ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
JAMA	All		ed	Mixture of "hydrogen fuelled" and "hydrogen-fuelled"	Change "hydrogen fuelled" to "hydrogen-fuelled"		X	
JAMA	I.J.1 (Rationale)	(d)	ed	Misspelling (d) Japan – Attachment 100 – Technical Standard For Fuel Systems Of Motor Vehicle <u>Fueled</u> By Compressed Hydrogen Gas;	Correct "Fueled" to "Fuelled"		X	
CTSG	3 (Rationale)	(a)	ge	No current rationale included to accommodate for conformable concepts	Add the following under 3. Hydrogen storage system (a) Compressed hydrogen storage system 19. Containers …… **20. A container may store hydrogen in a single chamber or multiple permanently interconnected chambers. Closure should not occur between the permanently interconnected chambers. Disassembly of a container should not be permitted and should result in permanent removal from service of the container.** **21. A container might have container attachments that are non-pressure bearing parts which provide additional support and/or protection to the container.** 22. During fuelling…	TF3 Accepted 7/22	X	Rationale – Added 8/2

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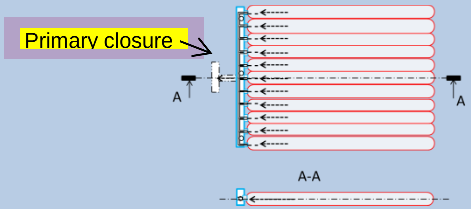
JAMA	3.12		ge	“space under the hood” is not an appropriate analogy for "Enclosed or semi-enclosed spaces" 3.12. "Enclosed or semi-enclosed spaces" indicates the special volumes within the vehicle (or the vehicle outline across openings) that are external to the hydrogen system (storage system, fuel cell system and fuel flow management system) and its housings (if any) where hydrogen may can accumulate (and thereby pose a hazard), as it may occur in the passenger compartment, luggage compartment and cargo compartment and space under the hood.	Delete the word as it may occur in the passenger compartment, luggage compartment and cargo compartment~~ and space under the hood.~~	TF 3 – Agrees to the following change: …as it may occur, e.g. in the passenger compartment, luggage compartment and cargo compartment.~~ and space under the hood.~~	X	
EC	3.3		ed		"***Burst disc~~Burst disc~~***" is the non-reclosing operating part of …”		X	
NHTSA	3.4		te	Check valve definition modification. “Check valve is a non-return valve that prevents reverse flow~~ in the vehicle fuel line~~.	“Check valve” is a non-return valve that prevents reverse flow.	TF 3 - Agreed	X	Done 8/2
EC	3.5		ed		"***Hydrogen concentration*** *~~Concentration of hydrogen~~*" is the percentage of …”		X	
TMC	3.6		te	Change the definition of container to allow such design that multiple pressure elements are connected. 	 Change the definition of container (3.6) as below. "Container" (for hydrogen storage) is the component within the hydrogen storage system that stores the primary volume of hydrogen fuel. **It can consist of a single pressure element or multiple pressure elements of which connections are permanently affixed.**	TF 3 – Consensus: Conformable containers are not ready for the mandatory part of the regulation at present. The subject is not closed. Ask Toyota/Linamar to introduce rationale to cover changes/interpretation of existing test procedures. In particular, T/L should consider all vulnerabilities to the design (including designs that don’t currently exist). For		See below comment

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						example, ensure the 1.25mm deep flaw cut condition is met, vibration requirements for manifolded vessels, etc.		
CT Subgroup	3.6		te	New definition for container	"Container" means the pressure-bearing component on the vehicle that stores the primary volume of hydrogen fuel in a single chamber or in multiple permanently interconnected chambers.	TF 3 - Agreed	X	Rationale needed – LNM to provide (8/2/21)
Linamar	3.x		te	Adding the definition of a permanent protective shell.	Permanent protective shell: protective shield or cover, manufactured as a part of the storage container, that does not directly assist the storage container with containing the internal gas pressure, which cannot be opened, disassembled or removed without significant effort and fulfills the protective function over the service life.	TF 3 – Tabled for next meeting (Japan) and to be combined with Toyota/Linamar deliverables on conformable container designs		
CT Subgroup	3.x		te	New definition for container attachments	"Container Attachments" means 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.	TF 3 – Agreed, but add "use of tools" element to the definition – done.		Rationale – LNM to provide (8/2/21)
EC	3.29		ed		"**Compressed ~~H~~hydrogen storage system (CHSS)" ~~indicates~~ means a system designed to store hydrogen fuel for a hydrogen-fuelled vehicle and is composed of** a pressurized container, pressure		X	

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					relief devices (PRDs) and shut off device(s) that isolate the stored hydrogen from the remainder of the fuel system and the environment."			
CT Subgroup	3.29		te	Revised definition for CHSS	"Compressed hydrogen storage system (CHSS)" means a system designed to store compressed hydrogen fuel for a hydrogen-fuelled vehicle, composed of a container, container attachments (if any), and primary closure devices, such as shut-off valve(s), check valve(s), and TPRD(s), required to isolate the stored hydrogen from the remainder of the fuel system and the environment.	TF 3 - Agreed		8/2/21 – The green revised is slightly different from current TF0 draft. "*Compressed hydrogen storage system (CHSS)*" is a system designed to store compressed hydrogen fuel for a hydrogen-fuelled vehicle, composed of a container, container attachments (if any), and all primary closure devices (such as shut-off valve, check valve, and TPRD) required to isolate the stored hydrogen

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								from the remainder of the fuel system and the environment.
EC	3.32		ed		"Luggage compartment" is the space in the vehicle for luggage **and/or goods** accommodation, bounded by the roof, hood, floor, side walls, as well as by the electrical barrier and enclosure provided for protecting the **occupants**~~power~~ train from direct contact with live parts, being separated from the passenger compartment by the front bulkhead or the rear bulkhead."		X	
EC	3.46		ed		"Rupture" **or**~~and~~ "burst" both mean to come apart suddenly and violently, break open or fly into pieces due to the force of internal pressure."		X	
NHTSA	3.49			Current definition for shutoff valve is unclear: "*Shut-off valve"* is a valve between the storage container and the vehicle fuel system that can be automatically activated; this valve defaults to "closed" position when not connected to a power source.	"Shut-off valve" is an automatically activated valve between the storage container and the vehicle fuel system that must default to the "closed" position when not connected to a power source.	TF 3 - Agreed	X	Done 8/2/21
NHTSA	3.51		ed	Can the definition for solid insulator be deleted?			X	
EC	5.1		ed		Compressed hydrogen storage system This section specifies the		X	

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				HMC - To allow the multiple pressure elements, it should be defined that the mounting method between container and primary closure devices.	requirements for ~~the integrity of~~ the compressed hydrogen storage system. The hydrogen storage system consists of the high pressure storage container and primary closure devices for openings into the high pressure storage container. Figure 1 shows a typical compressed hydrogen storage system consisting of a pressurized container, three closure devices and their fittings. The closure devices **shall** include **the following functions, which may be combined:** (a) ~~A~~ TPRD; (b) ~~A c~~Check valve that prevents reverse flow to the fill line; and (c) ~~An a~~Automatic shut-off valve that can close to prevent flow from the container to the fuel cell or ~~ICE~~**internal combustion** engine. Any shut-off valve, and TPRD that form the primary closure of flow from the storage container shall be mounted directly on or within each container. At least one component with a check valve function shall be mounted directly on or within each container." ~ "primary closure devices for openings into the high pressure storage container directly or into some device combining each			

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					container for multiple pressure elements system.~"			
EC JRC	5.1		te	Over many cycles at extreme conditions, hydrogen diffusion may damage the liner, particularly non-metallic liners, causing blistering and cracking, leading to excessive permeation or leakage. This form of damage may be influenced by the maximum and minimum temperatures experienced during fuelling and during normal fuel use in vehicle operation (container defueling). Liner buckling has been evidenced when it was vented to atmospheric pressure following a pressure test.	Include performance based qualification test to demonstrate that liner buckling will not occur under operating conditions. Consider to add a rapid depressurization test. Alternatively, mitigate depressurization by means of e.g. restricting valves	TF 3 – Unlikely failure mode in service due to the need for multiple failures to occur, e.g. EFV, OTV and pressure regulator. Current GTR has 50 maintenance defueling cycles in pneumatic sequential test. Buckling may not be a life terminating event.		
Linamar	5.1		te	Define protective shell. Include shell parts that are permanently affixed to the container into the tests (dome caps, tank supports, protections…). See: GTR13-6-03 Linamar - Protective shell proposal See permanent protective shell definition proposed is section 3. This section clarifies that the permanent protection shell shall be included in the tests.	~~"Protective shell is a shield of the hydrogen storage system that does not directly assist the storage container with containing the internal pressure."~~ ~~"The parts of the protective shell that are permanently affixed to the storage system shall be included in the qualification tests."~~ This section specifies the requirements for the integrity of the compressed hydrogen storage system. The hydrogen storage system consists of the high pressure storage container, and primary closure devices for openings into the high pressure storage container. Figure 1 shows a typical compressed hydrogen storage system consisting of a pressurized container, **a permanent protective shell**	TF 3 – Add protective shell definition language to Section 3 and create text to require the shell to be part of the testing if the shell is permanently attached for Section 5.1. Linamar to provide revised language		

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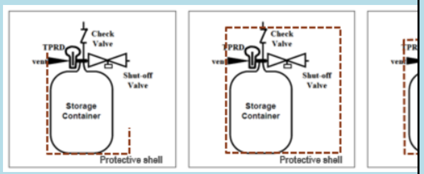
					(optional), three closure devices and their fittings.  **When applicable, the permanent protective shell shall be included with the storage container to satisfy the requirements of paragraph 5.1.**			
CT Subgroup	5.1		te	Revised definition for compressed hydrogen storage system	5.1 Compressed hydrogen storage system This section specifies the requirements for a compressed hydrogen storage system (CHSS): (a) The primary closure devices shall include the following functions, which may be combined: (i) TPRD; (ii) Check valve; and (iii) ~~Automatic~~ Shut-off valve (b) The primary closure devices (shut-off valve and check valve?) shall be mounted directly on or within each container.	TF 3 – Need to decide on “use of tools” element Agreed to delete section (d) to allow for innovation on NWP and service life. Note 5.1.6 would need modification (last sentence). Add (or equivalent) to TPRD Need to clarify “directly on or within each container” – expand the requirement to be clearer. Tentatively agreed to delete section (b) TF 3 – agreed to maintain (b) but wait for NHTSA feedback		*LNM to confirm 8/2/21 draft

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<table>
<tr><th>ORG</th><th>Clause/ Subclause (e.g. 3.1)</th><th>Paragraph/ Figure/ Table/ (e.g. Table 1)</th><th>Type of comment[2]</th><th>Comments</th><th>Proposed change</th><th>Observations/Actions</th><th>RL</th><th>Ration-ale</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>~~(c) Temporary removal and reinstallation of container attachments shall require the use of tools~~

~~(d) 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 less.~~

(e) The CHSS shall meet the performance test requirements summarized in Table 1. The corresponding test procedures are specified in paragraph 6.</td><td>Agreed to delete (c) regarding use of tools since now in the definition for container attachments

Per IWG meeting Jun 29, 2021, suggested to remove “Automatic”

TPRDs may be mounted remotely from the primary closure devices but shall remain in direct fluid contact with the container.

New clause (b): The primary closure devices shall be mounted directly on or within each container. Additional TPRDs may be mounted remotely from the primary closure devices but shall remain in direct fluid contact with the container.

CPs to review this new (b)</td><td></td><td></td></tr>
<tr><td>NHTSA</td><td>5.1</td><td></td><td>te</td><td colspan="3">Table 1 Overview of performance qualification test requirements
<table>
<tr><td>Requirement section</td><td>Test article</td></tr>
<tr><td>5.1.1. Verification tests for baseline metrics</td><td>Container or container plus container attachments, as applicable</td></tr>
<tr><td>TF5.1.2. Verification test for performance durability</td><td>Container or container plus container attachments, as applicable</td></tr>
<tr><td>5.1.3. Verification test for expected on-road performance</td><td>CHSS</td></tr>
<tr><td>5.1.4. Verification test for service terminating performance in fire</td><td>CHSS</td></tr>
</table></td><td></td><td></td></tr>
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				5.1.5. Verification test for closure durability — Closure devices TF 3 - Agreed				
CSA	5.1.1, 6.2.2		te	There is no specification for rate of data collection or what happens if a portion of a pressure cycle or pressure hold test (parking performance) is out of the temperature or pressure specification.		JAMA JARI - To be discuss. Will need to be discuss with specific value. TF 3 – Data log at 1 Hz, recognize that these requirements are a minimum safety level, so acceptability of data should be left to the lab's measurement uncertainly calculation. Add to 6.2.1. "Unless otherwise specified data sampling for pressure cycling shall be at least 1 Hz."	X	No rationale needed
NHTSA	5.1.1.1.		te	3 containers from a batch of 10 containers is not ok for a self-certification approach	Test 3 containers randomly selected Check if within 10% of BPo specified by manufacturer. Should initial BPo be average of 3 burst pressures? 3 randomly selected containers would provide increased rigor for validating the BPo. However, to maximize the effectiveness of this requirement, the language should stipulate that the 3 containers not come from the same batch.	JAMA JARI - Disagree. The multiple batches include the production variation and are not appropriate for design qualification test., that is, container integrity evaluation. To be discuss. Different test procedure may be necessary for self-certification approach. TF 3 – Add a statement to cover the fact that regulatory authorities do not need to source three		

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						containers from the same batch for their "market surveillance" validation purposes. Include this statement at the end of 5.1.1.1: "For the purpose of market surveillance or compliance validation testing, the containers do not need to be sourced from the same manufacturing batch. In this case, the tested containers do not need to have a burst pressure within +/- 10% of BP0." Also include the following statement at the end of 5.1.1.2: "For the purpose of market surveillance or compliance validation testing, the containers do not need to be sourced from the same manufacturing batch." Keep in mind that countries that do not perform market surveillance or compliance validation testing, this statement does not apply.		

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						JAMA JARI – As discussion of June 25th, It should be stated that in this case the containers tested may not have a burst pressure within±10 per cent of BP0. **NHTSA has withdrawn the comment.**		
	5.1.1.1		Te	Clarify whether container attachments are included in the test or not. As it is unlikely that the container attachments will have adverse effect, the inclusion of container attachments could be optional for manufacturer.	5.1.1.1. Baseline initial burst pressure Three (3) new containers randomly selected from the design qualification batch of at least 10 containers, are hydraulically pressurized until burst (para. 6.2.2.1. test procedure). **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.** ~~.~~ **[or are not affected by the test procedure]** ~~At the discretion of the manufacturer, the container attachments may also be included in the test.~~ The manufacturer shall …	**CT SG 9/21,** container attachments shall be included in all test not left at the manufacturer's discretion. (Toyota) New proposal, to keep a possibility not using container attachments in exceptional cases. (Linamar) Is there any precedent on how the manufacturer's demonstration has been allowed in regulatory documents? **CT SG 10/8, [or are not affected by the test procedure]** added. • Baseline initial burst pressure (5.1.1.1) might not need container	Toyota	No rationale

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						attachments but the cycle test (5.1.1.2.) will need the container attachments, i.e. coating needs to be demonstrate that can survive cycling without cracking. • ***See 5.1.2.1**		
NHTSA	5.1.1.2		te	Specifies ambient temp of 20±5 C	Recommend extending temperature range – possibly to 10-40 deg C.	JAMA JARI - Disagree. See JARI comment for 5.1.1.2. TF 3 – Reject, see JARI comment below.		
EC	5.1.1.2		te		Three (3) new containers randomly selected from the design qualification batch are hydraulically pressure cycled at 20(**±**5)°C to 125 per cent NWP **(+2/-0 MPa)** without rupture for 22,000 cycles or until a leak occurs (para. 6.2.2.2. test procedure). Leakage shall not occur within a number of Cycles, where the number of Cycles is set individually by each Contracting Party at 5,500, 7,500 or 11,000 cycles for a 15-year service life."	JAMA JARI - Disagree with (+2/-0 MPa). The pressure condition should be "**≥**125% NWP and specified by manufacturer value". TF 3 – Agree with JAMA JARI comment on pressure, i.e. change the pressure requirement to be ≥125% NWP. Add general comment that states "Unless otherwise specified, maximum and minimum test pressures shall be specified by the	X	8/2/21 – Tolerances need to be revised per "NHTSA Proposal for GTR-13 Tolerances 07JAN2021 - TesTneT additions.xlsx" (= Tolerance xls)

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						manufacturer." Add to 6.2.1. (This comment has been superseded by PTL 5.1.1.2 below) JAMA JARI – It should be changed to "Add general comment that states "**Unless otherwise specified, the tolerances above the ~~maximum~~ (minimum) and/or below the ~~minimum~~ (maximum) test parameters may be recommended by the manufacturer.**" Add to 6.2.1." TF 3 – Agree with JAMA JARI comment		
JARI	5.1.1.2		te	Specifies ambient temp of 20±5 C The temperature shall be specified based on ISO 554-1976 and JIS Z 8703:1983. The parts of temperature measurement are specified in Clause 6.2.2.2.	Recommend extending temperature range – possibly to 5-35 deg C.	TF 3 – Agree with this comment. Change to 5-35°C. This applies to other tests conducted at ambient temperature.	X	Phase 2 Change #1
PTL	5.1.1.2		te		Three (3) new containers randomly selected from the design qualification batch are hydraulically pressure cycled at 20(**±**5)°C to **≥**125 per cent NWP…	JAMA JARI - Partly agreed. The pressure condition should be "≥125% NWP and specified by manufacturer value". TF 3 – Agree with JAMA JARI comment on pressure, i.e. change the pressure requirement to be ≥125% NWP.	X	See Tolerance s.xls

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						Add general comment that states "Unless otherwise specified, the tolerances above the maximum and/or below the minimum test parameters may be recommended by the manufacturer or requesting party." Add to 6.2.1.		
Toyota	5.1.1.2		Te	Clarify whether container attachments are included in the test or not. (idea #3) As it is unlikely that the container attachments will have adverse effect, the inclusion of container attachments could be optional for manufacturer.	5.1.1.2. Baseline initial pressure cycle life Three (3) new containers randomly selected from the design qualification batch are hydraulically pressure cycled at 20 (± 15)°C to □125 per cent NWP without rupture for 22,000 cycles or until a leak occurs (para. 6.2.2.2. test procedure). **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.** **[or are not affected by the test procedure]** ~~At the discretion of the manufacturer, the container attachments may also be included in the test.~~ Leakage shall not …	**CT SG 9/21,** container attachments shall be included in all test not left at the manufacturer's discretion. (Toyota) New proposal, to keep a possibility not using container attachments in exceptional cases. **CT SG 10/8, [or are not affected by the test procedure]** added. • Baseline initial burst pressure (5.1.1.1) might not need container attachments but the cycle test (5.1.1.2.) will need the container attachments, i.e. coating needs to be demonstrate that can		LNM/ CTSG to confirm

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						survive cycling without cracking. • ***See 5.1.2.1**		
Toyota	5.1.2			Clarify the test article. Improve consistency. **Verification tests for performance durability (Hydraulic sequential tests)** If all three pressure cycle life measurements made in para. 5.1.1.2. are greater than 11,000 cycles, or if they are all within ±25 per cent of each other, then only one (1) container is tested in para. 5.1.2. Otherwise, three (3) containers are tested in para. 5.1.2. A hydrogen storage container shall not leak during the following sequence of tests, which are applied in series to a single system and which are illustrated in Figure 2. At least one system randomly selected from the design qualification batch shall be tested to demonstrate the performance capability. Specifics of applicable test procedures for the hydrogen storage system are provided in para. 6.2.3.	Amend to read: **Verification tests for performance durability (~~Hydraulic~~ sequential hydraulic tests)** If all three pressure cycle life measurements made in para. 5.1.1.2. are greater than 11,000 cycles, or if they are all within ±25 per cent of each other, then only one (1) container is tested in para. 5.1.2. Otherwise, three (3) containers are tested in para. 5.1.2. **[Unless otherwise specified, the tests in para.5.1.2 shall be conducted on the container equipped with its container attachments (if any) that represents the CHSS without the primary closures.]** A ~~hydrogen storage~~ container shall not leak during the following sequence of tests, which are applied in series to a single system and which are illustrated in Figure 2. At least one system randomly selected from the design qualification batch shall be tested to demonstrate the performance capability.	**CT SG 9/21,** container attachments shall be included in all test not left at the manufacturer's discretion. (Toyota) suggested sentence is, in fact, redundant but explains the principle.		LNM/ CTSG to confirm

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					Specifics of applicable test procedures ~~for the hydrogen storage system~~ are provided in para. 6.2.3.			
EC	5.1.2.1		te		A storage container is pressurized to 150 per cent NWP **(+2/-0 MPa)** and held for **at least** 30 sec (para. 6.2.3.1. test procedure). A storage container that has undergone a proof pressure test in manufacture is exempt from this test."	JAMA JARI - Partly agreed. It should be "at least 30 sec and specified by manufacturer value". The pressure condition should be "≥150% NWP and specified by manufacturer value". TF 3 – Change to "≥150% NWP and held for at least 30 seconds."	X	See Tolerances.xls
PTL	5.1.2.1		te		Recommend: A storage container is pressurized to **≥**150 per cent NWP and held for **at least** 30 sec…	JAMA JARI - Partly agreed. It should be "at least 30 sec and specified by manufacturer value". The pressure condition should be "≥150% NWP and specified by manufacturer value". TF 3 – Change to "≥150% NWP and held for at least 30 seconds."	X	See Tolerances.xls
Toyota	5.1.2.1		Te	Proof pressure test will be carried out during the manufacturing and depending on the manufacturing process, before or after the installation of the container attachments.	Amend to read: 5.1.2.1. Proof pressure test ~~A storage~~ **The** container is pressurized to □ 150 per cent NWP and held for at least 30 sec. (para. 6.2.3.1. test procedure). **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**	**CT SG 9/21,** container attachments shall be included in all test not left at the manufacturer's discretion. (Toyota) New proposal, to keep a possibility not using container		LNM/ CTSG to confirm

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					results. ~~.~~ **[or are not affected by the test procedure]** ~~A~~ ~~storage~~ **The** container that has undergone a proof pressure test in manufacture is exempt from this test.	attachments in exceptional cases. ***CT SG 10/8, [or are not affected by the test procedure]** added. • Due to their manufacturing process, Toyota would like to perform proof pressure test prior installing container attachments. • For consistency purposes, Toyota proposes to include this sentence in the description of additional tests. • NHTSA may just purchase containers and do not communicate with manufacturer. This will be difficult to accept. • Proof pressure test (5.1.2.1) precedes hydraulic sequential test. Container attachments are needed for hydraulic sequence. Hence, proof pressure test should include the container attachments.		

