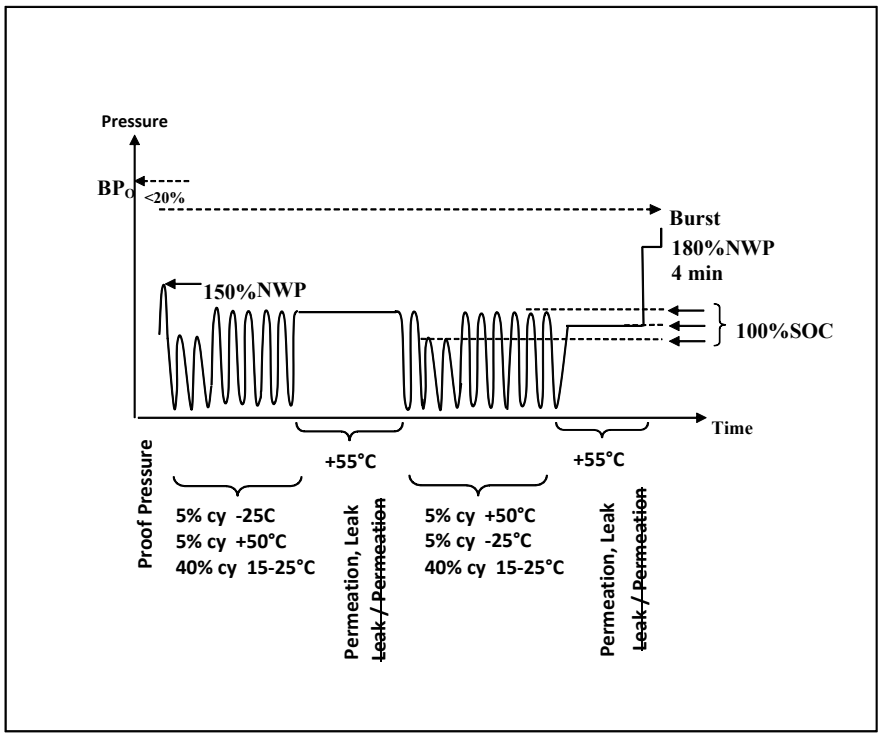
"5.3. Verification test for expected on-road performance (Pneumatic sequential tests)

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)."

Paragraph 5.4., amend to read:

"5.4. Verification test for service terminating performance in fire

The CHSS shall undergo the two-stage localized/engulfing fire test specified in Annex 3, paragraph 5.

The CHSS is filled to 100 per cent state-of-charge (SOC) with compressed hydrogen as the test gas.

…

If the container pressure has not fallen below 1 MPa when the time limit defined above is reached, then fire testing is terminated and the CHSS fails the fire test (even if rupture did not occur).

During the entire fire test additional TPRDs shall maintain connected to the container by at least one attachment point.

Paragraph 7.1.5., amend to read:

"7.1.5. Fuel system leakage

The hydrogen fuelling line 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 ~~(~~per Annex 5, paragraph 5.~~5. test procedure)~~ **and meet the leakage requirements therein**."

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~~ to 9.2.3.2.)** shall satisfy the following additional requirements;

9.2.1. Every container ~~[or, upon agreement of the Type Approval Authority[and Technical Service], 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.**~~ **If applicable, upon agreement of the Type Approval Authority and Technical Service, as an alternative, every pressure bearing chamber and every high-pressure fuel line of multiple permanently interconnected chambers and supply lines for additional TPRDs may be subjected to the same test described above individually. When applying this separate testing option, the test article shall be connected to a hydraulic pressure source at one of its openings by use of appropriate hydraulic mating connections and the remaining openings, if any, shall be closed by use of appropriate means.**"

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 ~~**containers as well as supply lines for additional TPRDs (if any) through appropriate adaptors,**~~ 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**, as well as supply lines for additional TPRDs (if any) through appropriate adaptors**, 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.]**~~

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

13.11~~2~~. **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.**

13.12~~1.~~ **Notwithstanding paragraph 13.11~~0~~., 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/ parts which are not affected by the changes introduced by the 03 series of amendments.** "

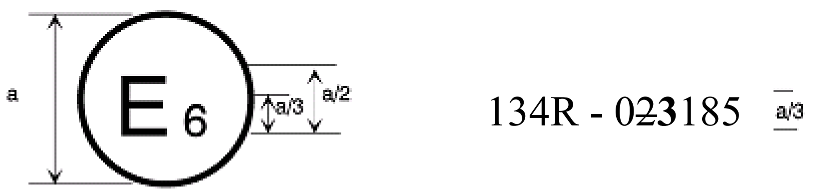
Paragraphs 13.8. and 13.9. (former), renumber to 13.13~~2~~. and 13.14~~3~~.

