COMMENTS RECEIVED WITH RESPECT TO EIHP2 PROPOSALS FOR DRAFT ECE COMPRESSED GASEOUS HYDROGEN (CGH_2) REGULATION Version 9 Dated 06.05.02	GRPE/ISO **N 09** 2002-07-30 Replaces: Document GRPE/ISO **N 03**

Introduction

1. The original wording used by the commenting organisations is provided below.
2. The numbering refers to Rev.9 of the CGH_2 draft.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
General		Powertech	Instead of MPa to denote pressure, ISO cylinder standards (7866, 9809, 11119, 11439, etc.) all use “bar”. MPa is reserved for describing a mechanical-type force.		
General			Reconsider terminology for working pressure, e.g. max. allowable working pressure.		
General			Check and change Class O to Class 0		
General		Quantum	Some tests require a min cycle pressure of 2Mpa others require 10% of service pressure. It should be 2Mpa		
General		Quantum	Non metallic parts need to be defined. Should not be applicable for o-rings and valve seats in metallic valve assemblies.		
General		Quantum	When non metallic parts tested the spec. is for rubber and not really suitable for other non metallic parts like Teflon etc.		

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General		Quantum	It would be very helpful to attach a list of already approved materials for high pressure hydrogen applications.		
General		RDW	Add Annex 11: Provisions regarding hydrogen identification marks for public service vehicles and new 14.11: 14.11 Identification of vehicles of categories M2 and M3 */ equipped with a hydrogen system. 14.11.1 Vehicles of categories M2 and M3 equipped with a *Hydrogen System* shall carry a plate as specified in Annex 11. 14.11.2 The plate shall be installed on the front and rear of the vehicle and one to the side of each set of doors. */ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3), annex 7 (TRANS/WP.29/78/Rev.1/Amend.2). Note: Proposed changes provided by Volvo Annex 11 will be provided from an earlier revision by Volvo		
General		PSA	Proposals for additional criteria concerning container(s) installed in a removable support See end of comments table		
General		Air Products	I only found comments on receptacles, but not nozzles. Is this		

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			intentional? I did not notice any discussion of geometry or any reference to an ISO standard or SAE standard which would specify geometry. I recommend that you consider removing Nozzle and Receptacle from this document, and just reference ISO or SAE standard.		
2.1.4		UTC Fuel Cells	Need to more accurately define the boundary between the Hydrogen System and fuel cell system. Proposal: After pressure regulation to Class 2 levels for entry into fuel cell systems.		
2.1.5		Luxfer	Define batch of liners and cylinders in more detail rather than under the test conditions (e.g. A.5.1.1). Proposed changes: 2.1.6 "Batch (of liners)": Production quantity of up to 200 finished liners successively produced (plus units required for destructive testing) of the same nominal, length, thickness and design, from the same material cast and heat treated to the same conditions of temperature and time 2.1.7 "Batch (of finished cylinders)": Production quantity of up to 200 finished cylinders successively produced (plus finished cylinders required for destructive testing), of the same nominal diameter, length, thickness and design. The batch of finished cylinders may		

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			contain different batches of liners, fibres and matrix materials		
2.1.10		Luxfer	Definition of composite container needs to be consistent with A.4.2.1. Proposed changes: 2.1.10 "Composite Container": A Container fabricated from a Liner Over-wrapped with continuous filament windings.		
2.1.24			Define boundaries of the scope of this document.		
2.1.33 & Annex 1-12, 13 & Annex 7-B19	15869-1.2 5.2.1.2.6	Techno-Product Center	Both of pressure-activated and thermal-activated PRD are permitted in EIHP draft. However only thermal-activated PRD is permitted in ISO/CD 15869 and in other standards on container for CNGV, e.g. ISO 11439, ANSI/NGV2. Proposed change: Container shall be protected using a thermal-activated PRD.		
2.1.41			Service Life applies to specific components: "*Service Life*": The life in years during which the *Hydrogen Components* are permitted to be used in accordance with this Regulation.		
2.1.47		UTC Fuel Cells	i) Generalise Working Pressure as a "nominal" condition that characterises general use of the equipment. ii) State for tanks, if it is a full charge at 15^0C.		