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						• Unless proof test is just a container test and it doesn't influence the durability and the coating is applied later. • Examples of container attachments: coatings, constraining brackets, permanent enclosures, side protector. • If the attachment does not affect the results of this test and the manufacturer can demonstrate it, then why to put the attachments through all test? • The container attachment could affect the results but also the test could affect the container attachment. i.e. coating system • R-134 (25JN2015), conformity of production, requires every container to be tested in accordance with par. 5.2.1. Proof pressure. • Also R-134 requires 9.3.2. Batch testing at least 1 container (from a		

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						batch of max 200 containers) to be submitted to rupture test par. 9.3.2.1. and also to pressure cycle test 9.3.2.2. • Although this could be brought up into R-134, to do not need container attachments for batch testing since they have been proven under design qualification or type approval, it might be easier if GTR-13 allows for container to be tested without container attachments. • GTR-13 does not include manufacturing batch acceptance test. • If container attachments do not exist then manufacturer does not need to demonstrate. • Challenges to get type approval and self-certification to agree with this language about allowing manufacturer to demonstrate. GTR20 has language that allows for the manufacturer to		

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						demonstrate performance and could be used as a precedent.		
Toyota	5.1.2.2.		Ed	Clarification of the tested article Container attachments must be included in the test if exists.	Amend to read: 5.1.2.2. Drop (impact) test The ~~storage~~ container **with its container attachments (if any)** is dropped at several impact angles (para. 6.2.3.2. test procedure).			
Toyota	5.1.2.3. to 5.1.2.8.		Ed	Clarification of the tested article Inclusion of container attachments are described in 6.2.3.3. according to the flow chart discussed on Sep 8.	Replace "storage container" with "container". TBD to write as **"container with its container attachments (if applicable)"** in addition to the additional description in 5.1.2.			
NHTSA	5.1.2.4		te	Specifies ambient temp of 20±5 C	Recommend extending temperature range – possibly to 10-40 deg C.	JAMA JARI - Disagree. See JARI comment for 5.1.2.4. TF 3 - Change to 5-35°C.	X	Phase 2 Change #1
PTL	5.1.2.4		te	20±5 C is an unnecessarily stringent test temperature range for the container skin and fluid. Recommend expanding test temperature range or allowing skin and fluid temperatures to rise to a reasonable temperature incapable of harming a robust container or materially affecting test performance.	Recommend extending temperature range – possibly to 10-40 deg C. OR The storage container is exposed to chemicals found in the on-road environment and pressure cycled to 125 per cent NWP at 20° (**±**5)°C as measured in air for 60 per cent number … The temperature of the container skin and internal fluid may exceed 25 C during the test however may not exceed 40 C.	JAMA JARI - Disagree. See JARI comment for 5.1.2.4 for temperature range. It is not necessary to specify measurement points which are shown in 6.2.3.4 as is described. TF 3 - Change to 5-35°C. PTL withdraws "OR" comment.	X	RATIONALE Done 1/26 – Phase 2 Change #1

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EC	5.1.2.4		te		The storage container is exposed to chemicals found in the on-road environment and pressure cycled to 125 per cent NWP **(+2/-0 MPa)** at 20° (±5)°C for 60 per cent number of Cycles pressure cycles (para. 6.2.3.4. test procedure). Chemical exposure is discontinued before the last 10 cycles, which are conducted to 150 per cent NWP **(+2/-0 MPa)**.	JAMA JARI - Not agreed. The storage container is exposed to chemicals found in the on-road environment and pressure cycled to **≥125% NWP and specified by manufacturer value** at **temperature range 5-35 deg C** for 60 per cent number of Cycles pressure cycles (para. 6.2.3.4. test procedure). Chemical exposure is discontinued before the last 10 cycles, which are conducted to **≥150% NWP and specified by manufacturer value**. TF 3 - change the pressure requirements to be ≥125% NWP and ≥150% NWP.	X	Tolerance s.xls
PTL	5.1.2.4		te	Allow flexibility in setting an upper pressure limit.	The storage container is exposed to chemicals found in the on-road environment and pressure cycled to **≥**125 per cent NWP at 20° (±5)°C for 60 per cent number of Cycles pressure cycles (para. 6.2.3.4. test procedure). Chemical exposure is discontinued before the last 10 cycles, which are conducted to **≥**150 per cent NWP	JAMA JARI - Not agreed. See above "EC 5.1.2.4". TF 3 – Agree to ≥ 125% and 150% values.	X	Tolerance s.xls
JARI	5.1.2.4		te	Specifies ambient temp of 20±5 C The temperature shall be specified based on ISO 554-1976 and JIS Z 8703:1983. The parts of temperature measurement are specified in Clause 6.2.2.2.	Recommend extending temperature range – possibly to 5-35 deg C.	TF 3 – Agree, see above.	X	Rationale Phase 2 Change #1

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JARI	5.1.2.4		te	Chemical exposure can be continued up to the last 10 cycles. It seems not to be affect to increase just a few hours of chemical exposure.	Chemical exposure is discontinued **after** ~~**before**~~ the last 10 cycles, which are conducted to **≥**150 per cent NWP	JAMA JARI - Partly agreed: Chemical exposure is discontinued **after** ~~**before**~~ the last 10 cycles, which are conducted to **≥**150 per cent NWP **and specified by manufacturer value**. TF 3 – Agree to add: "Chemical exposure is discontinued after the last 10 cycles." Rationale is that this change makes the test less burdensome without changing the severity of the test.	X	RATIONALE Done 1/26 – Phase 2 Change #2
EC	5.1.2.5		te		The storage container is pressurized to 125 per cent NWP **(+2/-0 MPa)** at ≥85°C for **at least** 1,000 hr (para. 6.2.3.5. test procedure).	JAMA JARI - Not agreed. The storage container is pressurized to **≥**125 per cent NWP **specified by manufacturer** at ≥85°C **specified by manufacturer** for **at least** 1,000 hr (para. 6.2.3.5. test procedure). TF 3 – Agree to change pressure requirement to ≥125% NWP, and add "for at least 1,000 hr."	X	See Tolerances.xls
PTL	5.1.2.5		te	Allow flexibility in setting an upper pressure limit.	The storage container is pressurized to **≥**125 per cent NWP at ≥85°C for **at least** 1,000 hr (para. 6.2.3.5. test procedure).	JAMA JARI - Partly Agreed. See above JAMA/JARI comment on "EC 5.1.2.5". TF 3 - Agree	X	See Tolerances.xls

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NHTSA	5.1.2.5, 6.2.3.5		te	5.1.2.5 states temp ≥ 85 deg C 6.2.3.5 states temp 85±5 deg C	Recommend 85±5 deg C	JAMA JARI - Not agreed. See above JAMA/JARI comment on "EC 5.1.2.5". TF 3 – Agree with ≥85°C only.	X	See Tolerances.xls
CSA	5.1.2.6		te	There is no tolerance specified for relative humidity during the +85°C cycles.	Recommend >95% RH.	JAMA JARI - Disagree. ≥80% RH is preferable like PLI proposal. It is impossible to keep ">95% RH" due to condensation on the piping at lower temperature of fluid at the start of the testing. Actual measurement value was 89% RH to 98% RH humidity setting of constant temperature chamber from the results of JARI's testing. TF 3 – Agree to change to ≥80% relative humidity	X	~~RATIONALE-1/26: Hold for agreement on tolerances based on 1/21 TF3 mtg~~ 8/2/2021 See Tolerances.xls
CSA	5.1.2.6		te	There is no tolerance specified for temperatures	Recommend -40°C (-5/+0)°C and +85°C (-0/+5)°C	JAMA JARI - Not agreed. The storage container is pressure cycled at ≤ -40°C **specified by manufacturer** **……**and at ≥ +85°C **specified by manufacturer** …… TF 3 – Change temperature tolerances to ≥85°C and ≤-40°C.	X	See Tolerances.xls
EC	5.1.2.6		te		The storage container is pressure cycled at ≤ -40°C to 80 per cent NWP **(+2/-0 MPa)** for 20 per cent number of Cycles and at ≥ +85°C	JAMA JARI - Not agreed. The storage container is ….to ≥80 per cent NWP **specified by manufacturer**	X	See Tolerances.xls

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					and 95 per cent relative humidity to 125 per cent NWP **(+2/-0 MPa)** for 20 per cent number of Cycles (para. 6.2.2.2. test procedure).	for 20 per cent number …≥125 per cent NWP **specified by manufacturer** for 20 per cent number of Cycles (para. 6.2.2.2. test procedure). TF 3 – Change pressure tolerance to ≥80% NWP and ≥125% NWP.		
PTL	5.1.2.6		te	There is no tolerance specified for relative humidity during the +85°C cycles.	Recommend ≥80% RH.	JAMA JARI - Agree. More realistic. TF 3 – Agree to change to ≥80% relative humidity.	X	See Tolerances.xls
PTL	5.1.2.6		**te**	Allow flexibility in setting an upper pressure limit.	The storage container is pressure cycled at ≤ -40°C to **≥**80 per cent NWP for 20 per cent number of Cycles and at ≥ +85°C and ~~**95**~~ **≥80 per cent relative humidity to ≥125 per cent NWP for 20 per cent number of Cycles**	**JAMA JARI - Not agree. The storage container is pressure cycled at ≤ -40°C to ≥80 per cent NWP specified by manufacturer for 20 per cent number of Cycles and at ≥ +85°C and ~~95~~ ≥80 per cent relative humidity to ≥125 per cent NWP specified by manufacturer for 20 per cent number of Cycles** **TF 3 – Agree, see above. Specified by manufacturer already discussed above.** Made change indicated in proposed change column and also added the following to 6.2.1:	X	See Tolerances.xls

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						"Unless otherwise specified, the tolerances above the maximum and/or below the minimum test parameters may be recommended by the manufacturer."		
NHTSA	5.1.2.6		**te**	Extreme temperature cycling starts with cold cycling followed by hot cycling. This is not in accordance with HGV2 and EC79	Recommend resolution between standards.	**EC JRC - Regulation EC 79 /2009 is to be repealed. UN Reg. 134 applies in the EU with additional criteria for material qualification Agree with the comment, also harmonization with ISO/DIS 19881 would be desirable.** **JAMA JARI - Disagree. The original text shall be kept. When testing the hot cycling first, it may be disadvantageous for the Type3 containers due to the decreasing of residual stress by autofrettage.** ~~**TF 3 – Agree, change the order of hydraulic testing to be hot cycles first, then cold cycles to be consistent with other standards (HGV 2, ISO/DIS 19881 and EC R79). This will be inconsistent with SAE J2579. Rationale is that switching from hot cycling to cold cycling**~~		

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						~~**may be tougher for type 3 designs.**~~ ~~**Ensure that the new test procedure in 6.2.3.6 covers method of switching from hot cycling to cold cycling which addresses JARI JAMA comment.**~~ TF 3 – After further discussion, keep the sequence as is, cold then hot cycling.		
EC	5.1.2.7		te		Hydraulic residual pressure test. The storage container is pressurized to 180 per cent NWP **(+2/-0 MPa)** and held **at least** 4 minutes without burst (para. 6.2.3.1. test procedure)."	JAMA JARI - Not agreed. Hydraulic residual pressure test. The storage container is pressurized to **≥**180 per cent NWP **<u>specified by manufacturer</u>** and held **at least** 4 minutes **<u>specified by manufacturer</u>** without burst (para. 6.2.3.1. test procedure)." TF 3 – Agree to ≥180% NWP and add at least 4 minutes.	X	See Toleranc es.xls
PTL	5.1.2.7		ed		The storage container is pressurized to 180 per cent NWP and held **for** 4 minutes without burst (para. 6.2.3.1. test procedure).	JAMA JARI - Agree. TF 3 – Agree to ≥180% NWP and add at least 4 minutes.	X	See Toleranc es.xls
JAMA	5.1.2.7		ed	In a process of developing UNR for motorcycles, the WG drafted it based on UNR134 and made a couple of editorial	~~Hydraulic residual pressure test~~ **Residual proof pressure test**		X	

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				changes to make clear the meaning of the terms. They recommend those changes should be reflected to GTR13 and UNR134.				
PTL	5.1.2.8		ed	The statement "…baseline initial burst pressure (BPo) determined in para. 5.1.1.1…" is confusing and needs clarification. BPo is called "midpoint burst pressure", not "baseline initial burst pressure", in 5.1.1.1. Also, BPo is not determined in 5.1.1.1 since it is supplied by the manufacturer and may be confused with the test results from 5.1.1.1.	"…verify that the burst pressure is at least 80 per cent of the ~~baseline burst pressure determined in~~ **BPo** found in para. 5.1.1.1."	JAMA JARI - Agree. Both references to BP_O (5.1.2.8 and 5.1.3.5) now read "**the burst pressure is at least 80 per cent of the BP_O provided by the manufacturer in para. 5.1.1.1.**"	X	
JAMA	5.1.2.8		ed	See JAMA04	5.1.2.3. ~~Residual burst strength test~~ **Residual strength burst test**		X	
HEX	5.1.2.8		ed	"…verify that the burst pressure is at least 80 per cent of the ~~baseline burst pressure determined in~~ **BPo** found in para. 5.1.1.1." BPo is not found in para 5.1.1.1, but it is provided by the manufacturer	"…verify that the burst pressure is at least 80 per cent of the ~~baseline burst pressure determined in~~ **BPo** provided by the manufacturer."		X	
EC JRC	5.1.3		ge	Verification test for expected on-road performance is complicated to execute because lack of tolerance is some test parameters and because test conditions are demanding for test equipment	Bear in mind that the pneumatic sequential tests has to be practicable and repeatable, allowing reproducibility of results in different test facilities	TF 3 – Agree, this is the purpose of the current exercise.	n / a	
EIGA	5.1.2		ge/te	EIGA presented WG 24 refuelling risk assessment which identified risks for tank over-temperature scenarios possibly necessitating the addition of tests to cover 95°C and 140°C gas temperatures.	Increase test temperature to 95°C in parking performance test and add one hydraulic pressure cycle to 140°C. EIGA invites experts to attend EIGA-hosted industry working group.	TF 3 – Reserve judgment until members have digested EIGA analysis and recommendation. JAMA JARI - Disagree. (1) JAMA-JARI basically thinks that the station-		

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						side should respond to station failures (2) EIGA should explain the rationale of the proposals on 95C and 140C. Most of TF3 member do not understand the technical background or rationality of the proposals at all. It should also be explained why these station failures cannot be handled within station technologies. TF 3 to solicit results of EIGA industry working group (Paul Karzel) HMC - Rationale of EIGA should be justified TF 3 – Paul Karzel reported that no resolution was reached until now, but there are follow up actions that will be explored. Will report back. New tank designs that are coming online may not perform well under this upset condition. Japanese car manufacturers disagree that this is a concern.		

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						There is a new rationale (Section L) that speaks to the vehicle and station acting as a system. From Guy de Reals: The approach we are suggesting is a performance based approach. PRR control failure would result in high flow and as a consequence overheating of the tank. However, the overheating would depend on the characteristics of the tank. Making a high temp hydraulic test would mean taking assumptions on the CHSS behavior that would result on unnecessary margins in most of the cases. In addition, it seems (relatively) easy to have a few high flow cycles during the pneumatic sequential tests. If there would be a mechanical restriction (flow orifice) on HRS limiting the flow at a certain value this could be a way to select it. Otherwise, we could find another way to determine what is the maximum credible flow at the nozzle. The good news is that below a certain ramp rate, the max		

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						liner temperature remains more or less constant. Then we should decide if the objective of the qualification test is to demonstrate that PRR control failure does not create a major hazard or to demonstrate that the CHSS performances are not affected (provided it is a single time event). TF 3 – Is this considered a life terminating event? Or inspection of CHSS required (TPRD affected)?		
EC JRC	5.1.3		te	The gas bulk temperature is typically 5-10°C higher than the tank material temperature. Fixing the inner tank temperature limit to 90°C would make the test procedure more similar to the expected on-road performance	Consider adding a test where the softening temperature of the polymeric materials are measured at a temperature as high as 105 °C	TF 3 – Should material requirements be specified (e.g. Tg and Tsoft), or should a performance test be specified? JAMA JARI - Disagree with 105℃. Although performance test is ideal there is not appropriate test procedure. If the material requirements are necessary it should be the same description as SAE J2579 below. ----------------------------------- SAE J2579-2018JUN : F.1.2 Softening Temperature Polymeric materials from finished liners shall be tested according to ISO 306 with		8/3/21 – Need to resolve. Is language necessary and where to add?

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						the appropriate method specified by the supplier of the polymeric material. The softening temperature shall meet requirements of the containment vessel manufacturer, to at least 100 °C. TF 3 – Agree with JAMA JARI recommended language.		
PTL	5.1.3		ed/te	Figure 3 includes proof test, gas cycle, permeation and burst. Each test has its own pass/fail criteria. The criteria “shall not leak” is only applicable to the gas cycle test. Further, the ‘hydrogen storage system’ does not undergo the entire sequence (burst test is container only).	Remove sentence and insert in section 5.1.3 (ambient and extreme temperature gas pressure cycling test). Replace sentence with “A hydrogen storage system (or container only, as specified) shall undergo the following sequence of tests, which are illustrated in Figure 3.	TF 3 – Agree	X	
PTL	5.1.3		te	Pass/fail criteria for the gas cycle test may need to be elaborated on. Does the OTV and all its components have to be functional (check valve, shut-off valve, TPRD)? Does “leak” include internal leakage or external leakage only? Does the OTV have to be used as intended in the vehicle or is it only there to be part of the pressure cycles? There is extensive testing on the OTV in section 5.1.5. Does this cover any of the above questions?	Add language that states the fuel system shall not leak and the specific components (shut-off valve, check valve and TPRD) shall maintain functionality during the test.	TF 3 – Agree		8/3/21 – Need to resolve
HEX	5.1.3		te	Definition of the fuel system leak needed, otherwise judgement not possible.	Add language that defines the requirements of a fuel system leak or no leak.	TF 3 Agree to include to leak rate as: The maximum allowable hydrogen leak rate from the	X	RATIONALE – Done 8/2/21

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				Permanent leak detection needed because leaks may appear in transition phase and e.g. only @ low temperatures and @ high test pressures. Or would this be acceptable, as long as it is not a permanent leak? Do we have to monitor leak of the specific components or only the complete HSS? However, external leak detection of individual components during test difficult because the HSS is usually tested in a chamber and emissions of the other components (mainly cylinder permeation) may influence detection capability of the single components leaks. The different components would have to be separated from each other (e.g. by gas tight housings) and permanently supervised as well.	Some cylinder standards define a leak as “any gas detected beyond the allowable permeation rate” (HGV2). Proposal of a leak definition: “The maximum allowable hydrogen leak rate from the compressed hydrogen storage system is 46 mL/h/L water capacity of the storage system” If single component leak needs to be evaluated as well, carryover of leak definition from component test sections (e.g. 6.2.6.1.8. for TPRDs): “The total hydrogen leak rate shall be less than 10 NmL/hr” If permanent leak detection is too much burden, include static leak test @ -40 or -25°C because low temperatures represent the worst case for o-rings and fittings design/materials. This should be added for either system or single component leak requirement evaluation.	compressed hydrogen storage system from a single point is in accordance with 5.1.3.3(c).		Phase 2 Change #23
EC	5.1.3.1		te		A system is pressurized to 150 per cent NWP **(+2/-0 MPa)** for **at least** 30 seconds (para. 6.2.3.1. test procedure). A storage container that has undergone a	JAMA JARI - Not agreed. A system is pressurized to 150 per cent NWP **<u>specified by manufacturer</u>** for **at least** 30 seconds **<u>specified</u>**	X	Tolerance s.xls

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					proof pressure test in manufacture ~~is~~**may be** exempted from this test.”	**by manufacturer** (para. 6.2.3.1. test procedure). ….. TF 3 – change pressure to ≥150% NWP and change time to at least 30 seconds. No change for exemption language.		
Toyota	5.1.3.1.			Clarify that this test will be conducted on container before assembling as CHSS. Improve consistency.	Amend to read: 5.1.3.1. Proof pressure test ~~(hydraulic)~~ **The container of a CHSS** ~~A system~~ is pressurized to ≥ 150 per cent NWP for at least 30 seconds (para. 6.2.3.1. test procedure). **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. [or are not affected by the test procedure]** ~~A storage~~**The** container that has undergone a proof pressure test in manufacture is exempt from this test.	(Toyota) New proposal, to keep a possibility not using container attachments in exceptional cases. **CT SG 10/8, [or are not affected by the test procedure]** added. • ***See 5.1.2.1**		8/2/21 – CTSG to confirm
PTL	5.1.3.2		te	The new section 5.1.3.2 will include a reference to SAE J2601 to set ramp rate targets. This fuelling protocol now covers all HSS sizes because of the inclusion of a ‘D category’ (>10kg). This is great but also not so great because the D category tables are identical to the C category (7-10kg) tables. This means a 30kg HSS would be subject to the same ramp rates as a 7kg HSS. Since ISO 19885, which is currently under construction, will soon be covering medium	Update the current suggested text as follows: “The ramp rate shall be as per the SAE J2601 fuelling tables (communication, no top-off) **and as per ISO 19885** according to the size of the fuel system.”	TF 3 – comment tabled for future discussion		

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				and heavy-duty vehicles, a reference to this standard should be added. Can this be done even though it has not been released yet?				
PTL	5.1.3.2		te	The new section 5.1.3.2 will include a reference to SAE J2601 to set ramp rate targets. The first 5 cycles of the pneumatic sequence are performed with +20C gas. There is no ramp rate table available in J2601 for this fuel delivery temperature.	Suggestions: 1. "Use ramp rate per J2601-4 (ambient fuelling)." or 2. "A reasonable ramp rate may be used" or 3. "The T20 tables from SAE J2601 may be used"	TF 3 – Select a ramp rate that ensures the container gas temperature never exceeds 85C during the fill.	X	RATIONALE NEEDED – 8/2/21. Combine with below change. Confirm w/ Tanja/PTL table in 5.1.3.2. is latest in TF0 doc. Ramp rate for first 5 cycles added in 8/2 doc.
PTL	5.1.3.2		te	The new agreed upon ambient temperature for all testing in 5.1.1 to 5.1.3 is now 20°C±15°C. This covers baseline metrics, performance durability and on-road performance testing. In 5.1.3.2 it will now be specified to determine the ramp rate by using the SAE J2601 fuelling tables. This means that for ambient cycling, 5 different ramp rates could now be applicable (see image below). Technically 6 ramp rates if you linearly interpolate for 5°C.	Here are some proposed solutions to this problem: A) Use nominal rate at 20°C (21.8 MPa/min) regardless of the Tamb reading during the test - benefit: consistent for entire test, uncomplicated for test lab - drawback: HSS would be tested <u>less</u> stringently than real-life fuelling at ambient temps less than 20°C	TF 3 – Option D is preferred. Specify a tighter ambient temperature requirement of 20 +/-5C for this test only. Require the use of the 20C APPR per the appropriate table. Suggested text in general section: "Ambient temperature shall be 20°C ± 15°C unless otherwise specified." Suggested text for 5.1.3.2: "Ambient temperature shall be 20°C ± 5°C." (Note to Ian)	X	Rationale for 5.1.3.2. 8/2 – Changed amb temp to +/-5C.

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				(see table below)	(see text below)			

Comments:

H70-T40 Capacity Category B Comm		APRR [MPa/ min]	Target Pressure P_{target} [MPa]	Target Pressure Top-Off [MPa]	Top-Off-APRR [MPa/ min]		
			0,5 - 5 (no interpolation)			0,5	2
Ambient Temperature, T_{amb} [°C]	>50	no fueling	no fueling	no fueling	no fueling	no fueling	no fueling
	50	5,1	78,2	87,5	2,6	see Top-Off	see Top-Off
	45	8,1	76,3	87,5	4,0	see Top-Off	see Top-Off
	40	11,5	73,2	87,5	5,4	see Top-Off	see Top-Off
	35	12,4	72,9	87,5	5,6	see Top-Off	see Top-Off
	30	15,3	70,6	87,5	6,6	see Top-Off	see Top-Off
	25	18,5	69,0	87,4	7,2	see Top-Off	see Top-Off
	20	21,8	67,9	87,4	7,6	see Top-Off	see Top-Off
	10	28,0	66,3	87,4	9,0	see Top-Off	see Top-Off
	0	28,5	no Top-Off	no Top-Off	no Top-Off	78,4	84,6
	-10	28,5	no Top-Off	no Top-Off	no Top-Off	82,2	87,1
	-20	28,5	no Top-Off	no Top-Off	no Top-Off	86,0	86,8
	-30	28,5	no Top-Off	no Top-Off	no Top-Off	86,8	86,5
	-40	28,5	no Top-Off	no Top-Off	no Top-Off	86,5	86,2
	<-40	no fueling	no fueling	no fueling	no fueling	no fueling	no fueling

Proposed change:

B) Use most stringent rate at 5°C (28.25 MPa/min) regardless of the Tamb reading during the test
- benefit: consistent for entire test
- drawback: HSS would be tested more stringently than real-life fuelling and internal container temp could approach or reach 85°C, which would complicate things for the test lab

C) Use applicable rate at start of fill depending on Tamb reading at that time
- benefit: HSS would be tested equal to real-life fuelling
- drawback: Test labs would have to implement additional controls, potentially inconsistent fuelling throughout test (each cycle may have a different ramp rate, not sure if this would be a concern to anyone)

D) Change Tamb back to 20°C±**5°C** for the on-road performance test only
- benefit: consistent for the entire test, uncomplicated for test lab
- drawback: inconsistent with the baseline and durability tests, more temperature

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					control requirements for test lab than a 5-35C range Option D is the preferred solution. Suggested text in general section: "Ambient temperature shall be 20°C ± 15°C unless otherwise specified." Suggested text for 5.1.3.2: "Ambient temperature shall be 20°C ± 5°C."			
PTL	5.1.3.2		te	Since J2601 will now be referenced for ramp rates, it should be understood that although the test temperature is specified as ≥50°C (which is in the 'no fueling' zone), the 50°C ramp rate should be used This is not applicable for cold fueling as the temperature has been changed from ≤-40°C to ≤-25C and cold ramp rates are all the same.	Add: "If the required ambient temperature is not available in the table, the closest ramp rate value or a linearly interpolated value shall be used."	TF 3 – Agreed	X	
TF	5.1.3.2		ed	Improve consistency.	Amend to read: 5.1.3.2. Ambient and extreme temperature gas pressure cycling test **(pneumatic)** The ~~system~~ **CHSS** is pressure cycled using hydrogen gas for 500 cycles (para. 6.2.4.1. test procedure).	**CT SG 10/8, OK** **Needs to go to TF3**		
EC	5.1.3.2(b)		te		The first group of pressure cycling, 25 cycles are performed to 80 per cent NWP **(+2/-0 MPa)** at ≤ -40 °C, then 25 cycles to 125 per cent NWP **(+2/-0 MPa)** at ≥ +50 °C and 95 **(±2)** per cent relative humidity, and the	EC JRC - Note that ISO/DIS 19881 tolerances for pressure are ±1 MPa. Does this make more sense? JAMA JARI - Not agreed.	X	Tolerance s.xls

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					remaining 200 cycles to 125 per cent NWP **(+2/-0 MPa)** at 20 (± 5) C; The second group of pressure cycling, 25 cycles are performed to 125 per cent NWP **(+2/-0 MPa)** at ≥ +50 °C and 95 **(±2)** per cent relative humidity, then 25 cycles to 80 per cent NWP **(+2/-0 MPa)** at ≤ -40 °C, and the remaining 200 cycles to 125 per cent NWP **(+2/-0 MPa)** at 20 (± 5) °C."	The first group of pressure cycling, 25 cycles are performed to ≥80 per cent NWP **specified by manufacturer** at …. then 25 cycles to ≥125 per cent NWP **specified by manufacturer** at ≥ **+**50 °C and **≥80** per cent relative humidity, and the remaining 200 cycles to ≥125 per cent NWP **specified by manufacturer** …… The second group of pressure cycling, 25 cycles are performed to ≥125 per cent NWP **specified by manufacturer** at …..and **≥80** per cent relative humidity, then 25 cycles to ≥80 per cent NWP **specified by manufacturer** at ….the remaining 200 cycles to ≥125 per cent NWP **specified by manufacturer** at …… TF 3 – Previous agreed changes to pressure and temperature tolerances are covered.		
EC JRC	5.1.3.2 (b)		te	There is no tolerance for temperature fluctuations in the CHSS during cold / warm cycles	Allow ±5°C fluctuation in the system during cold / warm cycles	TF 3 – Previous agreed changes to pressure and temperature tolerances are covered.	X	Tolerance s.xls
PTL/ NHTSA	5.1.3.2 (b)		te	Add a table to clearly itemize the test parameters	Table to be provided by PTL/NHTSA	TF 3 – Agree	X	

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EC JRC	5.1.3.2(b)		te	Container performance does not seems to significantly change for pneumatic cycle made at -40°C ambient in comparison to tests made at ambient -25 °C	Consider performing test at -25 °C, but adding a test where the tensile properties of the plastic materials are measured at temperatures lower than -40 °C	TF 3 – Agree to change the ambient temperature for cold gas cycling to -25°C. Rationale – Reduction of test burden for test facilities due to component restriction of -40°C performance. New temperature (-25°C) is a more realistic real world operating condition for defueling rates required in the test. This rationale is already used for the hot ambient gas cycling condition where +50°C ambient temperature is specified, yet components are rated to +85°C. This change does not compromise the safety intent of the test because in-tank gas temperatures will reach -40°C. Also note that hydraulic pressure cycling covers extreme temperatures of +85C and -40C conditions. Also refer to Battelle/NHTSA report showing that -25C results compare to -40C results.	X	RATIONALE Done 1/26 – Phase 2 Change #3
NHTSA	5.1.3.2(b)		te	Cold cycles are done at 80% NWP. This is not representative of real world conditions.	Recommend cycling to NWP.	EC JRC – Agree JAMA JARI - Disagree.		