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)

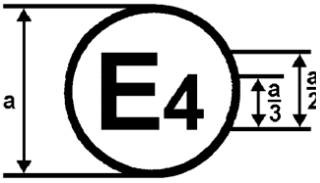


a = 8 mm min

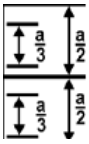
The above approval mark affixed to a vehicle/ storage system/specific component shows that the vehicle/storage system/specific component type concerned has been approved in Belgium (E 6) for its the safety-related performance of hydrogen-fuelled vehicles pursuant

to Regulation No. 134. The first two digits of the approval number indicate that the approval already contained the 0~~2~~**3** series of amendments at the time of approval.

Model B
(See paragraph 4.5. of this Regulation)



100	02 2492
134	0~~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 0~~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., 3.4 to 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 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.

The test article shall be dropped in any one of the following four orientations, **the orientation chosen for the test shall be determined by the Technical Service in consultation with the manufacturers:**

…"

Annex 3, Paragraph 3.3, amend to read:

"3.3. Surface damage test (unpressurized):

(a) Surface flaw generation: A saw cut at least 0.75mm deep and 200mm long is made on the surface specified above. If the container is to be

* The latter number is given only as an example.

affixed to the vehicle by compressing its composite surface **or container attachments for additional TPRDs and/or supply lines are attached to composite surface of the container**, then a second cut at least 1.25 mm deep and 25 mm long is applied at the end of the container which is opposite to the location of the first cut;"

Annex 3, Paragraph 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]

Changed Item		*Required Tests*
~~[~~**Supply lines for additional TPRDs**	**Changed location of additional TPRD, ~~changed flow resistance~~, ~~[change to attachment of additional TPRD]~~**	**- Fire test[8]~~[, 9]~~**
	~~Length,~~ ~~d~~Diameter[2] ≤ 20%, ~~line routing~~	**- Initial burst and Initial pressure cycle life[8]~~[, both with supply lines for additional TPRDs attached[8]]~~**
	Diameter[2] > 20%	**- Initial burst, Initial pressure cycle life[8] - Sequential hydraulic test[8] - Fire test[8]~~[, 9]~~**
	Bend radius	**- Initial burst, Initial pressure cycle life[8] - Sequential hydraulic test[8] - Fire test[8]~~[, 9]~~**
	~~Length ≤ 50%,~~	**~~- Initial burst, Initial pressure cycle life[8] - Fire test[8][, 9]~~**
	Length ~~> 50%,~~	**- Initial burst, Initial pressure cycle life[8] - Fire test[8]~~[, 9]~~ ~~[~~- Sequential hydraulic test[8]~~]~~**
	Line routing	**- Initial burst, Initial pressure cycle life[8] - Fire test[8]~~[, 9]~~**
	Number of fittings	**- Pneumatic sequential test[8] - Initial burst, Initial pressure cycle life[8] - Fire test[8]~~, 9~~**
	~~[Removal of existing additional TPRD and its supply line]~~	**~~- Fire test~~**

…

8. Fire test, initial burst, initial pressure cycle life, hydraulic and pneumatic sequential tests are not required if the parameters of the supply lines are covered by the tested worst-case configuration.

~~[9. Fire test is not required, provided the overall flow resistance of the supply line has not increased considering all different changes made to the supply line. A calculation method may be used to determine the overall change of flow resistance in agreement with the technical service and the type approval authority.]~~"

Insert new Annex 9:

"Annex 9

Overview of applicability of component and system tests for supply lines for additional TPRDs

Test no.	Test title	CHSS	Container with attachments (if any)	Primary closure devices	Supply lines	Notes
5.1.	Verifications 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 or contamination 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]	
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 permeation, leak test (pneumatic)	x	x	x	x	
5.3.4.	Residual proof pressure test (hydraulic)	~~x~~	x	~~x~~	x[1]	
5.3.5.	Residual strength burst test (hydraulic)	~~x~~	x	~~x~~	x[1]	
5.4.	Verification test for service terminating performance in fire	x	x	x	x	

1. Supply lines for additional TPRDs (if any) shall be tested with the container 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 GTR 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.

To address changes to supply lines to additional TPRDs after initial type certification of the CHSS a respective item including differentiation of changes of different characteristics of the lines was added to the change of design table. However, as clarified in footnote 8, the repetition of these tests is only needed if the changes are not already covered by the worst-case approach applied during the CHSS certification tests.

For changes to supply lines to additional TPRD affecting the characteristics length, diameter ≤ 20%, , and, line routing that are not covered by the worst-case approach the required test was limited to the baseline initial burst and cycle life test instead of the sequential hydraulic test. This is justified by the fact that the drop, surface damage and chemical exposure tests included in the sequential hydraulic test only impact the container but not the supply lines to additional TPRDs. And as the supply lines for additional TPRD are also limited to metallic lines performing the cycle life at ambient temperatures is equivalent to the extreme temperature cycles in the sequential hydraulic test and the high temperature static test does not have an adverse effect on the metallic lines.