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			iii) Add definition of Maximum Allowable Working Pressure(MAWP) based on liquid H2 document.		
2.1.47		AGA AB	Not sufficiantly defined. It means that all pressures from zero to infinity can be working pressure Please use the the definition of working pressure of the ISO Standard ISO 10286 Gas Cylinders – Terminology Working Pressure: Settled pressure at a uniform temperature of 288 K (15 °C) for a full gas cylinder		
2.2 Container Types		Powertech	Type 5 design is not covered under any of the test requirements under Annex 7: Part B. Since these test requirements would need to be defined for any Type 5 design, there is no advantage in including a “Type 5” at this time. Delete.		
2.2		Lincoln	Since a Type 5 is not described, the testing that applies to it is not defined. Given that no one has presented a design for consideration that falls outside of those defined in Types 1 through 4, it seems an unneeded risk to identify a Type 5.		
2.4.2		Quantum	Why is the service pressure of a H2 system defined by the vehicle manufacturer		

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2.4.5	ISO/CD 15869-1, clause 4.8	Secretariat of ISO/TC 197	Comment: The reference should be listed as follows: ISO 14687:1999/Cor 1:2001. This standard was published in 1999 and a technical corrigendum was issued in 2001.		
2.4.6		Quantum	Higher gas temperature than 85 C for hydrogen should be permitted if overfill controls like temperature and pressure control are in place. You already allow material temperature to be 85 C which would mean higher gas temperature during fill for a short time anyway.		
2.4.7		Faber	We do not agree on the principle stated at 2.4.7, Service Conditions, Filling & Pressure Cycles, (page no.9). The concept of a pressure vessel with life determined by the number of filling to be counted by an additional (and most likely separate) device is against the principles that have been inspired all standards in the High Pressure sector. In addition to that such a way to determine the cycles of the cylinder would penalize the user who refills frequently just to top-up the cylinder. If the present prescriptions for the cycling tests for cylinders for other gases appear too stringent, then a statistical evaluation for refilling should be carried.		
2.4.7		Lincoln	This definition for fill cycles is different than ISO 15869, but with the same intent. I will bring your approach to the ISO committee for their consideration. The idea of a usage monitoring and control system is		

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			new to the ISO group - we will want to consider this and the impact on our requirements.		
2.4.7		Quantum	i) The design life is specified in # of cycles, calculated from the expected lifetime mileage of the vehicle. Then the standard limits the maximum lifetime in years under 2.4.1. Reference should be made only in years or # of cycles. Why is a safety factor of 3 applied, a factor of 2 is enough considering then 2 million kilometers for the vehicle in that given example ii) In the example the # of calculated cycles is 5 000 and with the applied safety factor 15 000. Various test procedures refer to 'the # of pressure calculated '. It is not clear if it refers to 5 000 or 15 000 cycles. B17, B21, B24 etc.		
2.4.7		Luxfer	The wording of this clause needs to be re-written to be clear. The possibility to have cycle life less than 5000 is not clear. The number of pressure cycles in this clause is referenced a number of times in Annex 7 Part A. What number of cycles is required when conducting a test? 5000 or 15000? Also needs to be clear that a manufacturer can define a design life of less than 20 years and a cycle life of less than 5000 (15000?) cycles. Proposed change: Define maximum number of filling cycles to be 5000. Require approval testing to be conducted to 10 000 pressure cycles.		