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						The map of non-communication refuelling in J2601 should be referred to meet the real world conditions. NHTSA withdraws comment.		
PTL	5.1.3.2(b)		te	Cycles are performed to 80% NWP at -40C.	Recommend cycling to NWP. SAE J2601 H70T40 target pressures for fueling from 2MPa at -40C are ≥70MPa.	EC JRC – Agree JAMA JARI - Disagree. The map of non-communication refuelling in J2601 should be referred to meet the real world conditions. PTL withdraws comment.		
NHTSA	5.1.3.2(b)		te	No lower container temperature specified for cold gas cycling.	Container temperature should be allowed to go below -40 deg C.	EC JRC - Agree. Results of JRC experiments show that for the cycles with temperature equilibration tank wall temperatures reach -47°C while for the consecutives cycles without equilibration temperatures the tank wall cools down to -60°C. JAMA JARI - Disagree. Lower container temperature should not be specified. Container temperature can be allowed to go below -40 deg C according to current description.		

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						NHTSA withdraws comment.		
PTL	5.1.3.2(b)		te	No lower container temperature specified for cold gas cycling.	Should be a requirement that minimum container temperature is lower than -40C. When performing cold cycles at ≤-40C, it is impossible to complete the defuel if the tank reaches an internal temperature of -40C (tank cannot warm up, as ambient temperature is already below -40C)	EC JRC - Alternatively consider performing the test at an ambient temperature of -30°C (as in ISO/DIS 19881). JAMA JARI - Disagree. Lower container temperature should not be specified. Container temperature can be allowed to go below -40 deg C according to current description. PTL withdraws comment.		
CSA	5.1.3.2(b)		te	There is no tolerance specified for the relative humidity during +50°C cycles (5.1.3.2 (b)).	Recommend >95% RH.	EC JRC - Prefer ≥80% RH JAMA JARI - Not agreed. Delete the humidity condition. It is not needed to evaluate the influence of humidity in the pneumatic sequential tests. Because that is evaluated in the hydraulic sequential tests. TF 3 – Reduce relative humidity requirement to ≥80% to be consistent with hydraulic test requirements.	X	Tolerance. xls
PTL	5.1.3.2(b)		te	There is no tolerance specified for the relative humidity during +50°C cycles (5.1.3.2 (b)).	Recommend ≥80% RH.	EC JRC - Agree, in any case as RH depends on temperature: 80% RH at 55°C means that as soon as	X	Tolerance. xls

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				95%RH at 50C is an unrealistic condition that is unnecessarily severe for an "on-road performance" test. If the intent is to cycle the HSS in an extreme humidity environment, 80%RH at 50C should be sufficient.		temperature decreases in the tank water condensates in its outer walls (e.g. during emptying). JAMA JARI - Not agreed. Delete the humidity condition. See the above JAMA/JARI comment. TF 3 – Reduce relative humidity requirement to ≥80% to be consistent with hydraulic test requirements.		
CSA	5.1.3 5.1.3.2(c)		te	Figure 3 specifies fueling with hydrogen gas at <-35°C (5.1.3) whereas Clause 5.1.3.2 (c) specifies a hydrogen gas fueling temperature of ≤-40°C.	Recommend SAE J2601 T40 fueling specification window of -33°C to -40°C within 30 seconds of fueling initiation. Follow the procedure in Powertech report. Figure 5.1.3 does not match the text and is not according to SAE J2601. Recommend following SAE J2601 (correction confirmed by NHTSA).	EC JRC – Agree JAMA JARI - Agreed. TF 3 – Agree.	X	RATIONALE – Done 1/26. Phase 2 Change #4. (D table in J2601 for HDV)
PTL	5.1.3.2(c)		te	Fueling gas temperatures ≤-40°C violate SAE J2601 fueling conditions.	Recommend SAE J2601 T40 fueling specification window of -33°C to -40°C within 30 seconds of fueling initiation.	EC JRC - Alternatively consider performing the test at an ambient temperature of -30°C (as in ISO/DIS 19881). JAMA JARI - Agreed. TF 3 – Agree.	X	RATIONALE – Done, see above Phase 2 Change #4.
JAMA	5.1.3.3		ed	See JAMA04	Extreme temperature static **gas** pressure leak/permeation test.		X	

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HEX	5.1.3.3		te	Add static low temperature leak test if permanent leak supervision will not be agreed upon.		TF 3 – Comment withdrawn by HEX (resolved above)	X	
EC	5.1.3.4		te		The storage container is pressurized to 180 per cent NWP **(+2/-0 MPa)** and held **at least** 4 minutes without burst (para. 6.2.3.1. test procedure)."	JAMA JARI - The storage container is pressurized to ≥180 per cent NWP **specified by manufacturer** and held **at least** 4 minutes **specified by manufacturer** without burst (para. 6.2.3.1. test procedure)." TF 3 – Agree to change pressure to ≥180% NWP and time to at least 4 minutes.	X	Tolerances.xls
Toyota	5.1.3.4.		ed	Clarify that this test is conducted without primary closures.	Amend to read: 5.1.3.4. Residual proof pressure test (hydraulic) The ~~storage container~~ **CHSS (after removal of its primary closures)** is pressurized to …	**CT SG 10/8, OK** **Needs to go to TF3**		
EC	5.1.3.5		te		The storage container undergoes a hydraulic burst to verify that the burst pressure is ~~within 20~~**at least 80** per cent of the baseline burst pressure determined in para. 5.1.1.1. (para. 6.2.2.1. test procedure)."	JAMA JARI - Agreed. TF 3 – Agree	X	Tolerances.xls
PTL	5.1.3.5		ed, te	The statement "…baseline burst pressure determined in 5.1.1.1…" is unclear as "baseline burst value" is not a defined value. Does this mean the average of the 3 bursts in 5.1.1.1? Does this mean BPo (called "midpoint burst pressure", not "baseline initial burst pressure", in 5.1.1.1)? Also, BPo is not determined in 5.1.1.1 since it is	"…verify that the burst pressure is ~~within 20~~ **at least 80** per cent of ~~the baseline burst pressure determined in~~ **BPo found** in para. 5.1.1.1."	JAMA JARI - Agreed. The same as Clause 5.1.2.8. (Residual burst strength test). TF 3 – Agree Based on Livio's recommendation to	X	

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				supplied by the manufacturer and may be confused with the test results from 5.1.1.1. Agree with EC that 5.1.3.5 wording should be consistent with 5.1.2.8		reference 5.1.1.1, Both references to BP_O (5.1.2.8 and 5.1.3.5) now read "**the burst pressure is at least 80 per cent of the BP_O provided by the manufacturer in para. 5.1.1.1.**"		
HEX	5.1.3.5		ed, te	"…verify that the burst pressure is at least 80 per cent of the ~~baseline burst pressure determined in~~ **BPo** found in para. 5.1.1.1." BPo is not found in para 5.1.1.1, but it is provided by the manufacturer	"…verify that the burst pressure is at least 80 per cent of the ~~baseline burst pressure determined in~~ **BPo** provided by the manufacturer."	TF 3 – Agreed	X	
CSA	5.1.4		te	Testing may be performed using compressed air – this can lead to an unsafe condition (high pressure air combined with minor oil residue).	Delete the clause: ~~However, Contracting Parties under the 1998 Agreement may choose to use compressed air as an alternative test gas for certification of a container for use only within their countries or regions.~~	JAMA JARI - Agreed. TF 3 – Agree. Rationale is that there must be a way to measure any potential leakage that creates a flame greater than 0.5m. Therefore nitrogen and helium cannot be used.	X	RATIONALE – Done 1/26 Phase 2 Change #5
PTL	5.1.4		te	Agree with CSA however nitrogen or helium could be used in place of air.	"may choose to use ~~compressed air~~ nitrogen or helium as an alternative test gas for certification…"	JAMA JARI - Partly agreed. Nitrogen should not be used. Because the increasing rate of temperature of nitrogen gas may be lower than that of hydrogen gas. TF 3 – Disagree. Rationale is that there must be a way to measure any potential leakage that creates a flame greater than 0.5m. Therefore		

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						nitrogen and helium cannot be used.		
PTL	5.1.4		te	If there is a concern with devices venting through the pressure relief device but NOT through the intended outlet port, the proposed edit should be considered. Powertech has experienced TPRDs that vented but not through the intended outlet meaning that hydrogen gas or ignited hydrogen gas would possibly vent at the TPRD into the surrounding area rather than through its vent line.	“A temperature-activated pressure relief device shall release the contained gases in a controlled manner **through its intended vent or outlet port** without rupture.”	JAMA JARI - Need to be discussed on definition of “intended vent”. TF 3 – Agree JAMA JARI – It should be stated that "intended vent or outlet port" is the exit of TPRD TF 3 – Agree with the following: “A temperature-activated pressure relief device shall release the contained gases in a controlled manner through its intended outlet port without rupture.”	X	RATIONALE – 8/2 Defer to TF4
EC	5.1.5.2		ed		Check valve and automatic shut-off valve qualification ~~on~~ requirements. Design qualification testing shall …”		X	
NHTSA	5.1.6		te	Remove statement	~~Date of removal from service shall not be more than 15 years after the date of manufacture.~~	TF 3 - Agreed	X	8/2/21 - Done
Toyota	5.1.6.		te	The labelling when the container is fully enclosed by container attachments.	Amend to read: 5.1.6. Labelling A label shall be permanently affixed on each container **or the container attachments** with at least the following information: name of the	**CT SG 10/8,OK** **Needs to go to TF3**	X	8/2/21 - Done

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					manufacturer, serial number, date of manufacture, NWP, type of fuel, and date of removal from service **as well as** . ~~Each container shall also be marked with~~ the number of cycles used in the testing programme as per para. 5.1.1.2. Any label ~~affixed to the container~~ in compliance with this section shall remain in place and be legible for the duration of the manufacturer's recommended service life for the container. Date of removal from service shall not be more than 15 years after the date of manufacture.			
EC	5.2		ed		This section specifies requirements for the ~~integrity of the hydrogen~~ **vehicle** fuel ~~delivery~~ system, which includes the **compressed** hydrogen storage system, piping, joints, and components in which hydrogen is present."		X	
JAMA	5.2.1.1.2		ge	Harmonize with UN R134	Add underlined words Fuelling receptacle label A label shall be affixed close to the fuelling receptacle; for instance inside a refilling hatch, showing the following information: fuel type <u>(e.g. "CHG" for gaseous hydrogen)</u>, NWP, <u>MFP,</u> date of removal from service of containers.	TF 3 – Agree	X	
JAMA	5.2.1.3.1	(a)	te	Not restrict the protection means to a cap. (a) Storage system TPRDs. The outlet of the vent line, if present, for hydrogen gas	Modify as below. Storage system TPRDs. The outlet of the vent line, if present,	TF 3 – Agree with first suggestion, i.e.:	X	

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				discharge from TPRD(s) of the storage system shall be protected by a cap;	for hydrogen gas discharge from TPRD(s) of the storage system shall be protected from ingress of dirt and water (e.g. by a cap); Or from blockage with foreign substances. (e.g. by using a cap)	Storage system TPRDs. The outlet of the vent line, if present, for hydrogen gas discharge from TPRD(s) of the storage system shall be protected from ingress of dirt and water (e.g. by a cap);		
EC	5.2.1.3.1 (c)		ed		Other pressure relief devices (such as a burst **disc**~~disk~~) may be used outside the hydrogen storage system. The hydrogen gas discharge from other pressure relief devices shall not be directed: (i)Towards exposed electrical terminals, exposed electrical switches or other ignition sources; (ii)Into or towards the vehicle passenger or ~~cargo~~ **luggage** compartments; (iii)Into or towards any vehicle wheel housing; (iv)Towards hydrogen gas containers."		X	
NHTSA	5.2.1.4 and 6.1.3		te	This may be difficult to enforce. How is the industry verifying compliance with this and other 6.2 requirements and test procedures?		Looking for feedback from OEMs…		
EC	5.2.1.4.1		ed		Hydrogen leakage and/or permeation from the hydrogen storage system shall not directly vent into the passenger **or**~~,~~ luggage~~, or cargo~~ compartments, or to any enclosed or semi-enclosed spaces within the		X	

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					vehicle that contains unprotected ignition sources."			
NHTSA	5.2.1.4.1		te	How to enforce? Direction of permeation, etc		Discussed but impasse…		
EC	5.2.1.5		ed		The hydrogen fuelling line **(e.g. piping, joint, etc.**~~) and the hydrogen system(s)~~ 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 (para. 6.1.5. test procedure)."		X	
JAMA	5.2.1.6		ed	Correction	(b) Yellow in ~~colour~~ color if the detection system malfunctions and shall be red in compliance with ~~section~~ para. 5.2.1.4.3;		X	
NHTSA	5.2.1.6 (e)		te	The safety risk from hydrogen remains even if the power system is off. Should the warning remain illuminated even when the vehicle is powered off? Or should a shut-off have already occurred because of a CHSS pressure drop or abnormal flow from the CHSS? In this case, there would not be any accumulation to warn about.		TF 3 - Not possible to remain illuminated with power off…		
EC	5.2.1.6(b)		ed		Yellow in colour if the detection system malfunctions **(e.g. circuit disconnection, short-circuit, sensor fault).** ~~and~~**It** shall be red in compliance with section para. 5.2.1.4.3;"		X	
EC	5.2.1.6(d)		ed		Remains illuminated when 2 ± 1.0 per cent concentration or detection **system** malfunction~~)~~ exists and the ignition locking system is in the "On" ("Run")		X	

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					position or the propulsion system is activated."			
JAMA19	5.2.1.6. (d)		ed	"Remains illuminated when 2 ± 1.0 per cent concentration…." It should be harmonized with 5.2.4.1.3.	Amend to read: "Remains illuminated when **>3** ~~2 ± 1.0~~ per cent or higher concentration…."	TF0 – Should be reviewed by TF3 in relation to 5.2.1.4.3. Will forward. TF 3 – Request JAMA to confirm 2% is correct given change to 3% level warning…		
EC	5.2.2.1		te		The volumetric flow of hydrogen gas leakage shall not exceed an average of 118 NL per minute for **the time interval, Δt, as determined in accordance with paragraph 6.1.1.1. or 6.1.1.2.**~~60 minutes after the crash~~ (para. 6.1.1. test procedure.	JAMA JARI - Agree. TF 3 – Agree	X	
EC	5.2.2.2		ed		Hydrogen gas leakage shall not result in a hydrogen concentration in the air greater than 3 ± 1.0 per cent~~]~~ by volume in the passenger **and**~~,~~ luggage ~~and cargo~~ compartments (para. 6.1.2. test procedures). The requirement is satisfied if it is confirmed that the shut-off valve of the storage system has closed within 5 seconds of the crash and no leakage from the storage system"		X	

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JAMA	5.2.2.2		te	The legal thresholds of the hydrogen concentration should not have tolerances	Amend to read: "Hydrogen gas leakage shall not result in a hydrogen concentration in the air greater than ~~3 ± 1.0~~**4.0** per cent by volume…"			
JAMA	5.2.2.3		ed	Correction	Container ~~D~~displacement		X	
JAMA	5.3.1.4.3.		te	The legal thresholds of the warning and shut-down should not have tolerances.	Amend to read: "If, during operation, a single failure results in a hydrogen concentration exceeding ~~2 ± 1.0~~ **3.0** per cent by volume in air in the enclosed or semi-enclosed spaces of the vehicle, then a warning shall be provided (para. 5.2.1.6.). If the hydrogen concentration exceeds ~~3 ± 1.0~~ **4.0** per cent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the main shutoff valve shall be closed to isolate the storage system. (para. 6.1.3. test procedure)."			
Toyota	Chapter 6		ed	**Improve consistency**	**Throughout chapter 6, replace "storage system" or "hydrogen storage system" with "CHSS"**			
EC	6.1.1		ed		The main stop valve and shut-off valves for hydrogen gas, located in the downstream hydrogen gas piping, are **in normal driving condition**~~kept open~~immediately prior to the impact."		X	

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NHTSA	6.1.1 (b)		te	$\rho_0' = -0.0027 \times (P_0')^2 + 0.75 \times P_0' + 0.5789$ equation doesn't match SAEJ2578 $Ds = -0.0027 \times (Ps\_15)^2 + 0.75 \times Ps\_15 + 1.07$ $De = -0.0027 \times (Pe\_15)^2 + 0.75 \times Pe\_15 + 1.07$ (Eq. A7) and SAE paper 2010-01-0133 $D_{H2\_288} = -0.0027 \times P_{H2\_288}^{\ 2} + 0.75 \times P_{H2\_288} + 1.07$ (Eq.3) D_{H2_288}: gas density (kg/m 3), P_{H2_288}: pressure (MPa) Can we check against SOC definition density table? Or should we just refer to the table instead of using the equation?		TF 3 – check with Glenn Scheffler		
NHTSA	6.1.1 (d)		ed?	Is main stop valve the same as shut-off valve. Or is it different?		TF 3 – likely means primary closure device valve. The vehicle should be in its normal operating mode…		
EC	6.1.1.2		te		Post-crash leak test - Compressed hydrogen storage system filled with compressed helium… The average helium flow rate over the time interval is therefore $V_{He} = (M_f - M_o) / \Delta t \times 22.41 / 4.003 \times$ (~~P_o/~~ P_{target} **/ P_0**) where V_{He} is the average volumetric flow rate (NL/min) over	JAMA JARI - Agreed. TF 3 – Agree with suggested language. Also change in the text Ptarget/P0.	X	

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					the time interval and the term ~~P_o/~~ P_{target} **/ P_o** is used to ….”			
EC	6.1.2		ed		Prior to the crash impact, the sensors are located in the passenger **and**~~,~~ luggage~~, and cargo~~ compartments of … (c)Atdistance within 100 mm of the top of luggage ~~and cargo~~ compartments within … … to more than 10 per cent of the targeted criteria in the passenger **and**~~,~~ luggage~~, and cargo~~ compartments.… The filtered readings from each sensor shall be below the targeted criteria of 3 ± 1.0 per cent for hydrogen **or**~~and~~ 2.25 ± 0.75 per cent for helium at all times throughout the 60 minutes post-crash test period.”		X	
JAMA	6.1.2		te	The legal thresholds of the hydrogen concentration should not have tolerances	Amend to read: “…The filtered readings from each sensor shall be below the targeted criteria of ~~3 ± 1.0~~**4.0** per cent for hydrogen **or**~~and~~ ~~2.25 ± 0.75~~**3.0** per cent for helium at all times throughout the 60 minutes post-crash test period.”			
TMC	6.2.5.1.2a		te	Rationale: Intent is to have the cylinder at 100%SOC. As written, “100% NWP” is confusing, as it could be interpreted as 70MPa at any temperature. Test environment temp dictates NWP, thus tank can be over/under 70MPa depending on ambient condition	“The container assembly is filled with compressed hydrogen gas to nominal working pressure, with pressure compensated for ambient test temperature.”	TF 3 – Agree to the following language: “The container assembly is filled with compressed hydrogen gas to 100% state of charge.”	X	RATIONALE – Done – 1/27. Phase 2 Change #6
JAMA	6.1.3.1.1.2.		te	The specification of the test gas should correspond to the respective requirements.	Amend to read:			

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					"Test gas: Two mixtures of air and hydrogen gas: ~~2 ± 1.0~~**>3.0** per cent concentration ~~(or less)~~ of hydrogen in the air to verify function of the warning, and ~~3±1.0~~**>4.0** per cent concentration ~~(or less)~~ of hydrogen in the air to verify function of the shut-down. The proper concentrations are selected based on the recommendation (or the detector specification) by the manufacturer."			
EC	6.1.3.2.1.3		ed		Prior to the test the vehicle is prepared to allow remotely controllable hydrogen releases from the hydrogen system. 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 **under a single failure condition** 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."		X	
JAMA	6.1.3.2.1.3		te	"Hydrogen releases from the hydrogen system" needs to alter the test vehicle. A test method without modification of fuel lines also should be provided.	6.1.3.2.1.3. Prior to the test the vehicle is prepared to simulate ~~allow~~ remotely controllable hydrogen releases from the hydrogen system. Hydrogen releases may be demonstrated by	TF 3 – Agree	X	

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					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.			
EC	6.1.4.3		ed		The measuring section of the measuring device is placed on the centre line of the exhaust gas flow within 100 mm from the exhaust **point of discharge**~~gas outlet~~ external to the vehicle."		X	
STEL	6.1.4.4		te	The exhaust hydrogen concentration is continuously measured during the following steps: (a) The power system is shut-down; (b) Upon completion of the shut-down process, the power system is immediately started; (c) **After a lapse of one minute**, the power system is turned off and measurement continues until the power system shut-down procedure is completed The startup process may last longer than one minute and may allow a "normal shutdown" not before one minute.	(c) **After completion of the start-up process**, the power system is turned off and measurement continues until the power system shut-down procedure is completed			

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				We recommend to alternatively turn off the system **after completion of the startup process**.				
JAMA2 1	6.1.4.5.		te	"The measurement device shall have a measurement response time of less than 300 milliseconds." The response time of less than 300 milliseconds is not always possible. For example, responding from zero to accurate reading of 8% within 300ms will be impossible. From Stellantis Sep. 27, 2021: The instrument which can be used for observation of hydrogen emissions with appropriate time resolution is a vacuum mass spectrometer. The pressure reduction from atmosphere to an appropriate vacuum level needs a respective length of a thin capillary which results in a travel time which is longer than 300 milliseconds. The time dependent gas composition (profile of pulse shape) is not influenced by the travel time in the capillary. We recommend to change the wording of "response time" into "resolution time". Alternatively a recording rate could be specified (as in JAMA´s comment below), but in this case the unit should be Hz (e.g. 10 Hz) instead of milliseconds.	Amend to read: "The measurement device shall have a recording rate of less than 300 milliseconds." or "recording rate" can be changed to "data acquisition time ".	TF0 – Should be reviewed by TF3, will forward. TF 3 – Measurement device is the device used to confirm hydrogen concentration from the exhaust during the test. Seek guidance from TUV SUD, TUV Rheinland. Do sensors exist that can do this? What is the fastest response time possible for commercially available products? Bill Buetner (sp?) - NREL		
EC	6.1.5.2.		ed		Hydrogen leakage is evaluated at accessible sections of the fuel		X	

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					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.”			
NHTSA	6.2.2.1		te	Specifies ambient temp of 25±5 C	Test is done outdoors so recommend extending temperature range – possibly to 10-40 deg C.	JAMA JARI - To be discussed with 6.2.2.2. See JARI comment of 5.1.1.2 Recommend extending temperature range – possibly to 5-35 deg C. TF 3 – Previously accepted ambient temperature of 5 to 35°C.	X	RATIONALE Done – See Phase 2 Change #1
PTL	6.2.2.1		te	20±5 C is an unnecessarily stringent test temperature range for the container skin and fluid. Recommend expanding test temperature range or allowing skin and fluid temperatures to rise to a reasonable temperature incapable of harming a robust container or materially affecting test performance.	Recommend extending temperature range – possibly to 10-40 deg C. OR “The burst test is conducted at an ambient air and initial external container skin temperature of 20±5 C The temperature of the container skin and internal fluid may exceed 25 C during the test however may not exceed 40 C.	JAMA JARI - To be discussed with 6.2.2.2. TF 3 – Previously accepted ambient temperature of 5 to 35°C.	X	RATIONALE Done – See Phase 2 Change #1
JARI	6.2.2.1		te	Specifies ambient temp of 20±5 C	The ambient temperature shall be specified at 5-35 deg C based on ISO 554-1976 and JIS Z 8703:1983. The temperatures of the container surface and the fluid shall not be specified.	JAMA JARI - To be discussed with 6.2.2.2. TF 3 – Previously accepted ambient temperature of 5 to 35°C.	X	RATIONALE Done – See Phase 2 Change #1

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HEX	6.2.2.1 a)		te	It should be up to the manufacturer to define the hydraulic fluid type.	The burst test is conducted at ….. using a ~~**non-corrosive**~~ **hydraulic** fluid.	TF 3 – Agreed	X	
JARI	6.2.2.2		te	The fluid temperature shall be deleted from the specified objects. Because it is impossible to control the fluid temperature due to changing to the pressure. Furthermore the text (d) can be deleted as it is specified in the text (b).	(b) The **environment and** the container ~~**and fluid**~~ are stabilized at the specified temperature and relative humidity at the start of testing; the environment~~**, fuelling fluid**~~ and container skin are maintained at the specified temperature for the duration of the testing. The **fluid** ~~**container temperature**~~ may vary from the environmental temperature during testing; ~~**(d) The temperature of the hydraulic fluid within the container is maintained and monitored at the specified temperature.**~~	TF 3 – Reject because we now allow ≤-40°C and ≥85°C. It is possible to maintain the fluid temperature at the specified test conditions. Suggest the following for (d): The temperature of the hydraulic fluid entering the container shall be maintained at the specified temperature and monitored as close as possible to the container inlet. JAMA-JARI – Agree		
JARI	6.2.2.2		te	To easier control during the testing, the pressure condition shall be specified ≤2 MPa. HMC-If allowed low pressure of containers for vehicle is 1MPa below, and then the test is conducted with 2MPa~target pressure, then the cycling performance of sample isn't able to verified correctly. Therefore, propose ≤0.2MPa as reference of min. maintained pressure on EC79/406. (The low pressure(≤0.2MPa) for all subsequent cycling test is applied equally.)	(c) The container is pressure cycled between ≤2 ~~**(±1)**~~ MPa and the target pressure at a rate not exceeding 10 cycles per minute for the specified number of cycles; (c) The container is pressure cycled between ≤0.2 MPa and the target pressure at a rate not exceeding 10 cycles per minute for the specified number of cycles;	TF 3 – Agree HMC comment withdrawn	X	
HEX	6.2.2.2 a)		te	It should be up to the manufacturer to define the hydraulic fluid type.	The container is filled with a ~~**non-corrosive**~~ **hydraulic** fluid;	TF 3 – Agreed	X	

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TMC	6.2.3.1		te	The "Proof pressure test" is referred in the proof test with the each manufactured container. The hydraulic fluid used in the test must be completely drained after the test. Test with gas is much easier for the drain.	Change the "6.2.3.1. Proof pressure test" as below. 6.2.3.1. Proof pressure test The system is pressurized smoothly and continually with a non-corrosive hydraulic fluid **<u>or gas</u>** until the target test pressure level is reached and then held for the specified time.	TF 3 – Agreed	X	
HEX	6.2.3.1		te	It should be up to the manufacturer to define the hydraulic fluid type.	Change the "6.2.3.1. Proof pressure test" as below. 6.2.3.1. Proof pressure test The system is pressurized smoothly and continually with a ~~**non-corrosive**~~ hydraulic fluid **<u>or gas</u>** until the target test pressure level is reached and then held for the specified time.	TF 3 – Agree	X	
Toyota	6.2.3.1.		Ed	**Improve consistency.**	Amend to read: 6.2.3.1. Proof pressure test The ~~system~~ **container** is pressurized smoothly and …	**CT SG 10/8, OK** **Needs to go to TF3**		
NHTSA	6.2.3.2		te	Drop test description is too convoluted and requires number of ambient cycling tests. Needs simplification. Also need to broaden temperature range for ambient temperature	Only one drop test per container. Compliance test can be done in any of the 4 orientations specified. Ambient temperature range increased to possibly 10 to 40 deg C.	JAMA JARI - Partly agreed. Agreed if the one orientation is done with the one container to be used in the further testing in paragraph 5.1.2. See JARI comment of 5.1.1.2 Recommend extending temperature range – possibly to 5-35 deg C.		