Table commenting on impact of the hydraulic sequential test to changes to supply lines to additional TPRD affecting the characteristics length, diameter ≤ 20%, and line routing:

Clause	Test	Impact on length	Impact on diameter[2] change ≤ 20%	Impact on line routing	Comment
5.2.1	Proof pressure test	no	no	no	For diameter change the wall thickness is scaled proportional; covering changes of diameter ≤ 20% by baseline tests is even permitted for chambers
5.2.2	Drop (impact) test	not applicable	not applicable	not applicable	-

5.2.3	Surface damage test	no	no	no	-
5.2.4	Chemical exposure and ambient-temperature cycling test	no	no for chemical exposure & 125%NWP cycles - yes for 150%NWP cycles, however, see comment	no	Cycles up to 125%NWP are part of baseline tests; covering changes of diameter ≤ 20% by baseline tests is even permitted for chambers
5.2.5	High temperature static pressure test	no	no	no	Extreme temperatures of -40°C to +85°C do not change durability of metallic lines significantly
5.2.6	Extreme temperature cycling test	no	no	no	
5.2.7	Residual proof pressure test	no	May be, however, see comment	no	For diameter change the wall thickness is scaled proportional; covering changes of diameter ≤ 20% by baseline tests is even permitted for chambers
5.2.8	Residual strength test	no	May be, however, see comment	no	

For changes to supply lines to additional TPRD affecting the characteristics diameter > 20% and bend radius that are not covered by the worst-case approach the full hydraulic sequential test is required as the mechanical properties may be reduced to an extent so that the final residual burst pressure test of the hydraulic sequential test may not be passed. Therefore, the hydraulic sequential test needs to be repeated in such change cases.

2. Annex 3, paragraph 3.2:

In part I of UN Regulation No. 134, a drop test on the storage container is requested.

In the 01 series of amendment to UN Regulation No.134, the requirement was to drop one or more additional container(s) in each of the 4 orientations. The drop test procedure was then modified in GTR 13 amendment 1: it has been streamlined such that only one container will be dropped once (“The container shall withstand the one drop out of any impact orientations specified in the test procedure”).

This updated procedure was then transposed in 02 series of amendment to UN Regulation No. 134. But it is not specified in the test who choose this orientation. This is clarified in our proposal.

3. Permeation & 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.

4. Localized leak test:

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

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

   The text does not specify a leakage threshold**.** The criteria for localized leakage is clarified in Annex 5, Paragraph 5.
   Compliance test for fuel line leakage allows two measuring methods:
   - ✓ Case 1: Using gas leak detector
     Pass/fail criteria: localized external leakage ≤ exceed 0.005 mg/sec (3.6Nml/min).
   - ✓ Case 2: Using leak detecting liquid
     Pass/fail criteria: visual check for bubbles caused by trace leaks. If bubbles are detected, OEM can ask to use gas leak detector method to measure leakage rate based on case 1.

   There is no change to the technical requirements.

6. COP – Rationale for allowance of different proof pressure test options for interconnecting fuel lines and supply lines of additional TPRDs:

   As already introduced in 02 Series of R134 it is permitted to separately test individual chambers of a container as an alternative to testing the assembled container. This was introduced to practically allow hydraulic pressure testing and in particular considering the subsequently necessary drying process for containers consisting of more than one chamber and their interconnecting lines. As in such case interconnecting lines of containers consisting of more than one chamber and supply lines to additional TPRDs (if any) are not tested, it was requested by one contracting party to also mandate a proof pressure test for these lines. However, applying this in practice is highly depending on the CHSS design, line size and connection type, and it significantly depends on the manufacturers assembly process how it is best to apply such pressure test. Hence, it is essential to allow manufacturers a high level of flexibility on how to apply this requirement and to focus the regulative requirements essentially on ensuring that the pressure test is conducted before the product is placed on the market. Therefore, it is left open for the CHSS manufacturer to define.

   - ➔ If the test should be conducted separately on each pressure bearing chamber and interconnecting line, separately on container/line sub-assemblies prior to final assembly of the container, the container assembly, or the vehicle fuel system assembly.
   - ➔ And if the tests are performed in house by the CHSS manufacturer, by suppliers of sub-components or by the vehicle manufacturer by use of appropriate contractual agreements.

   Comparing this to industry applications the quality control of pressure lines is well known and has been safely applied over decades. In standards that are including a 100% 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. As one example to be mentioned in Europe the Pressure Equipment Directive (PED; EU 2014/68) can be fulfilled by the harmonized standards EN 13480 for pressure lines (see EU 2019/1616):

   - ➔ It requires proof pressure testing on **the finished piping system** after final installation and inspection **where practicable**.

- ➔ However, in practice testing after final installation and inspection **of the finished piping system is not practicable** either
  - o due to issues getting the hydraulic test fluid out of the system
  - o or safety considerations when performing the test with gas.
- ➔ In such cases the standard is open to apply the proof pressure test on sub-systems or components.

As industry standards are also allowing such kind of flexibility it is reasonable and essential for the automotive industry to also allow this for automotive applications.