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2.4.7		Luxfer	Delete reference to the monitoring system as this technology has yet to be proven.		
2.4.7		Luxfer	The design lifetime definition of 5000 cycles in 2.4.7 is very conservative. To then expect a cylinder to exhibit a cycle performance factor of 3 times this is excessive and unnecessary if the cylinder exhibits a LBB failure mechanisms. Proposed change: Define maximum number of filling cycles to be 5000. Require approval testing to be conducted to 10 000 pressure cycles.		
2.4.7		Volvo	Volvo prepare a reworded version of 2.4.7 prior to the Munich meeting		
6.1.4		Techno-Product Center	Only uni-directional flow on all components is permitted. In case of even manual valve, shall in-let line and out-let line be established separately? Valve should be excluded.		
6.1.5		AGA AB	Components must be designed to the Design Pressure and not to the Working Pressure		

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			Reintroduce Design Pressure as of Draft 8 Clause 2.1.15		
6.1.13 iii)		UTC Fuel Cells	Why the isolation requirement for electrical equipment (other than the power bus)?		
6.2.2		Lincoln	As in 2.2, removal of this section is recommended.		
6.2.3		Lincoln	The impact of this section should be considered in more detail as to qualification testing. One consideration is that the bonfire test must be conducted on the entire system if, for example, all containers vent through a single PRD.		
14.1.9		UTC Fuel Cells	Not clear. Re-state in terms of MAWP. Proposal: Allow different MAWP's on different sides o fHEX's if streams are protected by different primary safety reliefs.		
14.1.10		Lincoln	With this test, I'm not sure if helium or the gas mixtures will give the same results as 100% hydrogen. Need to determine what, if any, result is needed here. One note - when first filled, our tanks do produce bubbles in the dome regions due to escape of air trapped between the liner and the composite in the dome region. After 30-60 minutes, this should subside.		

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14.1.11		Lincoln	It may be unclear what to include as components that can leak. Iwould say that any polymer material or any connection (valve, fittings, et al) could leak.		
14.1.15		Lincoln	Not clear how this is applied.		
14.1.17		UTC Fuel Cells	i) Pressurised components other than the fuel tank should be rated based on MAWP. ii) Why specify exactly 1.5 times working pressure for selection of equipment? This is equivalent to dictating a MAWP of 1.5 x working pressure. This may not be adequate even at the tank when you consider failures!		
14.3.2.1		Lincoln	Recommend this be modified: "A Pressure Relief Device shall be directly installed into the opening of a container or assembly referred to in Paragraph 6.2.3 of this Regulation, or into an opening in a valve assembled into the container, or onto a tube that is so mounted into the container or valve, in such a manner that it shall ..." We have had regulators believe that the PRD must be installed directly into the container, while the intent of the requirement is simply that there is a PRD and that it cannot be isolated from the container.		

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14.3.2.1		TUV	Delete “line” Proposed change discussed TUV/Volvo immediately after June meeting		
14.3.2.5		TUV	Delete “line” Proposed change discussed TUV/Volvo immediately after June meeting		
14.8.3		UTC Fuel Cells	i) Components should be bonded to vehicle chassis (“Earth grounding” is indirect) ii) Consider requirement for minimum resistance from chassis to ground. Proposal: SAE use 25megaOhm for minimum total resistance.		
14.8.4		UTC Fuel Cells	Suggest use of SAE J2578 or IEC 60079 for methods of protecting ignition sources from flammable gas		
Annex 7: A1 References		Faber	An additional standard shall be add: ISO 9809-2:2000 (Gas cylinders-Refillable seamless steel gas cylinders-Design, construction and testing - Part2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1100MPa).		

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			Comment: Prescriptions of prEN/ISO 11114-4 would be mandatory also for cylinders according to ISO 9809-2:2000.		
Annex 7: A1 References			ASTM D2344-84(1995) Standard Test Method For Apparent Interlaminar Shear Strength of Parallel Fibre Composites By Short Beam Method Replaced by D2344M-00e1 Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates?		
Annex 7: A1 References			ASTM G53-96 Standard Practice for Operating Light and Water - Exposure Apparatus (Fluorescent UV-Condensation Type) For Exposure Of Non-metallic Materials Replaced by G154-00ae1 Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials???		
Annex 7: A2.6 iv)		Luxfer	Circular reference with A6		
Annex 7: A2.7	ISO/CD 15869-1,	Lincoln	We should also allow etching onto the boss for some of the information. For example, we would etch the manufacturer name and a unique serial number identifier for the container so that we can		