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						TF 3 – The multiple drops on one tank is considered worse case. For self-certification the member country can select the drop orientation. Specify the ambient temperature as 5 to 35°C. Add the following to the end of the clause (a) (ii) and (iii): “Containers that cannot meet the 488J requirement within 1.8m shall be dropped with a height of the lower end at 1.8m.”		
HEX	6.2.3.2		te	No need to specify drop test temperature	The storage container is drop tested ~~**at ambient temperature**~~ without internal pressurization or attached valves	TF 3 – Agreed	X	
CSA	6.2.3.2		te	There is no specification for drop test concrete surface hardness or roughness		JAMA JARI – There is ISO 22965 as international standard for the concrete. However the general concrete surface will have enough hardness comparing with CFRP. So it will not be necessary to specify the concrete conditions. TF 3 – No need to specify concrete hardness		
EC	6.2.3.2		ed		Drop (impact) test (unpressurized)		X	

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					… No attempt shall be made to prevent the bouncing of containers, but the containers may be prevented from falling over during the vertical drop test described ~~in b)~~ above. If more than one container is used to execute all ~~three~~ drop specifications, then those containers shall … "			
JAMA	6.2.3.2		te	In case the container is very lightweight, dropping from the height of 1.8m will not give the potential energy of 488 J.	Dropped once onto the end of the container from a vertical position with the ported end upward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. When the potential energy is not 488 J or over even if the height of the lower end is set to 1.8 m, drop the container with the height of the lower end at 1.8 m; Dropped once onto the end of the container from a vertical position with the ported end downward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. When the potential energy is not 488 J or over even if the height of the lower end is set to 1.8 m, drop the container with the height of the lower end at 1.8 m. If the container is symmetrical (identical ported ends), this drop orientation is not required;	JAMA-JARI – Withdraw. (Resolved in the clause of NHSTA 6.2.3.2)		

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Linamar	6.2.3.2	a (iv)	ge	~~Orientation not defined for not cylindrical containers. Propose "worst case" orientation drop instead of 45deg for non-cylindrical containers.~~ Comment retracted. See NHTSA proposal.	~~"For irregular shape containers, perform angled drop from worst case orientation".~~	TF 3 – Rejected. No need to specify worst case orientation. However, NHTSA and Linamar will propose new language for irregular shaped containers, and to require only one orientation for the test. In other words, the manufacturer should continue to test to all four orientations, but regulatory authorities will test to at least one orientation.		
Linamar	6.2.3.2	a	ed	There are two 6.2.3.2. (a) sections.				
Toyota	6.2.3.2.		ed	**Improve consistency.**	Amend to read: 6.2.3.2. Drop (impact) test (unpressurized) The ~~storage~~ container **with its container attachments (if any)** is drop tested …	**CT SG 10/8, OK** **Needs to go to TF3**		
CTSG	6.2.3.2.		te	**6.2.3.2. Drop (impact) test (unpressurized)** The storage container is drop tested at ambient temperature without internal pressurization or attached valves. The surface onto which the containers are dropped shall be a smooth, horizontal concrete pad or other flooring type with equivalent hardness. No attempt shall be made to prevent a container from bouncing or falling over during a drop test. (a) ~~The orientation of the container being dropped (per requirement of para.~~	**Drop (impact) test (unpressurized)** The **storage** container and its container attachments (if any) is drop tested at ambient temperature without internal pressurization or attached valves. The surface onto which the test article is dropped shall be a smooth, horizontal concrete pad or other flooring type with equivalent hardness.	**20210617 TF3 Discussion:** **NHTSA Proposal:** Use shut off valve "location" instead of "interface". HL: Shut off valve is not present during this test. TF3: Continue using "shut off valve interface" and add "location". **NHTSA Proposal:** Use vehicle axis common nomenclature X, Y, Z. o Tank manufacturers cannot tell how the tank is mounted in vehicle.		CTSG Rationale – LNM to provide

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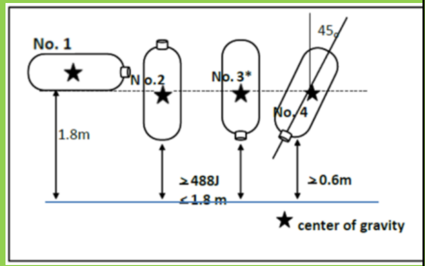
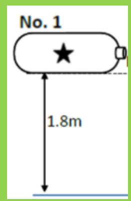
				~~5.1.2.2.) is determined as follows: One or more additional container(s) shall be dropped in each of the orientations described below. The drop orientations may be executed with a single container or as many as four containers may be used to accomplish the four drop orientations.~~ The container shall be dropped in any one of the following four orientations: (i) ~~Dropped once f~~From a horizontal position with the bottom 1.8 m above the surface onto which it is dropped; (ii) ~~Dropped once onto the end of the container f~~From a vertical position with the ported end upward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m;	(a) The test article shall be dropped in any one of the following four orientations:  (i) From a horizontal position with the bottom 1.8 m above the surface onto which it is dropped (In case of non-axisymmetric container, the shut off valve interface location ~~end~~ and its centre of gravity as well as the longest axis passing through the container shall be horizontally aligned.)  	○ Requalification needed if container goes in a different vehicle with a different vehicle orientation. **TF3**: Does protecting the threads make sense to prevent damage? **TF3:** Not normal condition to protect the threads since the container can be dropped with or without OTV in place. Thread damage is a general item that could be evaluated for all container and not only conformable.		

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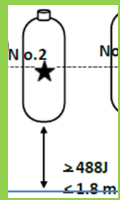
				(iii) ~~Dropped once onto the end of the container f~~From a vertical position with the ported end downward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. If the container is symmetrical (identical ported ends), this drop orientation is not required; (iv) ~~Dropped once at~~ From a 45° angle from the vertical orientation with a ported end downward with its centre of gravity 1.8 m above the ground. However, if the bottom is closer to the ground than 0.6 m, the drop angle shall be changed to maintain a	(ii) From a vertical position with the shut off valve interface location ~~end~~ upward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m (In case of non-axisymmetric container, the shut off valve interface location ~~end~~ and its centre of gravity shall be vertically aligned.);  (iii) From a vertical position with the shut off valve interface location ~~end~~ downward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. If the container is symmetrical (identical ends), this drop orientation is not required (In case of non-axisymmetric container, the shut off valve interface location ~~end~~ and its			

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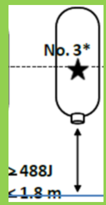
				minimum height of 0.6 m and a centre of gravity of 1.8 m above the ground.	centre of gravity shall be vertically aligned.);  (iv) From a 45° angle from the vertical orientation with the shut off valve interface location ~~end~~ downward and with its centre of gravity 1.8 m above the ground. However, if the bottom is closer to the ground than 0.6 m, the drop angle shall be changed to maintain a minimum height of 0.6 m and a centre of gravity of 1.8 m above the ground. In case of non-axisymmetric container, the line passing the shut off valve interface location ~~end~~ and its centre of gravity shall be 45° angled from vertical orientation and the shut off valve interface location shall become the lowest.			

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					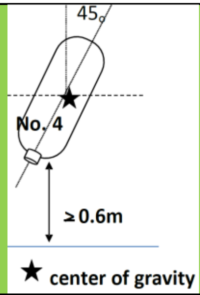			
Bosch	6.2.3.3/5.1.2.3	a	te	The current surface flaw requirement is taken for Type II, III and IV container based on ISO 19881 and ANSI HGV 2-2014. The mentioned standards require a different flaw requirement for Type I container. This classification should be also done in GTR 13.	Bosch recommends an additional paragraph for Type I container for the flaw requirements. A similar language to ISO 19881 could be used: "One uncoated type I container shall have two saw cuts in the longitudinal direction cut into the container sidewall. One flaw shall be minimum 25 mm long and minimum 0,42 mm deep and the other flaw shall be minimum 200 mm long and minimum 0,25 mm deep."	TF 3 – All-metal containers are exempt from the surface flaw generation portion of testing.	X	Rationale added 8/2 Phase 2 Change #24
NHTSA	6.2.3.3		te	No time specified between removal of container from environmental chamber and time of impacts.	Recommend max. time window of 30 min. 4between removal from chamber and impact test.	HMC: Agree to NHTSA JAMA JARI – Partly agreed. Recommend to add "The Pendulum impacts shall be added immediately after removal from the chamber". The time management effort should be avoided. TF 3 – Add the word "Immediately following a minimum of 12 hours…" to	X	

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						start the second sentence in 6.2.3.3(b)		
Linamar /TMC	6.2.3.3	a	te	~~The rationale for this test is the wear from straps can damage protective coatings. The designs that do not use straps or coatings are penalized.~~ ~~Suggesting to waive the cut test if mounting mechanism is tested with container.~~ Detailing the rationale behind the cut test. The 1.25mmx25mm (short and deep) cut is representative of the damage at the tank mounts (straps) and the 0.75mmx200mm (long and shallow) cut is representative of external contacts. We recommend to perform the cut test at the strap location. If the shell is damaged during the drop test, we suggest to continue the test on the damaged shell. If the container becomes exposed, perform the test on the container.	~~"If the vehicle mounting features are manufactured and tested with the pressure container, the cuts are not required on the pressure container."~~ -If the strap location is specified, perform the 1.25mmx25mm cut at the strap location. -If no straps are used, (e.g. boss mount) this cut test is not performed. -If the location is not specified or unknown, perform the cut on the cylindrical section. -If the protective shell is fully covering the pressure container when mounted in the vehicle, perform the 0.75mmx200mm cut on the protective shell. -Otherwise, perform the cut on the storage container cylindrical section.	TF 3 – To be tabled for future discussion. Linamar to re-draft the proposal to consider the discussion today: container drop test precedes flaw cuts so how to rationalize not performing flaw and chemical exposures, what happens if the shell is broken during drop test,		
Linamar	6.2.3.3	b	te	The rationale for this test is road debris damaging coatings or degrade exterior structural strength. Containers with protective shell should be tested with the shell. We believe that the storage container safety is enhanced by the protective shell. The minimal mechanical robustness of the protective shell is evaluated with the pendulum impacts and the cut test. Unlike,	"If the protective shell fully shields the storage container from road debris when mounted in the vehicle, apply the pendulum impact on the protective shell in areas closest to the pressure containers."	To be tabled for future discussion. Linamar to re-draft proposal to consider discussion today: Are we sacrificing container safety by encasing the container in a protective shell that does not have any specific requirements for in use and post crash integrity? Proposal should consider all		

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				the container surface, the protective shell mechanical damage is easier to evaluate during visual inspection. Since the protective shell is part of the storage container, its inspection will be part of the manufacturer's inspection manual. The shell is not proposed to be used against chemical exposure because fluid tightness is impossible to reliably inspect. The chemical exposure test is therefore kept on the storage container.		damage requirements and how these will be affected with a protective shell that may or may not be intact or present during lifetime.		

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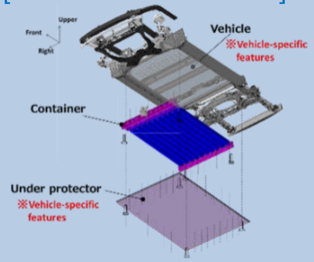
	6.2.3.3.			Surface damage test (unpressurized) The test proceeds in the following sequence: (a) Surface flaw generation: Two longitudinal saw cuts are made on the bottom outer surface of the unpressurized horizontal storage container along the cylindrical zone close to but not in the shoulder area. The first cut is at least 1.25 mm deep and 25 mm long toward the valve end of the container. The second cut is at least 0.75 mm deep and 200 mm long toward the end of the container opposite the valve;	Surface damage test (unpressurized) The surface damage tests and the chemical exposure tests (para. 6.2.3.4.) shall be conducted on the surface of the pressure bearing chamber of the container as long as it is accessible regardless of the existence of the container attachments. If the container attachments can be removed in accordance with the process specified by the manufacturer, then the container attachments shall be removed and the tests shall be conducted on the surface of the pressure bearing chamber of the container. Otherwise, the tests shall be conducted on the surface of the container attachments [as indicated in the flow diagram.]	Compared to CNG containers, which are often installed in luggage compartment for conversion, the possibility of the surface exposure to hard objects or strap or conformable container will be significantly lower because the conformable container will, in general, be designed as original equipment and more integrated into the vehicle structure. [Conformable container]  [CNG Container]  Position of mountings and container attachments are known by the storage manufacturer.		

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					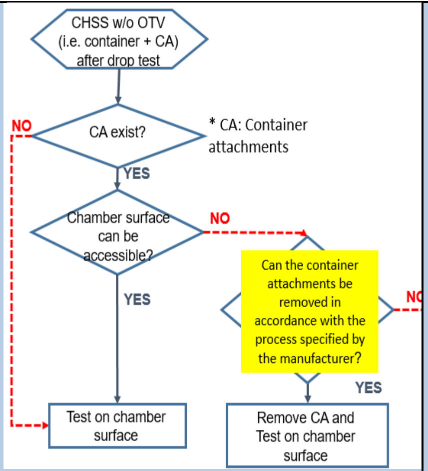 The test proceeds in the following sequence: (a) Surface flaw generation: A saw cut at least 0.75mm deep and 200mm long is made on **the surface specified above**. ~~In case that the container is intended to be installed by strapping it by its outer layer, a second saw cut at least 1.25mm deep and 25mm long is made at the interface where the container is secured by a restrain that is in contact with the container surface.~~ If the container is to be affixed by compressing its composite surface then a second cut at least 1.25 mm deep and 25 mm long is	CTSG 20210303: Potential NHTSA question, how do they know where this interface is? Customer is free to secure the cylinder however they want in conventional containers. Depth is based on some level of rejectable damage. Investigate the rationale for the depth/length. ISO19881 Rationale doesn't seem to have it. Look at NGV2 for rationale. The idea is that the surface damage test (flaw generation) provides robustness against real world damage. ISO19078-2013 refers to a document that has some information ISO 19078-2013 references Webster C.T., Wong J.Y. Tolerance of NGV Containers to Damage Induced Under Mounting Bracket Straps, GRI Report 97/0208, Gas Technology Institute, 1700 South Mount Prospect Road, Des Plaines, IL 60018, U.S.A. (Powertech Report 9221-36). Provides a short explanation about the cuts. It does not appear to be correlation between the field		

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					applied at the end of the container which is opposite to the location of the first cut.	data and the depth cut. 1.25mm does not seem to be a "typical" nor "worst case" case observed on cylinders. **CTSG 20210428:** NHTSA would like to add: "If the manufacturer does not provide a process to remove the container attachments, the test lab shall determine if and how the container attachments can be removed." NHTSA needs a statement like this because some manufacturers may not respond to NHTSA's request for the process to remove container attachments. " • CTSG: No harm in including this statement Additional questions from NHTSA: NHTSA's understanding is that once the container attachments are removed, they remain removed for the rest of 6.2.3. (Hydraulic Test) Is this interpretation correct? • CTSG: Yes However, could this lead to an issue because while some CAs are for shielding, others are for structural support, and we cannot		

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						distinguish these two types of CAs?" • CTSG: It does not make a difference to distinguish between them; if CA can be removed, it can stay off for the rest of the test. TF3 20210429: 1.25mm is based in a level of damage that can be visually identified (previously it used to be 40% of the container's wall thickness)		

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CTSG	6.2.3.3			Surface damage test (unpressurized) The test proceeds in the following sequence: (a) Surface flaw generation: Two longitudinal saw cuts are made on the bottom outer surface of the unpressurized horizontal storage container along the cylindrical zone close to but not in the shoulder area. The first cut is at least 1.25 mm deep and 25 mm long toward the valve end of the container. The second cut is at least 0.75 mm deep and 200 mm long toward the end of the container opposite the valve;	Surface damage test (unpressurized) The surface damage tests and the chemical exposure tests (para. 6.2.3.4.) shall be conducted on the surface of the pressure bearing chamber of the container as long as it is accessible regardless of the existence of the container attachments. If the container attachments can be removed in accordance with the process specified by the manufacturer, then the container attachments shall be removed, and the tests shall be conducted on the surface of the pressure bearing chamber of the container. Otherwise, the tests shall be conducted on the surface of the container attachments [as indicated in the flow diagram.]	TF3 Accepted 7/22	CTSG	8/2 – LNM to provide rationale

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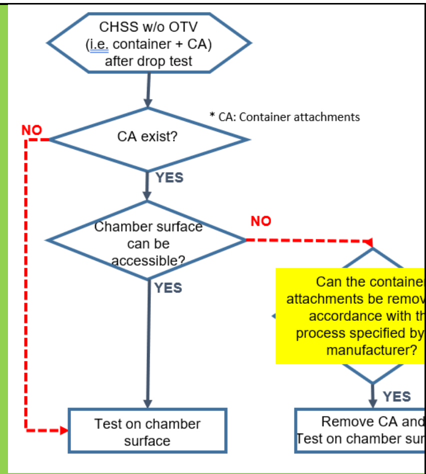
ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
					 The test proceeds in the following sequence: (a) Surface flaw generation: A saw cut at least 0.75mm deep and 200mm long is made on the surface specified above. If the container is to be affixed by compressing its composite surface, 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.			
CTSG				(b) Pendulum impacts: The upper section of the horizontal storage container is divided into five distinct (not overlapping) areas 100 mm in diameter each (see Figure 6). Immediately following a minimum of 12 hours preconditioning at ≤40 °C in an environmental chamber, the centre of each of the five areas	(b) Pendulum impacts: A surface of the container opposite to the surface specified above or a surface of a different chamber, in the case of a multiple permanently interconnected chambers container, is divided	TF3 Accepted 7/22		

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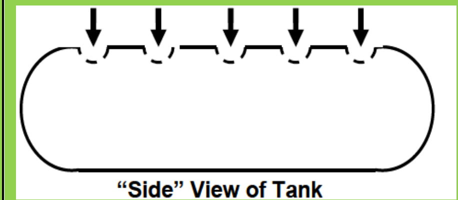
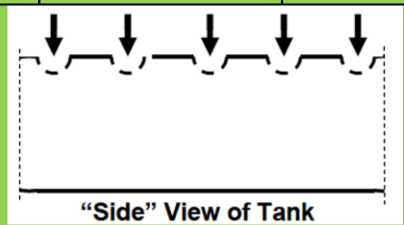
				sustains the impact of a pendulum having a pyramid with equilateral faces and square base, the summit and edges being rounded to a radius of 3 mm. The centre of impact of the pendulum coincides with the centre of gravity of the pyramid. The energy of the pendulum at the moment of impact with each of the five marked areas on the container is 30 J. The container is secured in place during pendulum impacts and not under pressure.	into five distinct (not overlapping) areas 100 mm in diameter each (see Figure 6). Immediately following a minimum of 12 hours preconditioning at ≤40 °C in an environmental chamber, the centre of each of the five areas sustains the impact of a pendulum having a pyramid with equilateral faces and square base, the summit and edges being rounded to a radius of 3 mm. The centre of impact of the pendulum coincides with the centre of gravity of the pyramid. The energy of the pendulum at the moment of impact with each of the five marked areas on the container is 30 J. The container is secured in place during pendulum impacts and not under pressure.			
CTSG	6.2.3.3	Figure 6 Side view of tank				TF3 Accepted 7/22		
CTSG	6.2.3.4.			6.2.3.4. Chemical exposure and ambient temperature pressure cycling test Each of the 5 areas of the unpressurized container preconditioned by pendulum impact…	6.2.3.4. Chemical exposure and ambient temperature pressure cycling test Each of the 5 areas of the unpressurized container **(with container attachments, if applicable)** preconditioned by pendulum impact…	TF3 Accepted 7/22		

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
CSA	6.2.3.3(a)		te	There is no specification for flaw cut dimensions, i.e. where one measures start of the length and depth, how does one cut the flaws, or width of flaws.		JAMA JARI – Wait for the specific proposals. TF 3 – Modify the sentence to: "The first cut is at least 1.25 mm deep and <u>at least</u> 25 mm long toward the valve end of the container. The second cut is at least 0.75 mm deep and <u>at least</u> 200 mm long toward the end of the container opposite the valve."	X	
EC	6.2.3.3(b)		te		"(b) Pendulum impacts: …. After 12 hours preconditioning at – 40 **(+0/-2)** °C in an environmental chamber, the centre of …."	HMC: ~~After 12 hours~~ → After 24 hours (for inconvenience of the test), ≤-40℃ TF – 3 Already changed per previous comment JAMA JARI – Disagree with－40 (+0/-2) °C. Should be changed to ≤-40°C. (Like the discussion at the last in-person meeting on Jun25.) TF 3 – Agree that this has been changed to ≤-40°C	X	Tolerances.xls
EC	6.2.3.4		te		Chemical exposure and ambient temperature pressure cycling test	HMC: ≥125 per cent NWP	X	Tolerances.xls

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					Each of the 5 areas of the unpressurized container preconditioned by pendulum impact (paragraph 6.4.**3.3.**~~2.5.2.~~) is exposed to … The exposure of the container with the glass wool is maintained for 48 hrs with the container held at 125 per cent NWP **(+2/-0 MPa)** (applied hydraulically) and 20 (±5) °C before …"	JAMA JARI – Disagree with 125 per cent NWP (+2/-0 MPa) and 20 (±5) °C. Should be changed to ≥125%NWP and 5-35°C. (Like the discussion at the last in-person meeting on Jun25.) TF 3 – Agree to change to ≥125%NWP and 5-35°C.		
CSA	6.2.3.4		te.	Difficult to ensure that test fluids pads are wetted for the duration of the test (6.2.3.4).	Recommend that a sufficient amount of the test fluid is applied to the glass wool sufficient to ensure that the pad is wetted across its surface and through its thickness for the duration of the 48 hour exposure. Use Powertech test procedure. States to soak wool pads and puts plastic covering to prevent evaporation. From test procedure: Wool pads soaked in the test fluids were placed on top of each area. The areas were then covered with plastic to prevent evaporation of the test solutions. Recommend that wetted pads are covered for the duration of the test	HMC: Agree to CSA. Wool pads soaked in the test fluids were placed on top of each area. The areas were then covered with plastic to prevent evaporation of the test solutions JAMA JARI – Agree. TF 3 – Add: "A plastic covering may be applied over the glass wool to prevent evaporation." to the end of the second paragraph.	X	
JARI	6.2.3.4		te	It is not necessary to specify the temperature for the ambient temperature pressure cycling test. Because that is already specified in Clause 5.1.2.4. Also as same as Clause 5.1.2.4, chemical	Pressure cycling is performed to the specified target pressures according to paragraph 6.2.2.2. at **specified temperature** ~~**20 (±5)°C**~~ for the specified numbers of	HMC: Agree to JARI TF 3 – Change the sentence to "The glass wool pads are removed and the container	X	

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				exposure will be continued up to the last 10 cycles.	cycles. The glass wool pads are removed and the container surface is rinsed with water **after** the final 10 cycles to specified final target pressure are conducted.	surface is rinsed with water after the final 10 cycles…"		
JARI	6.2.3.5		te	It is not necessary to measure the temperature of fluid. Only the control of the temperature of container surface will be enough. Also the tolerance of temperature shall be specified in only 5.1.2.5.	The storage system is pressurized to the target pressure in a temperature-controlled chamber. The temperature of the chamber and the **container skin** ~~**non-corrosive fuelling fluid is**~~ held at the target temperature ~~within ±5°C~~ for the specified duration.	HMC: Agree to JARI TF 3 – Agree to add: "The temperature of the chamber and the **container skin** ~~**non-corrosive fuelling fluid**~~ is held at the target temperature ~~within ±5°C~~ for the specified duration."	X	
Toyota	6.2.3.5.		ed	Avoid confusion of environment chamber and the pressure chamber of the CHSS.	6.2.3.5. Static pressure test (hydraulic) The ~~storage system~~**container** is pressurized to the target pressure in a temperature-controlled chamber. The temperature of the **environment** ~~chamber~~ and the **surface of the tested article** ~~non-corrosive fuelling fluid container skin~~ is held at the target temperature for the specified duration.			
Toyota	6.2.3.6.		te	Improve consistency.	6.2.3.6. Extreme temperature pressure cycling test The test is … (b) The container and fluid are stabilized at the specified temperature and relative humidity at the start of testing each test. The environment, fuelling fluid	TF 3 - Agreed		

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					and ~~container skin~~ **the surface of the tested article** are maintained at the specified temperature for the duration of the testing. The ~~container~~ container temperature ~~**of the tested article**~~ may vary from the environmental temperature during testing. (c) The container is …			
CSA	6.2.3.6 6.2.3.7		te	There are no detailed test procedures for the -40°C and +85°C extreme temperature cycles including information for temperature measurements in the environment and fluid.	Recommend including new Clauses 6.2.3.6 and 6.2.3.7 to describe test procedures for -40°C and +85°C extreme temperature cycles, respectively. Include suggested means for achieving >95% RH using water spray method per ISO 11119. New text added here: 5.1.2.6. Extreme temperature pressure cycling. The storage container is first pressure cycled at ≤-40°C to ≥80 per cent NWP for 20 per cent number of Cycles and then at ≥+85°C and ≥80 ~~95~~ per cent relative humidity to ≥125 per cent NWP for 20 per cent number of Cycles (para. 6.2.3.6~~2.2.~~ test procedure). New text: 6.2.3.6 Extreme temperature pressure cycling test	HMC: Agree 5.1.2.6 Extreme temperature pressure cycling. ~humidity to 125 per cent NWP for 20 per cent number of Cycles ~~(para. 6.2.2.2. test procedure)~~ → (para. 6.2.3.6 and para. 6.2.3.7 procedure) JAMA JARI – Disagree. There is no need to set up a new Clauses, the description in 5.1.2.6 is sufficient. TF 3 – Per NHTSA 5.1.2.6 comment above we need to create test procedures for 6.2.3.6 and 6.2.3.7 Powertech will create new Clauses 6.2.3.6 and 6.2.3.7 HMC – Agree to add specific test (6.2.3.6 and 6.2.3.7). Refer to "Powertech comments.docx" file	X	RATIONALE Done 1/26 – Phase 2 Change #7

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					The test is performed in accordance with the following procedure: (a) The container is filled with a hydraulic fluid for each test; (b) The container and fluid are stabilized at the specified temperature and relative humidity at the start of ~~testing~~ each test. The environment, fuelling fluid and container skin are maintained at the specified temperature for the duration of the testing. The container temperature may vary from the environmental temperature during testing. (c) The container is pressure cycled between ≤2 ~~(±1)~~ MPa and the target pressure at a rate not exceeding 10 cycles per minute for the specified number of cycles; (d) The temperature of the hydraulic fluid ~~within~~ entering the container ~~is~~ shall be maintained ~~and monitored~~ at the specified temperature and	TF 3 – Agreed to add PLI text.		