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	cl 6		supply a new label if the original is lost or damaged.		
Annex 7: A2.7			Transfer Annex 7: A2.7 to a new Annex 7: A4.3 and change references		
Annex 7: Table 7A.3 - Material Specif. and test data		Faber	The Hydrogen Compatibility Test should be applied to the resin and the fibers of type 4 cylinders. Comment: The resin and the fibers are in contact with the hydrogen that permeates throw the plastic liner.		
Annex 7-A3.1.4		Techno-Product Center	It is permitted the use of tapered or straight threads in all container types. Only straight threads shall be permitted in aluminum container and liner.		
Annex 7: A3.2.2		Lincoln	Reword to "Steels for containers and liners shall conform to the material requirements of ISO 9809." Type 4 bosses could safely be made from other steels.		
Annex 7 A3.2.2 A3.2.3	ISO/CD 15869-5,	Lincoln	Applicability to Type 4 bosses should be reviewed. Type 4 bosses could safely be made from other steels and aluminum.		

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	clauses 5.5				
Annex 7: A3.2.3		Lincoln	Reword to "Aluminium allows for containers and liners shall conform to the material requirements of ISO 7866." Type 4 bosses could safely be made from other aluminium alloys.		
Annex 7 A 3.3		AGA AB	Burst pressure ratios. As we have constantly commented upon the quoted Burst Pressure ratios in table 7A.5 are too low and must be increased. The note *2 A Burst Pressure ratio of 1.8 is not acceptable and shall be deleted		
Annex 7: Table 7A.5		Luxfer	Need minimum burst ratios for hybrid containers. Who ensures the stress ratios are met? Where are the strain gauges placed.		
Annex 7: Table 7A.5		Swedish Work Env. Auth.	Low safety factors not acceptable. Sweden has voted aginst the ISO standard due to the low safty factors.		
Annex 7: Table 7A.5			Transfer stress ratio definition to Section 2 of the main reg.		
Annex 7 A3.3 Tab. 7A.5	ISO/CD 15869-	Lincoln	On one hand, I agree that a 1.8 stress/burst ratio could be used for carbon fiber to give high reliability as it relates to stress ratio. On the		

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Note 2	3, clauses 6.3 ISO/CD 15869-4, clauses 6.3 ISO/CD 15869-5, clauses 6.3		other hand, I'm not sure that all other issues are addressed. We should conduct a FMEA before we consider addressing this in a regulation, and we should develop performance requirements for the monitoring system. One concern that needs to be addressed is "crash" performance. With the existing 2.25-2.35 requirement for carbon, in combination with the given performance tests, carbon fiber reinforced tanks have shown excellent performance in "crash" events (i.e. hitting bridges and curbs, dropping from vehicles and being run over). With a 1.8 stress/burst ratio, we don't know if this crash performance would still remain, and a monitoring system would be of little or no benefit. It may be we would need to consider a representative crash test requirement for such a system, with lowered stress/burst ratios, if it was to be implemented.		
Annex 7: Table 7A.5 Note 2		Swedish Work Env. Auth.	A extreme low burst pressure ratio of 1.8 can be used. This is not acceptable. I believe that this note is not accepted in the ISO standard proposal. Sweden has voted aginst the ISO standard due to the low safty factors.		
Annex 7: Table 7A.5 Note 2		Volvo	It is not appropriate to specify a precise BPR of 1.8 when the integrity monitoring system and degree of damage that may be sustained is not specified. Clarify or delete note.		
Annex 7: A3.3 Tab. 7A.5	ISO/CD 15869-	Lincoln	Wording needs to be adjusted in note 3 to reflect that only the "structural" fiber needs to meet the stress ratio requirements if the		