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					monitored as close as possible to the container inlet. **Note:** It is recommended that the container is kept at greater than atmospheric pressure for the duration of the testing and is only depressurized once stabilized to ambient temperature.			
EC	6.2.4		ed		Test procedures for expected on-road performance (para. 5.1.3.) (Pneumatic test procedures are provided; hydraulic test elements are described in para. **6.2.2.1.**~~6.3.2.~~)"		X	
PTL	6.2.4		ed		Test procedures for expected on-road performance (para. 5.1.3.) (Pneumatic test procedures are provided; hydraulic test elements are described in para. **6.2.3.**~~6.3.2.~~)"	I combined this and the above edit so the text now reads "(Pneumatic test procedures are provided; hydraulic test elements are described in **para. 6.2.2.1 and para. 6.2.3**)"	X	
CSA	6.2.4.1		te	Clause 6.2.4.1 requires filling at a constant 3 minute pressure ramp rate to 87.5 MPa (± 1 MPa). For gas cycles conducted at ambient temperatures of 20°C and 50°C, this could result in an unsafe storage system condition where the state of charges exceeds 100%. For gas cycles at ambient temperatures of -40°C, the maximum fill pressure of 56 MPa yields an overly conservative fill condition.	Recommend filling profiles in accordance with SAE J2601 H70T40 non-communications Table D13 (2-4 kg storage system) or Table D19 (4-7 kg storage system) or Table D25 (7-10 kg storage system). Fueling time should be increased for stage 1, 4, and 8. See Powertech report. Agree with above	EC JRC – Agree HMC: Agree to CSA JAMA JARI - Agree with the policy of the reference of non-communication Tables from SAE J2601 for the ramp rate and final fill pressure.		RATIONALE – Done Phase 2 Change #8

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					recommendation, however, according to latest version of SAE J2601 (Dec2016), tables listed above should be D19 (2-4kg), D25 (4-7kg) and D31 (7-10kg). Further, recommend using J2601/4 H70TA tables (currently under development) for cycles with fuel delivery temperature of 20C. Until J2601/4 is published, recommend ramp rate of ≤5MPa/min.	TF 3 – New PTL table addresses this comment.		
PTL	6.2.4.1		te	"..the fuel flow not to exceed 60 g/s" This should be removed as it is a vehicle safety requirement for fueling stations and has nothing to do with testing. The ramp rates in J2601 account for the tank size to ensure 60g/s is not exceeded.	Remove statement "...the fuel flow not to exceed 60 g/s".	TF 3 – Agreed, fueling rate should be established by the protocol document.	X	
PTL	6.2.4.1		te	"At the onset of testing, the storage system is stabilized at the specified temperature, relative humidity and fuel level for at least 24 hours." This is time consuming and unnecessary. It is sufficient to wait until the environmental conditions have been met and then begin cycling. With an initial equilibration you end up with 1 equilibrated cycle and 199 non-equilibrated cycles (ambient cycle phase as an example). "The specified temperature and relative humidity is maintained within the test environment throughout the remainder of the test."	Recommend: "~~At the onset of testing, the storage system is stabilized at the specified temperature, relative humidity and fuel level for at least 24 hours.~~ The specified temperature and relative humidity is maintained within the test environment throughout ~~the remainder of the test~~ **each pressure cycle**."	TF 3 – Agreed	X	

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				The “remainder of the test” is fairly vague wording and assumes there are no interruptions in the test.				
PTL	6.2.4.1		ed	“(When required in the test specification, the system temperature is stabilized at the external environmental temperature between pressure cycles.) This is a full sentence in brackets.	Remove brackets.		X	
PTL	6.2.4.1		te	Allow flexibility in setting the upper and lower limits. As long as the pressure cycle is within the prescribed range, it should meet the regulation.	Recommend: The storage system is pressure cycled between less than **or equal to** 2**~~(+0/-1)~~** MPa and **greater than or equal to** the specified maximum pressure **~~(± 1 MPa)~~**.	EC JRC - Note that ISO/DIS 19881 tolerances for pressure are ±1 MPa. HMC: ≤2MPa, ≥ NWP JAMA-JARI - Agree. TF 3 – Already covered by set minimum and maximum tolerances.	X	Tolerances.xls
Toyota	6.2.4.1-6.2.4.2		Ed	Improve consistency	Replace “storage system” with “**CHSS**”			
PTL	6.2.4.2		ed/te	The new steady state definition uses the word “reading” based on the steady state definition in J2579. This is a too ambiguous and can be confusing since a reading is typically a measurement instrument output. Replacing reading with the word “rate” would make this more clear.	“The test shall continue until the measured permeation reaches a steady state based on at least 3 consecutive ~~readings~~ **rates** separated by at least 12 hours being within ±10 % of the previous reading, or 500 hours, whichever occurs first.”	TF 3 - Agreed	X	
CSA	6.2.4.2		te	The test pressure for the gas permeation test is unclear (6.2.4.2).	Recommend filling the storage system to NWP at +15°C and heating the system to +55°C prior to the start of the test.	EC JRC – Agree HMC: Agree JAMA JARI – Disagree. No need to specify details of test procedure 6.2.4.2.		

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						Even if describing details, it should not be restricted to one method. Propose the following two options for conducting the stable condition of SOC 100% ≥55 deg C. Option 1) Stabilize after filling the storage system to NWP at +15°C. After that keeping the temperature of 55 deg C after the valve is closed. (The pressure is not controlled) Option 2) Once increasing the temperature to 55 deg C, stabilize after filling the storage system ≥115% NWP or ≥SOC 100%. TF 3 – Replace with “A storage system is fully filled with hydrogen gas to 100% state of charge and soaked for a minimum of 12 hours at ≥55°C in a sealed container prior to the start of the test. The test shall continue until the measured permeation reaches a steady state based on at least 3 consecutive readings separated by at least 12 h being within ±10 % of the previous reading, or 500 hours, whichever occurs first.		

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						If the latter, calculate the theoretical steady state value… Rationale for removing the 30 hour minimum: It has been replaced by the steady state determination (>36h). Discussion to be continued regarding continuing the test indefinitely or including a 500 h hard stop with extrapolation of steady state value.		
CSA	6.2.4.2		te	There is no definition for steady state for the gas permeation test (6.2.4.2).	Recommend steady state is achieved when three consecutive 24h readings do not fluctuate greater that 10%.	JAMA JARI - Disagree with 24h. Should be defined the same as SAE J 2579 below. ------------------------------------ SAE J2579-2018JUN : Appendix C steady-state permeation is defined as 3 consecutive overall permeation rates, at least 12 hours apart, where each successive value is within ±10% of the previous. TF 3 – Agree with SAE J2579 language: The test shall continue until the measured permeation reaches a steady state based on at least 3 consecutive readings		

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						separated by at least 12 h being within ±10 % of the previous reading, or 500 hours, whichever occurs first. If the latter, calculate the theoretical steady state value… Discussion to be continued regarding continuing the test indefinitely or including a 500 h hard stop with extrapolation of steady state value.		
NHTSA	6.2.4.2		te	There is no definition for steady state for the gas permeation test (6.2.4.2).	Recommend 3 consecutive readings separated by at least 12 hours.	EC JRC – Agree JAMA JARI – Agree. TF 3 – See above		
PTL	6.2.4.2		te	There is no definition for steady state for the gas permeation test (6.2.4.2).	Recommend steady-state permeation is defined as 3 consecutive overall permeation rates, at least 24 hours apart, where each successive value is within ±10% of the previous. Consecutively increasing rates are not considered to be at steady-state.	EC JRC - Separated at least 12 hours? HMC: Partly agree. ~~24 hours~~ → 12 hours JAMA JARI - Disagree with 24h. Should be defined the same as SAE J 2579 below. ------------------------------------ SAE J2579-2018JUN : Appendix C steady-state permeation is defined as 3 consecutive overall permeation rates, at		

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						least 12 hours apart, where each successive value is within ±10% of the previous TF 3 – See above		
EC	6.2.4.2		te		Gas permeation test (pneumatic) A storage system is fully filled with hydrogen gas at 115 per cent NWP **(+2/-0 MPa)** (full fill density equivalent to 100 per cent NWP at +15 °C is 113 per cent NWP at +55 °C) and held …"	JAMA JARI – Disagree with 115 per cent NWP (+2/-0MPa). Should be changed to ≥115%NWP. (Like the discussion at the last in-person meeting on Jun25.) TF 3 – Already covered above		
PTL	6.2.4.2		te	Allow flexibility in setting an upper limit.	Gas permeation test (pneumatic) A storage system is fully filled with hydrogen gas at **greater than or equal to** 115 per cent NWP (full fill density equivalent to 100 per cent NWP at +15 °C is 113 per cent NWP at +55 °C) and held …"	HMC: Agree to PTL to ≥115% NWP JAMA JARI – Partly agreed. The following parenthesized description is unnecessary. (full fill density……) TF 3 – Already covered above		
PTL	6.2.4.2		te	The 30 hour requirement makes no sense. This may be a copy error from SAE J2579 which prescribes a 30 hour hold at 55C prior to the permeation test (presumably to accelerate hydrogen saturation of the tank). There should also be a cap on the permeation test in case steady state is not reached. 500 hours is just a suggestion.	Recommend: "… and held at ≥55C in a sealed container until steady-state permeation ~~or 30 hours, whichever is longer~~ is reached. The test shall not exceed 500 hours."	EC JRC – Agree HMC-Partly agree. 500 hours is for ambient temperature permeation test of HGV2 and EC406. In case of ≥55C condition, it needs to shorten.		

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						JAMA JARI – Agree. TF 3 – See above		
EC JRC	6.2.4.2		te	Over many cycles at extreme conditions, hydrogen diffusion may damage the liner, particularly non-metallic liners, causing blistering and cracking, leading to excessive permeation or leakage. This form of damage may be influenced by the maximum and minimum temperatures experienced during fuelling and during normal fuel use in vehicle operation (container defueling). Liner buckling has been evidenced when it was vented to atmospheric pressure following a pressure test.	Examining the tank liner periodically (after each series of gas cycling and high pressure hold) requiring that the tank liner should not show cracks. This is in line with the proposal of hydrogen compatibility tests inclusion.	HMC: Not agree. JAMA JARI – Disagree. Confirming the cracks after each series places a heavy burden on the actual work (It is almost impossible.), it is realistic to check leaks during series tests and to conduct rupture test at the end. TF 3 – Reject comment, not practicable.		
JAMA	6.2.4.2		te	If only the lower limit of the temperature range(≥55 ° C) is defined, the permeation test may lose reproducibility because the temperature sensitivity is very high. The provision of a temperature range that does not hinder the ease of testing should be added.	A storage system is fully filled with hydrogen gas to 100% state of charge and soaked for a minimum of 12 hours ~~at ≥55°C~~ **with ambient temperature of 55 to 60° C** in a sealed container prior to the start of the test.	TF 3 – Agreed		
HEX	6.2.4.2		te	If permanent leak detection is too much burden, include static leak test @ -40 or -25°C because low temperatures represent the worst case for o-rings and fittings design/materials. This should be added for either system or single component leak requirement evaluation.	<u>**Low temperature leak test:**</u> A storage system is fully filled with hydrogen gas to 100% state of charge and soaked for a minimum of 12 hours at ≤ 25 or40°C in a sealed container prior to the start of the test.	HEX withdraws the comment as already resolved above.		

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					The total steady-state discharge rate due to leakage and permeation from the storage system is measured			
TF 3	6.2.4.2		te		Suggested language: A storage system is fully filled with hydrogen gas to 100% SOC and soaked for a minimum of 12 hours at 55 to 60°C in a sealed container prior to the start of the test. The test shall continue until the measured permeation reaches a steady state based on at least 3 consecutive readings separated by at least 12 h being within ±10 % of the previous reading, or 500 hours, whichever occurs first. ~~If the latter, calculate (extrapolate?) the theoretical steady state value of the storage system.~~	TF 3 Agrees	X	8/2/21 – Current TF0 draft temp requirement is at ≥55 °C, not 55° to 60° Need to resolve.
EC	6.2.5.1		ed		Fire test… Either one of the following two methods are used to identify the position of the system over the initial (localized) fire source: ~~6.2.5.1.1.~~ **(a)** Method 1: Qualification for a generic (non-Specific) vehicle installation … ~~6.2.5.1.2.~~ **(b)** Method 2: Qualification for a specific vehicle installation … fires originating from the direction of the passenger			

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					compartment, ~~cargo/~~luggage compartment, wheel wells or ground-pooled gasoline.			
EC	6.2.5.1.1		ed		The container may …			
EC	6.2.5.1.2		te		The following test requirements apply whether Method 1 or 2 (above) is used: (a) The container assembly is filled with compressed hydrogen gas at 100 per cent of NWP **(+2/-0 MPa)**. The container … **(b)** Localized portion of the fire test (**i**~~b~~) The localized fire exposure area is … (**ii**~~c~~) … within the localized fire **exposure** area, and at least … (**iii**~~d~~) Wind shields are … (**iv**~~e~~) … under the localized **fire** exposure area of … (**v**~~f~~) … in the localized fire **exposure** area has increased continuously to at least …. The temperature in the localized fire **exposure** area shall not exceed …. **(c)** Engulfing portion of the fire test … **(d)** Documenting results of the fire test ….	HMC: ≥100 per cent of NWP~ JAMA JARI - This item should be discussed in Task Force #4. TF 3 – Already changed to be 100% state of charge TF 3 – Remainder of comments are editorial		
PTL	6.2.5.1.2(c) 6.2.5.1.2(f)		te	Why is the engulfing fire length limited to 1.65 m and not entirely engulfing? For tanks greater than 1.65 m using more than one single-point sensing TPRD, this forces	"…the length of the test article ~~up to 1.65 m maximum~~ (at least 2	HMC: Agree		

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				system integrators to design systems for the test rather than a practical purpose. One approach is plumbing a TPRD back along the longitudinal axis of the tank to within 1.65 m of the other TPRD to ensure exposure during the engulfing portion. The engulfing fire should engulf the entire length of the container.	thermocouples within the localized fire…”	JAMA JARI - This item should be discussed in Task Force #4. TF 3 – Agree that this item should be discussed within TF 4.		
EC	6.2.5.2		te		Engulfing fire test: The test unit is the compressed hydrogen storage system. The storage system is filled with compressed hydrogen gas at 100 per cent NWP **(+2/-0 MPa)**. ….”	HMC: ≥100 per cent NWP JAMA JARI – Disagree with 100 per cent NWP (+2/-0MPa). Should be changed to ≥100%NWP. (Like the discussion at the last in-person meeting on Jun25.) TF 3 – Covered with addition of 100% state of charge requirement.		8/2/21 – This is resolved?
CSA	?		te	Storage systems containing repeating element tanks, i.e. 2 or more tanks of the same dimension and component and piping configuration, should be allowed to undergo a single tank pneumatic sequential test.		TF 3 – To be discussed TF 3 – HSS defined as a single container with primary closures, so there is no need for specific language allowing you to test only one container if the vehicle system utilizes more than one container of the same size. In other words, if you have three containers of the same dimensions, you only need to test one container. Include this discussion in the	n/a	RATIONALE – Done. Phase 2 Change #25 (8/2/21).

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						rationale section of the regulation (Part A section 3)		
PTL	6.2.6		ed	In this section the language changes to describe test targets as “not less than” and “not greater than” instead of “greater than” and “less than” or even ≤ and ≥. Since this is an international standard and to be consistent with the other test procedure sections, symbols should be used.	Remove “not less than” or “not greater than” language and replace with ≥ and ≤.			
Westport	6.2.6.1 6.2.6.1.1 6.2.6.2		te	Hydrogen quality (ISO 14687 or SAE J2719) used for testing is too stringent and unnecessary. If you’re trying to get bottled gas for a lab then this is not always possible, but you can order high purity hydrogen (i.e. 99.995%) that would be acceptable and meet the requirements even though it’s not labeled ISO/SAE. From the SAE J2579 and ISO 14687 tables the H2 purity must be ≥ 99.97%. The tables also show a maximum allowable concentration of the individual contaminants (i.e. methane < 100 µmol/mol, oxygen < 5 µmol/mol, etc.), but as long as the total non-hydrogen contaminants are below the requirement of 300 µmol/mol then it should be good for testing purposes. Most of the contaminants listed in the table are specific to fuel cell performance and degradation such as sulfur compounds, formaldehyde, etc. From previous H2 testing experience, the only real contaminants that could affect the results for these component tests would be water (potential sealing issues at -40C) and particulate concentrations.	Propose that hydrogen gas for the GTR tests meet either SAE J2719, ISO 14687-2(?), OR the following specs (based on the key SAE and ISO requirements): • Hydrogen fuel index: ≥ 99.97% • Total non-hydrogen gases: ≤ 300 µmol/mol • Water: ≤ 5 µmol/mol • Particle concentrations: ≤ 1 mg/kg	TF 3 - Agreed		

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CSA	6.2.6.1.1		te	Testing sequence incorrect	Recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.	HMC: Agree JAMA JARI – Agree. Furthermore the pressure conditions ≤2 MPa to ≥125% NWP is preferable TF 3 – Agree, and also agree with carrying over min and max temperature and pre ssure tolerances to component tests.		RATIONALE – Done for changing order, not for tolerances. Phase 2 Change #9
HEX	6.2.6.1.1		te	Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers"	At a sample temperature not less than 85 °C, the first 10 pressure cycles shall be from not greater than 2 MPa to not less than 150 percent of the manufacturer's specified nominal working pressure rating, followed by 2 240 pressure cycles from not greater than 2 MPa to not less than 125 percent of the manufacturer's specified nominal working pressure, followed by 10 000 pressure cycles at a sample temperature not less than 20 °C from not greater than 2 MPa to not less than 125 percent of the manufacturer's specified nominal working pressure, followed by a final 2 750 pressure cycles at a	TF 3 – Agreed Final wording – Five TPRD units undergo 15,000 internal pressure cycles with hydrogen gas having gas quality compliant with ISO 14687-2/SAE J2719 and at a rate not exceeding 10 cycles per minute. At a sample temperature not less than 85 °C, the first 10 pressure cycles shall be from not greater than 2 MPa to not less than 150 percent of the manufacturer's specified nominal working pressure rating, followed by 2 240 pressure cycles from not greater than 2 MPa to not less than 125 percent of the manufacturer's specified nominal working pressure,	X	Tolerances.xls

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					sample temperature not more than −40 °C from not greater than 2 MPa to not less than 80 percent of the manufacturer's specified nominal working pressure. The pressure cycling shall be performed with hydrogen gas at a rate not exceeding 10 cycles per minute.	followed by 10,000 pressure cycles at a sample temperature ~~**not less than**~~ **of** 20 °C ***(Westport: with appropriate tolerance)*** from not greater than 2 MPa to not less than 125 percent of the manufacturer's specified nominal working pressure, followed by a final 2,750 pressure cycles at a sample temperature not more than −40 °C from not greater than 2 MPa to not less than 80 percent of the manufacturer's specified nominal working pressure. Following this test, the pressure relief device shall comply with the requirements of the Leak Test (para. 6.2.6.1.8**.),** **Bench Top Activation Test (para. 6.2.6.1.9.), and** Flow Rate Test (para. 6.2.6.1.10.) and the ~~**Bench Top Activation Test (para. 6.2.6.1.9.).**~~ See Table 2 below for a summary of the pressure cycles.		

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				Table 2 — Pressure cycling conditions | Pressure cycles to % | No. of cycles | Sample temperatu[re] for cycles | | 2 MPa to 150 % | First 10 | 85 °C | | 2 MPa to 125 % | Next 2 240 | 85 °C | | 2 MPa to 125 % | Next 10 000 | 20 °C | | 2 MPa to 80 % | Final 2 750 | −40 °C | NOTE All cycles are conducted at a rate not greater than 10 cycles per minute.				
Emcara	6.2.6.1.2		te	Error in the equation (missing superscript or “to the power of” symbol)	T life= 9.1 x Tact^0.503. Emcara presentation yielded the following recommendation: The Accelerated Life test temperature is *TL*, given in °C by the expression: $T_L = \left(\frac{0.502}{\beta + T_f} + \frac{0.498}{\beta + T_{ME}}\right)^{-1} - \beta$ Where $\beta = 273.15$ if T is in Celsius and $\beta = 459.67$ if T is in Fahrenheit, T_{ME} is 85C (185F), and *Tf* is the manufacturer's specified activation temperature.	HPRD 1 is adopting revised formula (to be provided to GTR TF3 by CSA/Emcara) TF 3 – Agreed	X	RATIONALE – Placeholder: Phase 2 Change #11. 8/2/21 - LG to request revised from Emcara. The “entirety” should be included in Rationale.
CSA	6.2.6.1.2		te		Use of check valves to prevent pressure depletion should be optional since the failure of one sample results in the failure of the test.	TF 3 – Agree	X	Done 8/2
HEX	6.2.6.1.2		te	Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers"	Add following sentence: Pressure relief devices employing a glass bulb (thermobulb) or shape memory alloys (or other materials that do not exhibit creep	TF 3 – Reject comment		

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					rupture phenomena) for activation are exempted from this Clause.			
EC	6.2.6.1.2		ed		Accelerated life test. … and five at an accelerated life temperature, Tlife = 9.1 x Tact$^{0.503}$~~0.513~~. The TPRD is placed in …. The three TPRDs tested at **Tact**~~tact~~ shall activate in less than …"		X	
JARI	6.2.6.1.2		te	It will be necessary to use check valve to confirm the activation of TPRDs.	If a manifold system is used, each pressure connection includes a check valve to prevent pressure depletion of the system when one specimen **activates** ~~**fails**~~.	TF 3 – Reject, see above		
HEX	6.2.6.1.2		te	Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers"	The five TPRDs tested at Tlife shall not activate in less than 500 hours **and shall meet the requirements of 6.2.6.1.8 (Leak Test)**	TF 3 – Agreed	X	
CSA	6.2.6.1.3		te		Recommend specifying -40°C or lower, or -40°C (+0/-5°C).	HMC: ≤ -40℃ JAMA JARI – Should be unified by "-40 ° C or lower". TF 3 – Agreed to carry over pressure and temperature min max tolerances.		Tolerances.xls
CSA	6.2.6.1.4		te		Recommend accelerated cyclic corrosion test per ANSI HPRD 1 as this is a more representative automotive environment test.	Use pH 10 test JAMA JARI – Agree. TF 3 – Agree to include the accelerated cyclic corrosion test per ISO 19882. Note	X Exce	RATIONALE – Done 1/27 Phase 2 Change #10.

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						minor editorial comments to be provided by Graham Meadows GM: Below is the procedure from ISO 19982 (two minor edits in bold): Accelerated cyclic corrosion shall be performed in accordance with the following procedure: The pressure relief devices shall be exposed to an accelerated laboratory corrosion test, under a combination of cyclic conditions (salt solution, various temperatures, humidity, and ambient environment). The test method is comprised of 1 percent (approximate) complex salt mist applications coupled with high temperature, high humidity and high temperature dry off. One (1) test cycle is equal to 24 hours, as illustrated in Figure 1. The apparatus used for this test shall consist of a fog/environmental chamber, suitable water supply conforming to ASTM D1193	pt figure	8/2 - Copyright approval from CSA required and pending

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						Type IV, provisions for heating the chamber, and the necessary means of controlling temperature between 22 °C and 62 °C. The apparatus shall include provisions for a supply of suitably conditioned compressed air and one or more nozzles for fog generation. The nozzle or nozzles used for the generation of the fog shall be directed or baffled to minimize any direct impingement on the test samples. The apparatus shall consist of the chamber design as defined in ISO 6270-2. During “wet-bottom” generated humidity cycles, the testing agency must confirm that visible water droplets are found on the samples to verify proper wetness. Steam generated humidity may be used provided the source of water used in generating the steam is free of corrosion inhibitors. During steam generated humidity cycles, the testing agency must confirm that visible water droplets are		

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						found on the samples to verify proper wetness. The apparatus for the dry off stage shall have the ability to obtain and maintain the following environmental conditions: temperature: 60 ± 2 °C and humidity: ≤ 30 percent RH. The apparatus shall also have sufficient air circulation to prevent temperature stratification, and also allow thorough drying of the test samples. NOTE The force/impingement from this salt application should not remove corrosion or damage the coatings/paints system of test samples. **Figure 1 – Accelerated cyclic corrosion flow diagram *(Westport: see Figure copied below)*** The complex salt solution in percent by mass shall be as specified below: a) Sodium Chloride (NaCl): 0.9 % b) Calcium Chloride ($CaCl_2$): 0.1 % c) Sodium Bicarbonate ($NaHCO_3$): 0.075 %		

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						Sodium Chloride must be reagent grade or food grade. Calcium Chloride must be reagent grade. Sodium Bicarbonate must be reagent grade (e.g., Baking Soda or comparable product is acceptable). Water must meet ASTM D1193 Type IV requirements. NOTE Either $CaCl_2$ or $NaHCO_3$ material must be dissolved separately in water and added to the solution of the other materials. If all solid materials are added dry, an insoluble precipitate may result. The pressure relief devices shall be installed in accordance with the manufacturer's recommended procedure and exposed to the cyclic corrosion test method illustrated in the Flow Diagram (Figure 1). Repeat the cycle daily until 100 cycles of exposure have been completed. For each salt mist application, the solution shall be sprayed as an atomized mist, using the spray apparatus to mist the components until all areas		

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						are thoroughly wet / dripping. Suitable application techniques include using a plastic bottle, or a siphon spray powered by oil-free regulated air to spray the test samples. The quantity of spray applied should be sufficient to visibly rinse away salt accumulation left from previous sprays. **A total of four salt mist applications shall be applied during the ambient stage. Salt mist is not applied during any other stage of the test.** The first salt mist application occurs at the beginning of the ambient stage. Each subsequent salt mist application should be applied approximately ninety minutes after the previous application in order to allow adequate time for test sample to dry. Humidity ramp times between the ambient and wet condition, and between the wet and dry conditions, can have a significant effect on test acceleration (this is because corrosion rates are highest during these transition periods). The time from ambient to the wet condition shall be 60 + 5 minutes and the transition		

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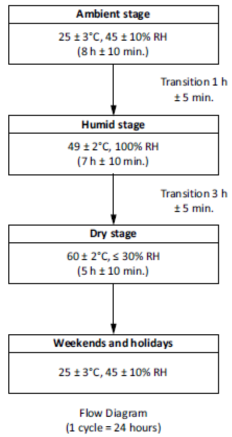
						time between wet and dry conditions shall be 180 + 10 minutes. ***Westport: This if updated Figure 1 that shows transition times more clearly (get official copy from CSA):*** **Figure 1** **Accelerated cyclic corrosion flow diagram** (See Clauses 7.5.1 and 7.5.3.)  		
CSA	6.2.6.1.4		te	Testing sequence incorrect	Recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.	TF 3 – Agree per above	X	Per above comment
HEX	6.2.6.1.4		te	Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers"		TF 3 – Agree per above	X	

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CSA	6.2.6.1.5		te	Unclear why sodium hydroxide and ammonium nitrate were added to vehicle environment test. Sodium hydroxide will react chemically and destroy aluminum (main body material of many PRDs) so a very difficult test if submerged (especially if conducted after sulfuric acid which affects anodized surfaces but does not cause mechanical degradation). Is this to check that aluminum coatings will prevent sulfuric acid interaction with bare aluminum? Methanol/gasoline is included in ANSI HPRD 1-2013 and ANSI HGV 3.1-2015 for vehicle crash scenarios, i.e. gasoline exposure from other cars.	Remove sodium hydroxide and ammonium nitrate	JAMA JARI – Agree. If testing with sodium hydroxide or ammonium nitrate is to be continued, It need to be described about the necessity of sodium hydroxide and ammonium nitrate. TF 3 – Keep the fluids but modify the procedure to allow for spray method only as described in HGV 3.1 – Revised per Stuttgart meeting – see next comment.		Rationale Phase 2 Change #12
HEX	6.2.6.1.5		te	Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers"	a) Sulfuric acid – 19 % solution by volume in water; b) Methanol/gasoline – 5 %/95 % concentration of M5 fuel meeting the requirements of Standard Specification for Automotive Spark-Ignition Engine Fuel, ASTM D4814; c) Windshield washer fluid (50 % by volume solution of methyl alcohol and water).	TF 3 – Agree TF3 – See WFS comment below. Change methanol to E10.	X	
CSA	6.2.6.1.5 (c)		te	Testing sequence incorrect	Recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.	JAMA JARI – Agree. TF 3 – Agree	X	
WFS	6.2.6.1.5 (also 6.2.6.2.5)		te	TF3 had previously agreed to the following fluids (comment from HEX per ISO 19882): a) Sulfuric acid – 19 % solution by volume in water; b) Methanol/gasoline – 5 %/95 % concentration of M5 fuel meeting the	"b) ~~Methanol/~~**Ethanol**/gasoline – ~~5 %/95 %~~ **10 %/90 %** concentration of ~~M5~~ **E10** fuel meeting the requirements of Standard Specification for Automotive Spark-Ignition Engine Fuel, ASTM D4814;"	TF 3 - Agree	X	8/2 – Rationale #12 - **E10** which is more representa tive for

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				requirements of Standard Specification for Automotive Spark-Ignition Engine Fuel, ASTM D4814; c) Windshield washer fluid (50 % by volume solution of methyl alcohol and water). HGV 3.1 under review is planning to update the M5 fluid to **E10** which is more representative for present fuels on the roads today. Note: HPRD 1 also has ethanol option. ISO standards should harmonize to E10 in next revision if GTR 13 makes this change.				present fuels on the roads today.
CSA	6.2.6.1.7		ed		Recommend clarifying that "Each unit is dropped in one of the six orientations (6 units = 6 orientations).	JAMA JARI – See JARI's proposal 6.2.6.1.7.		
CSA	6.2.6.1.7 (b)		te	Testing sequence incorrect	Recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.	JAMA JARI – Agree. TF 3 – Agree This and other 6.2.6.1.7 & 6.2.6.1.8 issues are addressed in Graham Meadows' document, which will be discussed along with NHTSA comments	Resolved below	
PTL	6.2.6.1.7		te	Suggest clarifying whether the TPRD may be dropped assembled to it's test jig or in a disassembled form.		JAMA JARI - Partly agreed. It is better to be able to use test jig but it needs to specify test jig TF 3 – Agree and suggest the following language in (a):		

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ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
						Six TPRD units representative of their final assembled form are dropped… One unit is dropped in six orientations without restricting its motion as a result of gravity…		
JARI	6.2.6.1.7		te	Current text can be read that each TPRD is dropped 6 times i.e. 36 times in total for 6 TPRDs.	Recommend should be selectable the following two options. Option 1) Each unit is dropped in one of the six orientations (6 units = 6 orientations). Option 2) One TPRD is dropped in 6 orientations (1 unit = 6 orientations) Here is the text: (a) Up to six TPRD units representative of their final assembled form are dropped from a height of 2 m or greater without restricting its motion as a result of gravity, at ambient temperature (20 ± 5°C) onto a smooth concrete surface. Each sample is allowed to bounce on the concrete surface after the initial impact. One unit is dropped in all six orientations (opposing directions of 3 orthogonal axes: vertical, lateral and longitudinal). Alternatively,	Graham Meadows to propose language to specify six samples = one orientation per sample OR one sample dropped in all six orientations. TF 3 – Accept. Also add language to indicate what to do when the part shows damage. HMC - Agree **Westport – Note that this was reviewed by NHTSA following Stuttgart meeting and was determined to have issues with enforceability as a Regulation.** **1. NHSTA would prefer to drop a sample in any one location – similar to the change**	Resolved By Next row	

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					up to six separate units may be used such that all six of the major axes are covered (i.e. one direction drop per sample). After each drop, the sample(s) shall be examined for visible damage. Any of the six dropped orientations that do not show visible exterior damage that indicates that the part is unsuitable for use, shall proceed to step (b); (b) Each of the ~~six~~ TPRD units dropped in step (a) that did not show visible damage and one additional unit not subjected to a drop are mounted in a test fixture in accordance with manufacturer's installation instructions and vibrated 30 minutes along each of the three orthogonal axes (vertical, lateral and longitudinal) at the most severe resonant frequency for each axis. The most severe resonant frequencies are determined using an acceleration of 1.5 g and sweeping through a sinusoidal frequency range of 10 to 500 Hz with a sweep time of ~~within~~ 10 minutes. The resonance frequency is identified by a pronounced	**recommendation for containers in 5.1.2.2/6.2.3.2 (Westport – recommends to finalize container procedure with TF3 then adjust wording for the TPRD drop test to similar requirements to containers… whether we go back to dropping six samples in one direction each or just drop one in "worst case" direction)** "show visible exterior damage that indicates that the part is unsuitable for use." **NHTSA indicated that this language is not enforceable (how does a technician determine this)... Westport – perhaps we say that any visible damage during drop it still has to continue on to vibration leak etc, except for cases where it cannot physically be installed after dropping (i.e. damage to threads that will not allow it to be installed).**		

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
					increase in vibration amplitude. If the resonance frequency is not found in this range, the test shall be conducted at 40 Hz. Following this test, each sample shall not show visible exterior damage that indicates that the part is unsuitable for use. It shall subsequently comply with the requirements of the Leak Test (para. 6.2.6.1.8.), Bench Top Activation Test (para. 6.2.6.1.9.), and Flow Rate Test (para. 6.2.6.1.10.) *Note: the Vibration test procedure for the shut-off valve and check valve (6.2.6.2.8) should be updated to include the same sine sweep as the TPRD shown above (10-500 Hz) since it is currently listed at 0-40 Hz. In both tests, the default value will remain at 40 Hz. For NGV 3.1/PRD 1, we are planning to move to the 40 Hz default value if no resonance frequency found from 10-500 Hz so this will likely change in HGV 3.1/HPRD 1 one year later.*			

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NHTSA	6.2.6.1.7		te	The updated TPRD drop test procedure allows one TPRD to be dropped in all six orientations, or alternatively, up to six separate TPRDs can be used for the six drops. Usually, when NHTSA has two options in a standard, the two options are of comparable stringency. In this case, conducting all six drops on one TPRD seems much more stringent that conducting one drop each on six TPRDs. What is the reason for providing these options when one option is much more stringent than the other? *8/2/21 - The reason is not to make it more stringent, but to make it more expedient to conduct the test.	Proposed language from Graham Meadows: a. TPRD units representative of their final assembled form are dropped from a height of 2 m or greater without restricting its motion as a result of gravity, at ambient temperature (20 ± 5°C) onto a smooth concrete surface. The TPRD is allowed to bounce on the concrete surface after the initial impact. Up to six separate units may be used such that all six of the major axes are covered (i.e. one direction drop per sample, covering the opposing directions of 3 orthogonal axes: vertical, lateral and longitudinal). Compliance testing can be performed in any of these six orientations. At	TF 3 – Agree	X	RATIONALE – 8/2 – Change #26 Done - The updated TPRD drop test procedure allows one TPRD to be dropped in all six orientations, or alternatively, up to six separate TPRDs can be used for the six drops. In this case, conducting all six drops on one TPRD

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					the manufacturer's discretion, one unit may be dropped in all six orientations. After each drop, the sample shall be examined for visible damage. Any of the six dropped orientations that do not have exterior damage that indicates that the part is unsuitable for use (i.e. threads damaged sufficiently that part is rendered unusable), shall proceed to step (b). Note: any samples with damage from the drop that results in the TPRD not being able to be installed (i.e. thread damage) shall not proceed to step (b) and shall not be considered a failure of this test. b. Each of the TPRD units dropped in step (a) that did not have visible damage and one			seems much more stringent that conducting one drop each on six TPRDs. *8/2/21 - The reason is not to make it more stringent, but to make it more expedient to conduct the test.

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					additional unit not subjected to a drop are mounted in a test fixture in accordance with manufacturer's installation instructions and vibrated 30 minutes along each of the three orthogonal axes (vertical, lateral and longitudinal) at the most severe resonant frequency for each axis. The most severe resonant frequencies are determined using an acceleration of 1.5 g and sweeping through a sinusoidal frequency range of 10 to 500 Hz with a sweep time of 10 minutes. The resonance frequency is identified by a pronounced increase in vibration amplitude. If the resonance frequency is not found in this range, the test shall be conducted at 40 Hz.			

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Date: 13 Oct 2021	Note:	Document#: **GTR13-XX-XX**

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					Following this test, each sample shall subsequently comply with the requirements of the Leak Test (para. 6.2.6.1.8.), Bench Top Activation Test (para. 6.2.6.1.9.), and Flow Rate Test (para. 6.2.6.1.10.)			
CSA	6.2.6.1.8		te		Recommend adding "Prior to conditioning the component shall be purged with nitrogen and sealed at 2.5 per cent of NWP."	JAMA JARI Korea - Partly agreed. Purge with nitrogen should be optional TF 3 - Disagree		
CSA	6.2.6.1.8		te		Recommend specifying that the unit is held for a sufficient time to ensure the bulk temperature of the unit meets the temperature requirements specified below.	JAMA JARI - Agreed. Sufficient time depends on test devices TF 3 – The unit is held for at least one hour and it is thermally stable at each temperature…	X	
CSA	6.2.6.1.8		te		Recommend specifying that the unit is immersed in a temperature controlled fluid <u>and monitored for leakage</u> (or equivalent method). See revised text here: **6.2.6.1.8. Leak test**	JAMA JARI - Agreed Adding monitor is acceptable. Basically it's sufficient with witness of the certifying officer. TF 3 – See comment below regarding harmonizing with 6.2.6.2.2	X	

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ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					~~A TPRD that has not undergone previous testing is tested at ambient, high and low temperatures without being subjected to other design qualification tests. The unit is held for one hour at each temperature and test pressure before testing. The three temperature test conditions are:~~ This test applies to one TPRD that has not undergone previous design qualification testing and additional units as specified in other tests in para. 6.2.6.1. The leak test is performed at ambient, high and low temperatures. The unit shall be thermally conditioned at each of the required test temperatures and held for at least one hour to ensure thermal stability before testing. The TRPD is pressurized with hydrogen at the inlet. The required test conditions are: (a) Ambient temperature: condition the unit at 20 (±5) °C; test at 5 percent NWP (+0/-2 MPa) and 150 per cent NWP ~~(+2/-0MPa)~~ or greater; (b) High temperature: condition the unit at 85 °C or higher; test at 5 percent NWP (+0/-2 MPa)	TF 3 – Agreed to adopt Graham Meadow's language **Westport – Note that NHSTA had comment regarding the following line:** "If bubbles are detected, the leak rate is measured by an appropriate method." **NHTSA comment: Need specification of what method in the GTR. Otherwise it is an unenforceable standard.** **Westport suggestion: change language to "If bubbles are detected, the leak rate is measured. ~~by an appropriate method.~~" No need to specify "appropriate method" since it is understood/implied that the measurement must be using an appropriate method (the same why that this is implied for measuring temperature and pressure).**		

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					and 150 per cent NWP ~~(+2/-0MPa)~~ or greater; (c) Low temperature: condition the unit at -40°C or lower; test at 5 percent NWP (+0/-2 MPa) and 100 per cent NWP ~~(+2/-0MPa)~~ or greater. ~~Additional units undergo leak testing as specified in other tests in para. 6.2.6.1 with uninterrupted exposure at the temperature specified in those tests.~~ ~~At all specified test temperatures, the unit is conditioned for one minute by immersion in a temperature controlled fluid (or equivalent method).~~ Following conditioning at each of the specified test temperatures, the unit is observed for leakage while immersed in a temperature controlled fluid (or equivalent method) for a minimum period of at least one minute at each of the test pressures listed above. If no bubbles are observed for the specified time period, the sample passes the test. If bubbles are detected, the leak rate is measured by an appropriate method.			

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					The total hydrogen leak rate shall be less than 10 NmL/hr.			
PTL	6.2.6.1.8 6.2.6.2.2		ed/te	"5 per cent NWP (+0/-2MPa)" 5% of 70MPa (+0/-2MPa) = 1.5 to 3.5 MPa 5% of 35MPa (+0/-2MPa) = -0.25 to 1.75 MPa	Suggest changing to ≤ 2MPa to stay consistent with container testing. Alternatively use ≤ 5%.	Graham Meadows to discuss with HGV3.1 TF 3 – Agreed change to ≤ 2MPa to stay consistent with container testing.		Tolerances.xls
CSA	6.2.6.1.9 6.2.6.1.10		te		Recommend three units instead of two to match the number of units required for the flow rate test.	JAMA JARI – Disagree. There is no need to match the number of new TPRD units between 6.2.6.1.9 and 6.2.6.1.10, so there is no need to change the current text. If the current text is changed, it is recommended to set two new TPRD units. TF 3 – Accept	X	RATIONALE – Done 1/27 Phase 2 Change #13
JAMA	6.2.6.1.9		ed	In the sentence below, "or" should be "and." *"Additional pre-tested units (pre-tested according to paras. 6.2.6.1.1., 6.2.6.1.3., 6.2.6.1.4., 6.2.6.1.5.* ***or*** *6.2.6.1.7.) undergo bench top activation testing as specified in other tests in para. 6.2.6.1.*	Additional pre-tested units (pre-tested according to paras. 6.2.6.1.1., 6.2.6.1.3., 6.2.6.1.4., 6.2.6.1.5. **and** 6.2.6.1.7.) undergo bench top activation testing as specified in other tests in para. 6.2.6.1.	HMC - Agree TF 3 – Agreed	X	
CSA	6.2.6.1.9 (c)		te		Recommend changing to "…two new (not pre-tested) TPRD units are pressurized to no more than 25 per cent NWP; and one new (not pre-tested) TPRD unit is pressurized to 100 per cent NWP."	JAMA JARI – Disagree. There is no need to match the number of new TPRD units between 6.2.6.1.9 and 6.2.6.1.10, so there is no need to change the current text.	X	RATIONALE – Done 1/27 Phase 2 Change #13

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ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
						If the current text is changed, it is recommended to set two new TPRD units. TF 3 – Agreed		
JAMA	6.2.6.1.9 (d)		te	At the TF3 meeting held on 4 March 2019, TF3 agreed to add one new (not pre-tested) TPRD unit which is pressurized to no more than 25 per cent NWP in Clause 6.2.6.1.9 (c) (Bench top activation time measurement test). Therefore, two values of baseline activation time will be obtained from the two new TPRD units that were pressurized to up to 25 per cent NWP. In Clause 6.2.6.1.9 (d), the baseline activation time is defined as follows: *"TPRD units previously subjected to other tests in para. 6.2.6.1. shall activate within a period no more than two minutes longer than the baseline activation time of the new TPRD unit that was pressurized to up to 25 per cent NWP."* So we need to redefine a new baseline activation time from the two values.	Recommend to define the baseline activation time by averaging the two values. So, recommend to modify Clause 6.2.6.1.9(d) as follows: "TPRD units previously subjected to other tests in para. 6.2.6.1. shall activate within a period no more than two minutes longer than the baseline activation time **which is defined as the averaged activation time** of the **two** new TPRD unit**s** that **were** pressurized to up to 25 per cent NWP."	HMC - Agree TF 3 – Agreed	X	
JAMA	6.2.6.1.9 (e)		te	The current requirement of benchtop activation test written in Clause 6.2.6.1.9(e) is *"The difference in the activation time of the **two** TPRD units that had not undergone previous testing shall be no more than 2 minutes."* As we added one TPRD unit that had not undergone previous testing, we need to redefine a new criterion among **three** values of activation time. The three values are	Recommend to define the new criterion as follows: "The **maximum** difference in the activation time of the **three** TPRD units that had not undergone previous testing shall be no more than 2 minutes."	HMC - Agree TF 3 – Agreed	X	

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ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
				obtained from two (not pre-tested) TPRD unit that were pressurized to up to 25 per cent NWP and one (not pre-tested) TPRD unit that was pressurized to 100 per cent NWP.				
TF 3	6.2.6.1.9		te	With the addition of the high pressure activation and flow test (3 samples) there is no longer a need to test a single sample at 100% NWP in this clause		TF 3 – Agreed, waiting for language suggestion from Graham Meadows **(Original text shown below in red with alterations in bold). Note: there was some difference above whether 2 or 3 samples for baseline, so I have gone with 3 samples from JAMA comment above (this is harmonized with new HPRD 1):** Bench top activation test ~~Two~~ **Three** new TPRD units are tested without being subjected to other design qualification tests in order to establish a baseline time for activation, **which is defined as the averaged activation time of these three units**. Additional pre-tested units (pre-tested according to paras. 6.2.6.1.1., 6.2.6.1.3., 6.2.6.1.4., 6.2.6.1.5. or 6.2.6.1.7.) undergo bench top activation testing as specified in other tests in para. 6.2.6.1.	X	Done 1/27 – Same as Phase 2 Change #13

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						(a) The test setup consists of either an oven or chimney which is capable of controlling air temperature and flow to achieve 600 (±10)°C in the air surrounding the TPRD. The TPRD unit is not exposed directly to flame. The TPRD unit is mounted in a fixture according to the manufacturer's installation instructions; the test configuration is to be documented; (b) A thermocouple is placed in the oven or chimney to monitor the temperature. The temperature remains within the acceptable range for two minutes prior to running the test; (c) **Prior to insertion, the TPRD unit is pressurized to no more than 25% NWP or 2 MPa, whichever is less. *(Westport: the 2 MPa option is for discussion with TF3…this is similar to the current test in HPRD 1 at 300 psi which is worst case vs 25% NWP)*** **(d)** The pressurized TPRD unit is inserted into the oven or chimney, and the time for the device to activate is recorded. ~~Prior to insertion into~~		

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
						~~the oven or chimney, one new (not pre-tested) TPRD unit is pressurized to no more than 25 per cent NWP (the pre-tested); TPRD units are pressurized to no more than 25 per cent NWP; and one new (not pre-tested) TPRD unit is pressurized to 100 per cent NWP;~~ ~~(d)~~ **(e)** TPRD units previously subjected to other tests in para. 6.2.6.1. shall activate within a period no more than two minutes longer than the baseline activation time ~~of the new TPRD unit that was pressurized to up to 25 per cent NWP;~~ (f) The **maximum** difference in the activation time of the ~~two~~ **three** TPRD units **that were used to determine the baseline activation time and** had not undergone previous testing shall be no more than 2 minutes.		
PTL	6.2.6.1.9		ed/te	New wording is “25% NWP or 2 MPa, whichever is less” 2MPa will always be less than 25%NWP unless NWP is <8MPa! 25% of 70 MPa: 17.5 MPa 25% of 35 MPa: 8.75 MPa 25% of 8 MPa: 2 MPa	Suggest using 2 MPa as 25% is outdated language from other standards	TF 3 – Agreed to use 2 MPa (+/- 1 MPa) Sections .9, .10, .11 will now be +/- 0.5 MPa		Tolerances.xls

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment[2]**	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
				Original wording was "no more than 25% NWP"				
EC	6.2.6.1.10		ed		Flow rate test (a) Eight TPRD units are tested for flow capacity. The eight units consist of three new TPRD units and one **TPRD**~~TRPD~~ unit from …"		X	
HEX	6.2.6.1.XX/ 6.2.6.1.11		te	Atmospheric exposure test missing for TPRDs. No provision for hydrogen exposure to non-metallic materials. Harmonize with section 6.2.6.2.6. for CV and shut-off-valves	**Atmospheric exposure test** The atmospheric exposure test applies to qualification of TPRDs if the component has non-metallic materials exposed to the atmosphere during normal operating conditions. (a) All non-metallic materials that provide a fuel containing seal, and that are exposed to the atmosphere, for which a satisfactory declaration of properties is not submitted by the applicant, shall not crack or show visible evidence of deterioration after exposure to oxygen for 96 hours at 70°C at 2 MPa in accordance with ASTM D572 or ISO 188 (standard test method for rubber- deterioration by heat and oxygen); (b) All elastomers shall demonstrate resistance to ozone by one or more of the following:	TF 3 – Agreed to include 6.2.6.2.6 for TPRDs	X	RATIONALE – Done 1/27 Phase 2 Change #14

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ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					(i) Specification of elastomer compounds with established resistance to ozone; (ii) Component testing in accordance with ISO 1431/1, ASTM D1149, or equivalent test methods			
NHTSA	6.2.6.1.11		ed	We need a statement similar to 6.2.6.1.6	"Test can be performed if testing agency does not know whether non-metallic material is exposed to atmosphere."			
HEX	6.2.6.1.XX/ 6.2.6.1.12		te	Add high pressure activation and flow test to the document. Harmonize test requirement with ISO 19882 "Gaseous hydrogen - thermally activated pressure relief devices for compressed hydrogen vehicle fuel Containers" Some pressure relief devices, in some tests, open and then reclose. This has been seen in bonfire tests with different devices and by various labs and has resulted in container rupture during the test. The opening characteristics, including the above noted conditions, are not consistent between different models of pressure relief devices. This may not itself be a problem, but the existing flow rating, namely a single flow value, implies that a given PRD flows a given amount, throughout its activation. This may lead to improper PRD selection. The two opening characteristics listed above are not consistent from test to test or unit to unit, so significant variation in the cumulative flow exists and is not tested for. This is counter to the assumption that a single	**High pressure activation and flow** Six devices must be tested to determine the flow performance when activated at high pressure with a large volume of gas. The test setup shall consist of a chimney which is capable of controlling air temperature and flow to achieve a consistent temperature of +600°C ± 10°C in the air surrounding the pressure relief device. The pressure relief device shall not be exposed directly to flame. The pressure relief device shall be mounted in a fixture that shall be documented. A volume of gas shall be installed ahead of the pressure relief device, in accordance with the manufacturer's installation instructions. The volume of gas shall be sufficient that the pressure relief device will vent	TF 3 – Agreed to include this test but reduce sample number to 3.		RATIONALE – Done 1/27 Phase 2 Change #15

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
				bonfire test is representative, and the requirement of ±5 % flow variation in the existing test. The current test is not representative of actual use, in that a tiny volume of gas at 25 % nominal working pressure is used in the test, avoiding any effect of the continuous flow, such as cooling, or other effects of the continuous flow and high pressure. This may overlook certain failure modes or create others. Both false high and false low values have been observed in testing.	down to 10 percent of the start pressure in no less than 10 seconds and shall be enough that the pressure relief device reaches a stable Cv before reaching 25 percent of starting pressure. The testing conditions for the new and aged pressure relief device comparison samples should be the same. Pressurize the pressure relief device to the manufacturer's specified nominal working pressure ± 2 percent. In the case of multiple rated nominal working pressures of a single design, the highest may be used as acceptable test conditions for all pressures. The gas temperature shall be below 40°C. The pressure of the stored gas shall be measured in such a way that it is not affected by flow past the pressure measurement device. Place a thermocouple in the chimney to monitor the temperature. The temperature shall remain within the acceptable range for two minutes prior to running the test. Insert the pressure relief device into the chimney. Record the pressure over time from the point of insertion into the chimney until venting is complete. The graph of the pressure data for all devices must be made			

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					available in the component literature. The flow of the devices shall not stop until the tank is below 1 MPa.			
NHTSA	6.2.6.1.12		te	6.2.6.1.12 is redundant with fire test 6.2.5.	Remove 6.2.6.1.12	TF 3 – Keep as a CP option – need language.		
PTL	6.2.6.1.12		ed/te	New high pressure activation and flow section from HPRD1. PRD pressure is “NWP ± 2 per cent”, which is harmonized with HPRD1, but inconsistent with the ≤/≥ convention that is now being used throughout the GTR.	Change to “≥100 per cent NWP” to stay consistent within GTR or leave as is to stay harmonized with HPRD1:2020 and ISO 19882?	TF 3 – Reject the suggested language		
CSA	6.2.6.2.3 (c)		ed		Add “hydrostatic” to “…and the <u>hydrostatic</u> strength test (para 6.2.6.2.1).”		X	
CSA	6.2.6.2.2		te	Last paragraph	Recommend specifying that the unit is immersed in a temperature controlled fluid and monitored for leakage (or equivalent method). See added text here: **6.2.6.2.2. Leak test** This test applies to one unit that has not undergone previous design qualification testing ~~is tested at ambient, high and low temperatures without being subjected to other design qualification tests. The three~~	This is an external leak test only. Internal leakage of check valve and shut off valve is needed. TF 3 – Agreed to add internal leakage tests per CSA HGV 3.1 for OTV and CV, not for TPRD. JAMA JARI - Agreed. Adding monitor is acceptable.	X	RATIONALE – Placeholder 1/27 Phase 2 Change #16

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					~~temperature test conditions are:~~ and additional units as specified in other tests in para. 6.2.6.2. The leak test is performed at ambient, high and low temperatures. The unit shall be thermally conditioned at each of the required test temperatures and held **pressurized to at least 2 MPa** for at least one hour to ensure thermal stability before testing. The outlet opening is plugged with the appropriate mating connection and pressurized hydrogen is applied to the inlet. The required test conditions are: (a) Ambient temperature: condition the unit at 20 (±5) °C; test at 5 percent NWP (+0/-2 MPa) and 150 per cent NWP ~~(+2/-0MPa)~~ or greater; (b) High temperature: condition the unit at 85 °C or higher ; test at 5 percent NWP (+0/-2 MPa) and 150 per cent NWP ~~(+2/-0MPa)~~ or greater; (c) Low temperature: condition the unit at -40°C or lower; test at 5 percent NWP (+0/-2 MPa) and 100 per cent NWP ~~(+2/-0MPa)~~ or greater.	Basically it's sufficient with witness of the certifying officer. TF 3 – Modify 6.2.6.1.8 and 6.2.6.2.2 to include conditioning for at least one hour, and exposure for 1 minute to check for leakage (per HPRD 1). Graham Meadows will draft language. TF 3 – Agreed to add Graham Meadow's language HMC to come back with thoughts on red bold – "pressurized to at least 2 MPa" HMC comment withdrawn		

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
				HMC-while soaking samples at each temp. prior to leak test, then the leak test results may vary depending on whether the test jig is pressurized in advance. Therefore, propose minimum pressure for soaking.	~~Additional units undergo leak testing as specified in other tests in para. 6.2.6.2 with uninterrupted exposure at the temperature specified in those tests.~~ ~~The outlet opening is plugged with the appropriate mating connection and pressurized hydrogen is applied to the inlet. At all specified test temperatures, the unit is conditioned for one minute by immersion in a temperature controlled fluid (or equivalent method).~~ Following conditioning at each of the specified test temperatures, the unit is observed for leakage while immersed in a temperature controlled fluid (or equivalent method) for a minimum period of at least one minute at each of the test pressures listed above. If no bubbles are observed for the specified time period, the sample passes the test. If bubbles are detected, the leak rate is measured by an appropriate method. The leak rate shall not exceed 10 Nml/hr of hydrogen gas.			

ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
					" ~ the unit shall be thermally conditioned at each of the required test temperatures and held pressurized to ≤0.2MPa* for at least one hour to ensure thermal stability before testing. ~" ** Please refer to suggestion on 6.2.2.2*			
CSA	6.2.6.2.3 (a)		ed		Change "the valve unit **are** installed…" to "the valve unit **is** installed…"		X	
CSA	6.2.6.2.3 (a) (ii)		te	Clause 6.2.6.2.3(a) (ii) This is not a proper operational cycle for a shut-off valve.	Recommend using the same cycling procedure as ANSI HGV 3.1-2015 "Each duty cycle shall consist of filling through the inlet port. ~~The inlet line shall then be depressurized.~~ The automatic container valve shall be opened and closed within a period of 10 ± 2 seconds. During the off cycle, the downstream pressure of the test fixture shall be reduced to 50 percent of the test pressure."	JAMA JARI – Agree Because it is difficult to understand the part "The inlet line shall then be depressurized.", please explain clearly. TF 3 – Agreed but with sentence stricken as shown. 50% degradation to be reviewed by CSA HGV 3.1 TAG.		RATIONALE? Placeholder 1/27 Phase 2 Change #17
CSA	6.2.6.2.4		te		Recommend accelerated cyclic corrosion test per ANSI HPRD 1 as this is a more representative automotive environment test.	JAMA JARI - On hold. A description of a specific cyclic corrosion test based on ANSI HPRD 1 is required. We want to judge by looking at specific description.	X Except	Done 1/27 – combined with prev rationale for TPRD 8/2 – Copyright

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Date: 13 Oct 2021	Note:	Document#: **GTR13-XX-XX**

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
						TF 3 – Need to circulate proposed language for the test. TF 3 – Also need to make sure corrosion test is consistent between OTV, CV and TPRD. **Westport: Note that the TPRD procedure from ISO 19882 is shown above with a couple small corrections per HPRD 1. This procedure should also be applicable to OTV and CV and will be harmonized with HGV 3.1** **TF 3 – Agreed to use test procedure from 6.2.6.1.4 above with mods to reflect “shutoff valves and check valves”**	Figure	pending CSA
EC	6.2.6.2.4. (a)		ed		The component ~~must now~~ **shall not** show signs of …”		X	
CSA	6.2.6.2.5 (a)		te	Clause 6.2.6.2.5(a) unclear why sodium hydroxide and ammonium nitrate were added to vehicle environment test. Sodium hydroxide will react chemically and destroy aluminum (main body material of many shut-off valves) so a very difficult test if submerged (especially if conducted after sulfuric acid which affects anodized surfaces but does not cause mechanical degradation).	Delete sodium hydroxide and ammonium nitrate, adding methanol/gasoline	JAMA JARI – Agree. If testing with sodium hydroxide or ammonium nitrate is to be continued, It need to be described about the necessity of sodium hydroxide and ammonium nitrate	X	Done 1/27 – combined with rationale for TPRD

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				Is this to check that aluminum coatings will prevent sulfuric acid interaction with bare aluminum? Methanol/gasoline is included in ANSI HPRD 1-2013 and ANSI HGV 3.1-2015 for vehicle crash scenarios, i.e. gasoline exposure from other cars.		TF 3 – Disagree, leave the chemicals as is since they are the same as the hydraulic sequential exposures for the container **GM: Note that the automotive fluids were updated for TPRD based on ISO 19882 (HEX comment for 6.2.6.1.5)…OTV and CV should have same chemicals as TPRD in 6.2.6.1.5 shown above.** **TF 3 – Agree to harmonize with chemicals from 6.2.6.1.5**		
CSA	6.2.6.2.6 (a)		te	Recommend adding ISO 188 as this is a similar test procedure to ASTM D572.		JAMA JARI – Agree TF 3 – Agree	X	
CSA	6.2.6.2.6 (a)		te	No provision for hydrogen exposure to non-metallic materials.	**Non-metallic material hydrogen immersion test** Non-metallic materials used in a component that are exposed to hydrogen gas shall be subjected to the test described below, except where the applicant submits a test result declaration for tests carried out on the material provided by the manufacturer. A part made of non-metallic material, which is in contact	TF 3 – Wait for proposal for modified NGV 3.1 test procedure for CNG exposure – Graham Meadows TF 3 – Reject. Difficult to establish an effective test procedure. Sample stability in question after the exposure. Add rationale/discussion – not necessary for regulatory		RATIONALE – Done 1/27 combined w/TPRD

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					with hydrogen during normal service, shall not show excessive change in volume or weight when tested in accordance with the following procedure. Prepare, measure and weigh one or more representative samples of each non-metallic material used in a component, then immerse the sample or samples at room temperature in hydrogen gas, at a pressure equal to its nominal working pressure, but not less than 100 kPa, for a minimum of 70 h. Immediately following this period of immersion, the test pressure shall be reduced to atmospheric pressure in less than 5 minutes without causing shredding or disintegration. The test samples(s) shall be measured and weighed within one hour of pressure reduction. No tested sample shall exhibit swelling greater than 25 % or	language – more appropriate for industry standards. Consider the reference to CHMC 2 in the future. Pressure cycle tests are conducted with hydrogen gas as part of the regulatory test.		

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					shrinkage greater than 1 %. The weight loss shall not exceed 10 %.			
PTL	6.2.6.2.7 (a)		te	Not all solenoid valves are 12 V or 24 V systems.	Recommend changing the opening voltage requirement from "…9v for a 12V system or equal to 18V for a 24 V system" to "the minimum opening voltage at NWP at room temperature shall be less than or equal to 66% of the nominal system voltage."	JAMA JARI – Is not "equal to 75%" rather than "equal to 66%"?. TF 3 – After further discussion, agreed to delete the sentence related to minimum opening voltage requirement: "~~The minimum opening voltage at NWP and room temperature shall be less than or equal to 9 V for a 12 V system and less than or equal to 18 V for a 24 V system.~~"	X	
NHTSA	6.2.6.2.8		te	No provision for leak testing at extreme temperatures.		JAMA JARI – Disagree Vibration test of Shut valve / Check Valve does not require extreme temperatures. TF 3 – Add extreme temperature leak tests, but review other performance tests that also require ambient temperature leakage test only (and modify to include extreme temperature leakage). Make sure OTV/CV and TPRD is harmonized re vibration test procedure and leakage tests	X	

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WFS	6.2.6.2.8		te	Vibration test currently requires 100% NWP with hydrogen. Safety consideration for labs performing this test especially if conducting indoors. Suggestion to harmonize with HGV 3.1 to allow inert gases for the vibration test. Note that components will still need to perform leak tests with appropriate leak test gas.	"The valve unit is pressurized with ≥100 per cent NWP with hydrogen, **helium, or blends of a minimum 5 per cent hydrogen with nitrogen** and sealed… "	TF 3 - agreed	X	
CSA	6.2.6.2.9		te		Recommend specifying this test is only applicable to valve units containing copper-based alloys exposed to the outside environment. This is not applicable to components containing copper-based alloy internal components (not exposed to the outside environment).	JAMA JARI – Agree TF 3 - Agree	X	
NHTSA	6.2.6.2.10		te	No provision for testing at extreme temperatures		JAMA JARI – Disagree In the Pre-cooled hydrogen exposure test, the gas temperature of -40 ° C. is considered. This is a sufficient consideration, extreme temperature is not necessary. TF 3 – Add extreme temperature leak tests	X	
EC	6.3.1.2.2.3 .4		te		Fourth step If V1 is greater than or equal to V2, … ~~The resulting Ri, which is the electrical isolation resistance value (in Ω), is divided by the~~	Electrical Tests to be removed from UN GTR 13	X	

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					~~working voltage of the high voltage bus in volt (V):~~ ~~Ri Ω / V = Ri Ω / Working voltage (V)~~ … If V2 is greater than V1, … ~~The resulting Ri, which is the electrical isolation resistance value (in Ω), is divided by the working voltage of the high voltage bus in volts (V).~~ ~~Ri Ω / V = Ri Ω / Working voltage~~ …" *In Table 3,* the reference to the figure, amend to read: "~~See Fig. 1 for full dimensions~~ **See Fig. 11 for full dimensions"** *In Figure 11,* the dimensions of the toe of the joint test finger, amend to read: "~~R2=0.05 cylindrical~~ **R2±0.05 cylindrical** ~~R4=0.06 spherical~~ **R4±0.05 spherical"** *Figure 12,* amend the title and replace the figure with: "Figure 12 Example of the test method using D.C. power supply, voltmeter and ammeter			

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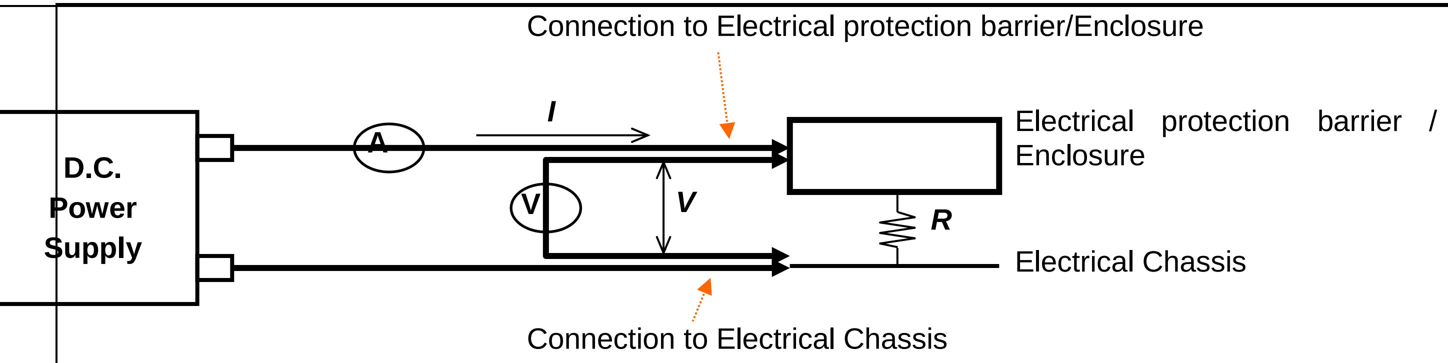

EC	7.2.4.2		te		Shut-off valves qualification requirements … The ~~valve~~ **shut-off devices** shall meet …"	Electrical Tests to be removed from UN GTR 13	X	
EC	7.3		ed		LHSS fuel system integrity … with the exception of para. 5.2.1.1.**1.** The fuelling receptacle label shall …"	Electrical Tests to be removed from UN GTR 13	X	
EC	7.4.1.2		ed		Baseline initial burst pressure …. if at least one of the two passing criteria described in para. **7.2.1.2.**~~5.2.1.2.~~ is fulfilled. …"	Electrical Tests to be removed from UN GTR 13	X	
EC	7.4.2.3		ed		Vacuum loss test … (d) The line downstream the first ~~safety~~ **pressure** relief device is blocked and … … For steel containers the second part of the test is passed if the second**ary** pressure relief device does not open below 110 per cent of the set pressure of the first ~~safety~~ **pressure** relief device and limits the pressure in the	Electrical Tests to be removed from UN GTR 13	X	

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					container to a maximum 136 per cent of the MAWP if a safety valve is used, or, 150 per cent of the MAWP if a burst disk is used as the second**ary** ~~safety~~ **pressure** relief device. For other container materials, an equivalent level of safety shall be demonstrated."			
EC	7.5.1		ed		Post-crash leak test for the liquefied hydrogen storage systems … ... Exhaust from the venting of the pressure controls or the PRDs shall not be vented to the passenger **or**~~,~~ luggage~~, or cargo~~ compartments during …"	Electrical Tests to be removed from UN GTR 13	X	
Quantum	6.2.2.2		te	The container manufacturer may specify a hydraulic pressure cycle profile that will prevent premature failure during the test.	Add: (e) The container manufacturer may specify a hydraulic pressure cycle profile that will prevent premature failure of the container due to test conditions outside of the container design envelope.	TF - Agree	X	RATIONALE – Done 1/27 Phase 2 Change #19
NHTSA	5.1.2.2/6.2.3.2		te	Proposed revision of the drop test per NHTSA comment submitted Sep. 11, 2019.	5.1.2.2. Drop (impact) test The storage container is dropped once in one of the impact orientations specified in para. 6.2.3.2. 6.2.3.2. Drop (impact) test (unpressurized) The storage container is drop tested at ambient temperature without internal pressurization or	TF 3 is conflicted with regards to modifying the test as proposed. TF 3 – Agree to maintain four drop orientation requirement and agree to NHTSA language.	X except	8/2 – To be replaced with drop test procedure from CTSG RATIONALE – The

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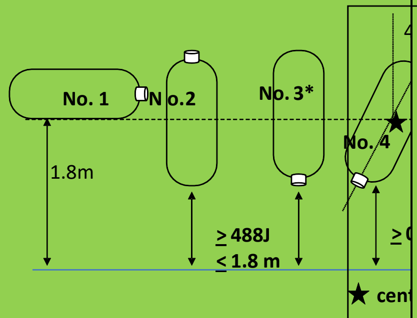
					attached valves. The surface onto which the containers are dropped shall be a smooth, horizontal concrete pad or other flooring type with equivalent hardness. No attempt shall be made to prevent a container from bouncing or falling over during a drop test, but the container shall be prevented from falling over during the vertical drop test. (a) The container shall be dropped in any one of the following four orientations: (i) From a horizontal position with the bottom 1.8 m above the surface onto which it is dropped; (ii) From a vertical position with the ported end upward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m; (iii) From a vertical position with the ported end downward with a potential energy of not less than 488 J, with the height of the lower end no greater than 1.8 m. If the container is symmetrical (identical ported ends), this drop orientation is not required; (iv) From a 45° angle from the vertical orientation with a ported end downward with its centre of gravity 1.8 m above the ground. However, if the bottom is closer to the ground than 0.6 m, the drop angle shall be changed to		the yellow	redline still has 1 drop. Needs to be corrected. Placeholder 1/27 Phase 2 Change #20

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					maintain a minimum height of 0.6 m and a centre of gravity of 1.8 m above the ground. The four drop orientations are illustrated below. Figure 5 **Drop orientations**  This section is deleted: If more than one container… and all following.			
NHTSA/ PTL	6.2.3.2 (ii) & (iii)		te	Wording is inconsistent. For light containers, at least 488J and not more than 1.8 m cannot simultaneously be achieved.	Revise statement. We believe the intent was at least 488J, unless the height would exceed 1.8m, then just use 1.8m and whatever lower energy level that results in	TF 3 – PTL to review wording and suggest alternative 1.8m intended as human-factor but concern with larger vessels – need to determine the controlling parameter. TF 3 – Tanja to share revised wording.		
EMC	6.2.6.1.8		ed	fluid can be liquid and gas but liquid should be used to visualize bubbles	"immersion in a temperature controlled fluid" should be "immersion in a temperature controlled **liquid**"		X	

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EMC	6.2.6.2.9		ed	we had a discussion at HPRD1 that copper alloys cover a wider range of alloys than copper-based alloys which includes only brass and bronze probably	all " copper-based alloy" terms should change to "copper alloys"		X	
TMC	6.2.3.4		ed	“Section 6.2.3.4. Chemical Exposure and ambient temperature pressure cycling test Each of the 5 areas of the unpressurized container preconditioned by pendulum impact (paragraph 6.4.2.5.2.) is exposed to one of five solutions…” ** There’s no paragraph 6.4.2.5.2. The pendulum impact is 6.2.3.3.(b)	Each of the 5 areas of the unpressurized container preconditioned by pendulum impact (paragraph **6.2.3.3.(b)**) is exposed to one of five solutions…”		X	
Nikola	5.2.1.4.3		te	The actionable leak percentages overlap, which results in confusion. The warning level is from 1 to 3%, whereas the valve closure level is 2 to 4%. Note the overlap in the region between 2 and 3%: If, during operation, a single failure results in a hydrogen concentration exceeding 2 ± 1.0 per cent by volume in air in the enclosed or semi-enclosed spaces of the vehicle, then a warning shall be provided (para. 5.2.1.6.). If the hydrogen concentration exceeds 3 ± 1.0 per cent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the main shutoff valve shall be closed to isolate the storage system. (para. 6.1.3. test procedure).	Suggest the following revision to achieve the following result: <4% issue warning >4% close shutoff valve If, during operation, a single failure results in a hydrogen concentration exceeding 2 ~~± 1.0~~ per cent by volume in air in the enclosed or semi-enclosed spaces of the vehicle, then a warning shall be provided (para. 5.2.1.6.). If the hydrogen concentration exceeds 3 ~~± 1.0~~ per cent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the	~~TF 3 – agrees with the following revision:~~ ~~<4% issue warning~~ ~~>4% close shutoff valve~~ ~~Also modify test requirements in 6.1.3 to reflect a test at 3+/-1% and at >4%~~ --- TF 3 – Agree to follow R134: If, during operation, a single failure results in a hydrogen concentration exceeding 3,0 per cent by volume in air in the enclosed or semi-enclosed	X	RATIONALE – Done 1/27 Phase 2 Change #21 Redline change to reflect R134 language done 8/2/21

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					main shutoff valve shall be closed to isolate the storage system. (para. 6.1.3. test procedure). ____________________ Suggest additional discussion on the topic – follow R134 clause 7.1.4.3: If, during operation, a single failure results in a hydrogen concentration exceeding 3,0 per cent by volume in air in the enclosed or semi-enclosed spaces of the vehicle, then a warning shall be provided (paragraph 7.1.6). If the hydrogen concentration exceeds 4,0 per cent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the main shut-off valve shall be closed to isolate the storage system.	spaces of the vehicle, then a warning shall be provided (paragraph 7.1.6). If the hydrogen concentration exceeds 4,0 per cent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the main shut-off valve shall be closed to isolate the storage system.		
NHTSA	3.XX		te	Need a definition for SOC	See definition at end of this table	TF 3 – Agree with definition but remove the link and add a table of values to the first decimal place. Shashi / Ian to provide table	X	
NHTSA	6.2.2.2 (b)		te	The text is not correct. “The container and fluid are stabilized at the specified temperature and relative humidity at the start of testing; the environment, fuelling fluid and container skin are maintained	The container and fluid are stabilized at the specified temperature and relative humidity at the start of testing; the environment~~,~~ **and** ~~fuelling~~	JAMA JARI – Disagree We understand that NHTSA's concern lies in the ambiguity of the text “The container	?	

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				at the specified temperature for the duration of the testing. The container temperature may vary from the environmental temperature during testing;" How can the container temperature be maintained and also allowed to vary?	**hydraulic** fluid **at the inlet to the container** ~~and container skin~~ are maintained at the specified temperature for the duration of the testing. The container **skin** temperature may vary from the environmental temperature during testing **by up to 5%;**	temperature may vary from the environmental temperature during testing" This sentence is a position like advice, and there is a specific value for each, so this sentence is not necessary. Also, it is not appropriate to specify the temperature range of the container skin as a percentage. Therefore, JAMA-JARI suggests changing to the following description. "(b) The container and fluid are stabilized at the specified temperature and relative humidity at the start of testing; the environment, hydraulic fluid at the inlet to the container and container skin are maintained at the specified temperature for the duration of the testing." TF 3 – Comment addressed via less than or equal to and greater than		

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
						or equal to requirements for temperature.		
NHTSA	6.2.6.2.7(a)(iii)		te	Specifies no external leakage, but no leak test. Should it refer to 6.2.6.2.2?				
NHTSA	5.1.5.2 (i) & 6.2.6.2.9		te	"This test is only applicable to valve units containing copper alloys exposed to the outside environment. This is not applicable to components containing copper alloy internal components (not exposed to the outside environment)." How would a tester know if a valve unit contains copper? Why can't this test just be applied to all valve units? If the unit does not have copper alloys, it should pass the test.	Make the test applicable to all valve units. If it can't apply to all valves, we need a test to check for copper content. Also, in that case, the exemption for non-copper containing valves should be in 5.1.5.2, not the test procedure.	TF 3 – CP option to perform this test – need language for this option NHTSA prefers to run this test Graham Meadows to review various SCC test procedures and suggest appropriate method. Graham Meadows - Approx. 20 different standards reviewed for CNG and H2 – proposed to leave it as is TF 3 – Agreed to leave as currently written in GTR TF 3 – Test can be performed if testing agency doesn't know whether copper is present	X	
NHTSA	5.1.1.2 5.1.2.4 5.1.2.6		ed	Why are some cycles capitalized as "Cycles"?	All cycles lowercase.		X	

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NHTSA	5.1.1.2		te	This goes along with the proposed change to the drop test above (5.1.2.2/6.2.3.2). If the drop test is changed as proposed above, there is no need for 3 containers to be tested in 5.1.1.2 baseline initial cycle life.	Only test one container in 5.1.1.2			
NHTSA	Throughout		te	We feel the use of > and < signs is problematic.	We suggest selecting specific tolerance limits for each case where tolerance limits are needed.	JAMA JARI - On hold There are many items that use of > and < signs in the test procedure, and having too narrow tolerance limits can make the test difficult to perform. Therefore, it is unrealistic to discuss the specific tolerance limits of all items from now on. What clauses does NHTSA think require the specific tolerance limits? JAMA-JARI think it is realistic to discuss the specific tolerance limits for limited clauses.		Tolerances.xls
NHTSA	Throughout		ge	Whenever we use a reference to ISO, SAE, ASTM, etc., we need to select an edition date.	Search all references in the text and select edition dates for them.	TF 3 – Agree (Over to TF 0)		8/2/21 – THIS NEEDS TO BE ASSIGNED

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ORG	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations/Actions**	**RL**	**Ration-ale**
OICA	New	Change of Design Table	te	There is a change of design table in (Table IV.3.11) in EU 406/2009 to define the required tests for the design change. There is no change of design provision in GTR 13 (ECE R134)	Changed Item — Required tes Fiber manufacturer: - Initial burst, Initial pressure cycle life - Sequential hydraulic tests Metallic container or liner material: - Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test Plastic liner material: - Sequential hydraulic tests - Sequential pneumatic tests Fiber material: - Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test Resin material: - Sequential hydraulic tests Diameter change ≤20%: - Initial burst, Initial pressure cycle life Diameter change >20%: - Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test Length change ≤50%: - Initial burst, Initial pressure cycle life Length change >50%: - Initial burst, Initial pressure cycle life - Sequential hydraulic tests - Fire test Nominal working pressure change: - Initial burst, Initial pressure cycle life - Fire test Dome shape: - Initial burst, Initial pressure cycle life - Sequential pneumatic tests Opening size: - Initial burst, Initial pressure cycle life Coating change: - Sequential hydraulic tests End boss design: - Sequential pneumatic tests Change in manufacturing process: - Initial burst, Initial pressure cycle life Fire protection system: - Fire test			8/2/ - DELETE RATIONALE? – Placeholder in section D.42. Phase 2 Change #22
PTL	-		te	As containers increase in size because of the industry shift towards heavy duty applications, testing will become more time consuming. If the test container volume were to be reduced by using a filler material, test durations could be shortened. There is currently nothing in the regulation that allows for something like this.	Include a clause to the effect of: "Container volume may be reduced by X% by using a filler material." A rationale must be formed as to what reduction percentage still allows for equivalent thermodynamic behaviour to an in-service container. Example standards: ISO 11515 Gas cylinders — Refillable composite reinforced tubes of water capacity between 450L and 3000L — Design, construction and testing (This test is required for all Type 4 tubes. A representative tube can be tested with the same diameter as the prototype tube but with a cylindrical length of at least twice the diameter of the prototype. Wrapping pattern of the subscale tube shall be representative of the prototype actual tube)	TF 3 – Concept is "interesting" but how to validate it? PTL to locate rationale for volume reduction in other documents. TF 3 – Tabled pending new information becomes available (research activities possibly underway soon).		

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					ISO 19884 Gaseous hydrogen — Cylinders and tubes for stationary storage (Where indicated, tests may be performed on full scale diameter pressure vessels of shorter length; however, the L/D ratio of sub-scale units shall be greater than 2,5. If the full scale cylinder L/D ratio is less than 2,5, a full scale cylinder is required. The winding pattern of the sub-scale unit shall be the same as the full scale pressure vessel) ISO/FDIS 17519 Gas cylinders — Refillable permanently mounted composite tubes for transportation (One tube shall be tested in accordance with, and meet the requirements of, A.19. The length to diameter ratio of the sub-scale shall be within ±30 % of the full scale tube. A sub-scale tube, as defined in 6.5.2.1.2, may be used in place of a full size tube for this test) It also must be determined which tests this would be applicable to. For example, pneumatic cycling only. SAE J2579 - Internal Volume Reduction. The opportunity to reduce the tank internal volume by using filler material is included in the test procedure to reduce test time and reduce risk to test			

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					facilities. For 70 MPa tanks of >1 kg hydrogen capacity, the pneumatic cycle time (in the absence of filler material) could be ~ 3 hours with realistic temperature profiles, so a failure at as little as 11000 cycles would require >3000 hours (18 weeks) to produce.			
OICA	3.3.10	Definition	te	Current definition of "Date of Manufacture" should be aligned more closely with EU406/2010 and reflect wide-scale manufacturing conditions.	Date of manufacture (of a compressed hydrogen container) is the date (month and year) of the proof pressure test ~~carried out during manufacture~~ or final inspection test carried out by the container manufacturer.	TF 3 - Agreed	X	
CSA	6.2.6.1		te	Not all tests in 6.2.6.1 require H2. Suggest updating this clause to cover inert gas where applicable (proposed chance also includes the H2 gas quality addressed in a previous comment already accepted by TF3). Also added details about leak test gas using EU 406 (EC 79) definition.	Update this clause as follows: Testing is performed with **either** hydrogen **or inert** gas **as specified in the following paragraphs**. **Hydrogen gas shall be** compliant with ISO 14687/SAE J2719 **or meet the following specifications:** • **Hydrogen fuel index: ≥ 99.97%** • **Total non-hydrogen gases: ≤ 300 µmol/mol** • **Water: ≤ 5 µmol/mol** • **Particle concentrations: ≤ 1 mg/kg** **Leak test gas shall be hydrogen, helium, or an inert gas mixture containing a demonstrated**			

ORG	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations/Actions	RL	Ration-ale
					detectable amount of helium or hydrogen gas. All tests are performed at ambient temperature 20 (±5)°C unless otherwise specified. The TPRD qualification performance tests are specified as follows			
CSA	6.2.6.1.1		te	Pressure cycling – is hydrogen gas required for pressure cycling test or would inert be acceptable? Note: leak check at end of cycling is performed with hydrogen or helium. HGV 3.1 is updating such that inert gas is acceptable for cycling provided that manufacturer can demonstrate that materials are hydrogen compatible.	Update first paragraph as follows: *Five TPRD units undergo 15,000 internal pressure cycles with hydrogen* ***or inert*** *gas ~~having gas quality compliant with ISO 14687-2/SAE J2719~~ and at a rate ≤10 cycles per minute.* Note: removed gas quality details since this is already covered in 6.2.6.1 above.			
CSA	6.2.6.1.2		te	New Accelerated Life Formula (from HPRD 1) has °C and °F option.	°C is sufficient for GTR (and used everywhere else). Remove °F as follows: *"Where β = 273.15 ~~if T is in Celsius and β = 459.67 if T is in Fahrenheit~~, T_{ME} is 85 °C ~~(185 °F)~~, and…"*			
CSA	6.2.6.1.2		te	Is hydrogen gas required for Accelerated Life test or would inert gas be acceptable? See comment for 6.2.6.1 permissible gases. It is temperature/pressure that cause PRD creep, independent of gas type.	Amend as follows: *"The ~~hydrogen~~ gas pressure on the TPRD inlet is ≥125 per cent NWP."* Alternatively: *"The hydrogen* ***or inert*** *gas pressure on the TPRD inlet is ≥125 per cent NWP."*			

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CSA	6.2.6.1.3		te	Thermal Cycle test: is hydrogen gas required for the pressure cycles in this or would inert gas be acceptable? Similar comment to pressure cycling test in 6.2.6.1.1 above. See comment for 6.2.6.1 re: permissible gases. Note: Leak checks at the end are performed with H2 or He.	Amend as follows: *"With the TPRD conditioned for a minimum of two hours in the ≤-40°C liquid bath, the internal pressure of the TPRD is cycled ~~with hydrogen gas~~ between ≤2MPa and ≥80 per cent NWP for 100 cycles while the liquid bath is maintained at ≤–40 °C;* Alternatively: *"cycle with hydrogen **or inert** gas…"*			
CSA	6.2.6.1.4		te	Corrosion test: HGV 3.1 TSC made minor adjustment to allow "food grade" sodium bicarbonate (in addition to reagent grade).	Propose to stay harmonized with HGV 3.1 with the following adjustment" *"Sodium Bicarbonate must be reagent grade **or food grade** (e.g., Baking Soda or comparable product is acceptable)."*			
CSA	6.2.6.1.6		te	Stress Corrosion Cracking Test – should add first paragraph re: applicability of this test to match the TF3 agreed upon applicability wording for the shut-off valve section in 6.2.6.2.9	Use same first paragraph from 6.2.6.2.9 (for check valves and shut-off valves) but adjust for TPRDs: ***"This test is applicable to TPRDs ~~valve units~~ containing copper alloys exposed to the outside environment. This is not applicable to components containing copper alloy internal components (not exposed to the outside environment). This test can be performed if testing agency does not know whether copper is present"*** Note: make sure the last sentence above re: testing agency is not duplicated at the end of 6.2.6.1.6			

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CSA	6.2.6.1.8		te	Leak Test: HGV 3.1 TSC is aligning test pressures with EU 406 (EC 79) leak test requirements (i.e. 125% NWP instead of 150% NWP).	Update leak test requirements as follows: *The required test conditions are:* *(a) Ambient temperature: condition the unit at 20 (±5) °C; test at 5 per cent NWP ~~(+0/-2MPa)~~ and ≥ **125** ~~150~~ per cent NWP;* *(b) High temperature: condition the unit at 85 °C or higher; test at 5 per cent NWP ~~(+0/-2MPa)~~ and ≥ **125** ~~150~~ per cent NWP;* *(c) Low temperature: condition the unit at -40°C or lower; test at ≥100 per cent NWP and 5 per cent NWP ~~(+0/-2MPa)~~* Note: tolerances were also strike-out above since they will be covered with tolerance table in appendix and -40C test order was reversed to show HP test then LP test (same as HGV 3.1)			
CSA	6.2.6.1.8		te	Leak Test: Suggest using "leak test gas" as defined in EU 406 (for EC 79): (40) 'Leak test gas' means hydrogen, helium, or an inert gas mixture containing a demonstrated detectable amount of helium or hydrogen gas; This change is planned for HGV 3.1 2022 edition.	Update as follows: *"The TRPD is pressurized with ~~hydrogen~~ **leak test gas** at the inlet."* Note: leak test gas is also defined in 6.2.6.1 comment above.			
CSA	6.2.6.1.11		te	Ozone test should also show test parameters to follow – shown in (iii). This harmonizes with HPRD 1 and HGV 3.1	Update Ozone test as follows: *(b) All elastomers shall demonstrate resistance to ozone by one or more of the following:*			

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					(i) Specification of elastomer compounds with established resistance to ozone; *(ii) Component testing in accordance with ISO 1431/1, ASTM D1149, or equivalent test methods;* ***(iii) the test piece, shall be stressed to 20 percent elongation, exposed to air at 40 °C with an ozone concentration of 50 parts per hundred million during 120 h. The non-metallic materials in the test piece shall not crack or show visible evidence of deterioration after exposure to ozone.***			
CSA	6.2.6.2		te	Same comment as 6.2.61 above. Not all tests in 6.2.6.2 require H2. Suggest updating this clause to cover inert gas where applicable (proposed change also includes the H2 gas quality addressed in a previous comment).	Update this clause as follows: *Testing is performed with* ***either*** *hydrogen* ***or inert*** *gas* ***as specified in the following paragraphs****.* ***Hydrogen gas shall be*** *compliant with ISO 14687/SAE J2719* ***or meet the following specifications:*** • ***Hydrogen fuel index: ≥ 99.97%*** • ***Total non-hydrogen gases: ≤ 300 µmol/mol*** • ***Water: ≤ 5 µmol/mol*** • ***Particle concentrations: ≤ 1 mg/kg*** ***Leak test gas shall be hydrogen, helium, or an inert gas mixture containing a demonstrated***			

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					detectable amount of helium or hydrogen gas. *All tests are performed at ambient temperature 20 (±5)°C unless otherwise specified.* *The check valve and shut-off valve qualification performance tests are specified as follows:*			
CSA	6.2.6.2.2		te	Leak Test: same comment as 6.2.6.1.8 above. HGV 3.1 TSC is aligning test pressures with EU 406 (EC 79) leak test requirements (i.e. 125% NWP instead of 150% NWP).	Update leak test requirements as follows: *The required test conditions are:* *(d) Ambient temperature: condition the unit at 20 (±5) °C; test at 5 per cent NWP ~~(+0/-2MPa)~~ and ≥* ***125*** *~~150~~ per cent NWP;* *(e) High temperature: condition the unit at 85 °C or higher; test at 5 per cent NWP ~~(+0/-2MPa)~~ and ≥* ***125*** *~~150~~ per cent NWP;* *(f) Low temperature: condition the unit at -40°C or lower; test at ≥100 per cent NWP and 5 per cent NWP ~~(+0/-2MPa)~~* Note: tolerances were also strike-out above since they will be covered with tolerance table in appendix and -40C test order was reversed to show HP test then LP test (same as HGV 3.1)			
CSA	6.2.6.2.2		te	Leak Test: same comment as 6.2.6.1.8 above.	Update as follows:			

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				Suggest using "leak test gas" as defined in EU 406 (for EC 79): (40) 'Leak test gas' means hydrogen, helium, or an inert gas mixture containing a demonstrated detectable amount of helium or hydrogen gas; This change is planned for HGV 3.1 2022 edition.	*"The outlet opening is plugged with the appropriate mating connection and ~~pressurized hydrogen~~ **leak test gas** is applied to the inlet."*			
CSA	6.2.6.2.2		te	Leak Test: there is currently no "internal leakage" requirement for shut-off valves and check valves. The way the current Leak Test is written implies only an external test. From the GTR perspective, do we need to consider "internal leakage" as a pass-criteria or is external leakage sufficient from a safety perspective in the regulatory context and leave internal leakage testing for industry standards?	Add requirement for internal leak test if TF3 determines that this is required. The test parameters (temperature and pressure conditions would be the same as the external leakage test requirements).			
CSA	6.2.6.2.3		te	Extreme temperature pressure cycling test: This is not really an "extreme" test since it just covers the operational limits so suggest renaming to harmonize with HGV 3.1.	Considering renaming to the following: **"Continuous Operation"** per HGV 3.1 or **"Endurance Test"** per EU 406			
CSA	6.2.6.2.3		te	Is hydrogen gas required for this cycling test or would inert be acceptable? Note: leak check at end of cycling is performed with hydrogen or helium. HGV 3.1 is changing such that inert gas is acceptable for cycling provided that manufacturer can demonstrate that materials are hydrogen compatible.	Adjust as follows: *The valve unit is installed in a test fixture corresponding to the manufacturer's specifications for installation. The operation of the unit is continuously repeated using hydrogen **or inert** gas at all specified pressures.*			
CSA	6.2.6.2.3		te	Check valve - # of cycles. Test has 11,000 cycles for check valve (matches GTR filling cycle	Consider harmonizing cycle count with HGV 3.1:			

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				count for container). HGV 3.1 uses 15,000 cycles for check valve (based on 20 year life). Note: TPRD pressure cycling in 6.2.6.1.1 was already adjusted to 15,000 cycles to harmonize with ISO 19882 (and HPRD 1)	15,000 check valve cycles instead of 11,000			
CSA	6.2.6.2.3		te	Test wording is a bit confusing in this section. Suggest breaking this into one sub-section for Check Valve and one sub-section for Shut-off Valve (with general temperature and pressure requirements listed in preamble). Note: proposed changes in document incorporate other 6.2.6.2.3 comments including previous comment to fix shut-off valve cycle and harmonize with HGV 3.1.	See separate 6.2.6.2.3 text below this table that re-words this section and includes all 6.2.6.2.3 comments listed above.			
CSA	6.2.6.2.4		te	Corrosion test: same comment at 6.2.6.1.4. HGV 3.1 TSC made minor adjustment to allow “food grade” sodium bicarbonate (in addition to reagent grade).	Propose to stay harmonized with HGV 3.1 with the following adjustment” *“Sodium Bicarbonate must be reagent grade **or** **food grade** (e.g., Baking Soda or comparable product is acceptable).”*			
CSA	6.2.6.2.6		te	Atmospheric exposure test: same comment as 6.2.6.1.11 above. Ozone test should also show test parameters to follow – shown in (iii). This harmonizes with HPRD 1 and HGV 3.1	Update Ozone test as follows: (b) All elastomers shall demonstrate resistance to ozone by one or more of the following: (i) Specification of elastomer compounds with established resistance to ozone; (ii) Component testing in accordance with ISO 1431/1, ASTM D1149, or equivalent test methods;			

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					(iii) the test piece, shall be stressed to 20 percent elongation, exposed to air at 40 °C (104°F) with an ozone concentration of 50 parts per hundred million during 120 h. The non-metallic materials in the test piece shall not crack or show visible evidence of deterioration after exposure to ozone.			
CSA	6.2.6.2.8		te	Vibration test – should add hydrostatic requirements as post-vibration requirement. This harmonizes with HGV 3.1 Proposal change also cover requiring leak checks at all temperatures (not just ambient)	Update the post vibration testing as follows: *"At the completion of the test, the unit shall comply with the requirements of the ~~ambient temperature~~ leak test ~~specified in~~ (para. 6.2.6.2.2**) and hydrostatic strength test (para. 6.2.6.2.1)**"*			
CSA	6.2.6.2.10		te	Pre-cooled hydrogen exposure test – is there any benefit to performing this test at the component level? This is already covered at the system level with the "Verification test for expected on-road performance (Pneumatic sequential tests)".	If a component level pre-cooled hydrogen exposure test is kept in this section, then suggest harmonizing with HGV 3.1 for this test: *The purpose of this test is to verify that all components in the flow path downstream of the receptacle to the container that are exposed to pre-cooled hydrogen during fuelling can continue to operate as designed.* *The component shall be subjected to three cycles of a pre-cooled hydrogen gas test at −40 °C gas temperature*			

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					and at a flow rate of 30 g/s for a minimum of 3 minutes each cycle. *The first cycle shall be conducted at ambient temperature (surrounding ambient conditions).* *The second cycle shall be conducted at 85 °C.* *The third cycle shall be conducted at −40 °C.* *Following the pre-cooled hydrogen exposure, the component shall comply with the leakage tests (para. 6.2.6.2.2).*			

Row Color Legend

1. Green Rows – Items with proposed sentences. We need the sentences for rationale also.
2. Orange Rows – Items with agreement but the sentences are lacked or not completed.
3. Light Blue Rows – Items disagreed or withdrawn. We need nothing to do.
4. Yellow Rows – Pending items
5. Purple Rows – New items

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"State of charge (SOC)" means the density ratio of hydrogen in the CHSS between the actual CHSS condition and that at NWP with the CHSS equilibrated to 15 °C. SOC is expressed as a percentage using the formula:

$$SOC(\%) = \frac{\rho(P,T)}{\rho(NWP, 15°C)} x100$$

The density of hydrogen at different pressure and temperature are listed in the Table below using the density correlation in SAE J2600 for calculating SOC during vehicle fueling based on NIST data.

Table ?

Compressed Hydrogen Density (g/l)

TEMPERATURE	PRESSURE (MPa)												
(°C)	1	10	20	30	35	40	50	60	65	70	75	80	87.5
-40	1.0	9.7	18.1	25.4	28.6	31.7	37.2	42.1	44.3	46.4	48.4	50.3	53.0
-30	1.0	9.4	17.5	24.5	27.7	30.6	36.0	40.8	43.0	45.1	47.1	49.0	51.7
-20	1.0	9.0	16.8	23.7	26.8	29.7	35.0	39.7	41.9	43.9	45.9	47.8	50.4
-10	0.9	8.7	16.2	22.9	25.9	28.7	33.9	38.6	40.7	42.8	44.7	46.6	49.2
0	0.9	8.4	15.7	22.2	25.1	27.9	33.0	37.6	39.7	41.7	43.6	45.5	48.1
10	0.9	8.1	15.2	21.5	24.4	27.1	32.1	36.6	38.7	40.7	42.6	44.4	47.0
15	0.8	7.9	14.9	21.2	24.0	26.7	31.7	36.1	38.2	40.2	42.1	43.9	46.5
20	0.8	7.8	14.7	20.8	23.7	26.3	31.2	35.7	37.7	39.7	41.6	43.4	46.0
30	0.8	7.6	14.3	20.3	23.0	25.6	30.4	34.8	36.8	38.8	40.6	42.4	45.0
40	0.8	7.3	13.9	19.7	22.4	24.9	29.7	34.0	36.0	37.9	39.7	41.5	44.0
50	0.7	7.1	13.5	19.2	21.8	24.3	28.9	33.2	35.2	37.1	38.9	40.6	43.1
60	0.7	6.9	13.1	18.7	21.2	23.7	28.3	32.4	34.4	36.3	38.1	39.8	42.3
70	0.7	6.7	12.7	18.2	20.7	23.1	27.6	31.7	33.6	35.5	37.3	39.0	41.4
80	0.7	6.5	12.4	17.7	20.2	22.6	27.0	31.0	32.9	34.7	36.5	38.2	40.6
85	0.7	6.4	12.2	17.5	20.0	22.3	26.7	30.7	32.6	34.4	36.1	37.8	40.2

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6.2.6.2.3. ~~Extreme temperature pressure cycling test~~ Continuous operation

The total number of operational cycles is 11,000 (or 15,000?) for the check valve and 50,000 for the shut-off valve. The valve unit is installed in a test fixture corresponding to the manufacturer's specifications for installation.

(a) The operation of the unit is continuously repeated using hydrogen or inert gas at all specified temperatures and pressures as follows:

(i) Ambient temperature cycling

The unit undergoes 90 per cent of the total operational cycles at ≥~~125~~ 100 per cent NWP with the part stabilized at 20 °C.

(ii) High temperature cycling

The unit then undergoes 5 per cent of the total operational cycles at ≥125 per cent NWP with the part stabilized at ≥85°C.

(iii) Low temperature cycling.

The unit then undergoes 5 per cent of the total operational cycles at ~~100~~ ≥80 per cent NWP ~~(+2/-0 MPa)~~ with the part stabilized at ≤-40°C.

(b) An operational cycle shall be defined as follows:

(i) Check Valve:

A check valve shall be capable of withstanding 11,000 (or 15,000?) cycles of operation, and 24 hours of chatter flow when submitted to the following test procedure.

The check valve shall be connected to a test fixture. The required test pressure is applied in six pulses to the inlet of the check valve with the outlet closed. The pressure shall then be vented from the check valve inlet. Failure of the check valve to reseat and prevent backflow shall constitute failure of the check valve. The pressure shall then be lowered on the check valve outlet side to less than 60 percent of NWP prior to the next cycle.

Following the operation cycles, the check valve shall be subjected to 24 hours of chatter flow at a flow rate that causes the most chatter (valve flutter).

At the completion of the continuous operation test, the check valve shall comply with the leak test (para. 6.2.6.2.2.) and the hydrostatic strength test

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(para. 6.2.6.2.1.).

(ii) Shut-off valve:

A shut-off valve shall be capable of withstanding 50,000 cycles of operation when submitted to the following test procedure.

The shut-off valve shall be mounted into a suitable test fixture. Each cycle shall consist of filling through the inlet port to the required test pressure. The shut-off valve shall then be opened (energized) and the pressure in the valve/fixture reduced to 50 percent of the filling test pressure. The shut-off valve shall then be closed (de-energized) prior to the next filling cycle.

Following the operation cycles, the automatic container valve shall be subjected to 24 hours of chatter flow at a flow rate that is within normal operating conditions that causes chatter (valve flutter), only if the automatic container valve is functioning as a check valve during fueling.

Note: *If no chatter is induced during normal flow rates, this test is not required*.

At the completion of the test the shut-off valve shall comply with the leak test (para. 6.2.6.2.2.) and the hydrostatic strength test (para. 6.2.6.2.1.).

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