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Note 3	3, clauses 6.3 ISO/CD 15869-4, clauses 6.3 ISO/CD 15869-5, clauses 6.3		"structural" fiber can meet the burst requirements with the "non-structural" fibers are removed.		
Ann.7: A4.2.1		Quantum	The recording of the winding parameters should be left to the discretion of the manufacturer.		
Ann.7: A4.2.1		Luxfer	It is unclear why the specification makes these requirements. The information is not required at any stage in the document. This should be left to the manufacturers quality control system. Proposed changes: Remove A4.2.1		
Ann.7: A5.1.1		Luxfer	Definition of batch of liners and containers to be moved to 2.1 Definitions		

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Ann.7: A5.1.1 iii)		Luxfer	No mention of plastic liner sample for material batch tests. Does the manufacturer have to provide a finished liner to conduct the plastic liner softening test?		
Ann.7: A5.1.2		Quantum	Batch testing of multiple batches must be defined more clear. Is the test conducted to approve multiple batches in the future or does approve the previous batches that have already been shipped.		
Annex 7: Table 7A.6 - Batch Tests		Faber	For Type 2 and 3 (Metallic liner) in the case of thin wall thickness (less than 3.0 mm) impact test shall not be required. Comment: Table 7B.1, ISO 9809-1:1999 and ISO 9809-2:2000 do not define any impact test value with a minimum wall thickness less than 3.0mm.		
Annex 7: Table 7A.6		Luxfer	Boss Torque Test and Leak Test should be included in this Table if they are required as batch test.		
Ann.7: A5.1.2 iii)		Luxfer	The concept of batch testing of multiple batches is always difficult and open to uncertainty. Is the test conducted to approve multiple batches in the future or does it approve the previous batches that have already been shipped? If a fault is found what happens to the multiple batches covered by the test? Section iv indicates that only		

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			one batch is rejected. Remove clause		
Annex 7: Table 7A.8			Rename title to be consistent with Ann.7: A7 – "Approval Testing Of Modifications" and delete "Design change" from title box		
Ann.7: Table 7A.8 Change of Design		Powertech	Hydrogen Compatibility tests for change of Fibre manufacturer, fibre material, and resin material is not logical – these materials are not in direct contact with the hydrogen (also there is no evidence they are affected by contact with hydrogen). Delete.		
Annex 7: Table 7A.8	ISO/CD 15869-5, clauses 8.2 Table A.1	Lincoln	This table needs to be reviewed. Some concerns I have are that, for a Type 4 container, a change to the liner material would not have an effect on LBB performance and bonfire results, and probably not any effect on impact damage test results. Similarly, changing the fiber material shouldn't change permeation, boss torque, or hydrogen cycling. Also, changing boss features such as threads, height, or others not affecting the boss/liner or boss/composite interfaces should not affect permeation, boss torque, or hydrogen cycling.		
Annex 7: Table 7A.8		Quantum	What is the definition of process change?		
Annex 7:		Luxfer	What is the definition of a design change in metallic container or liner		

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Table 7A.8			material? Is change of material supplier a design change? Proposed change: Define change limits required for these tests.		
Annex 7: Table 7A.8		Luxfer	What is the definition of a design change in fibre material? Proposed change: Define change limits required for these tests.		
Annex 7: Table 7A.8 Note 1		Luxfer	What is required if a working pressure change of <20% is made and the thickness change is not proportional? Proposed change: Define requirements more clearly.		
Annex 7: B1.2.1		Luxfer	No reference to using a test coupon for this yet A5.1.1 allows use of a heat treated test sample.		
Annex 7: B1.2.3		Luxfer	What is the sampling rate for fibres? B1.1 does not define Proposed change: Conduct one test per batch of fibre.		
Annex 7 B1.2.3 -		Lincoln	Doing strand tests with the fiber and resin systems and the container cure cycle is not recommended. A minor point is that the effects of a cure cycle on a strand may not be comparable to that of a container		

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			given the differences in configuration and heat transfer. More importantly, the results likely wouldn't give you valid information. When we have used glass and aramid fibers in the past, we did strand tensile tests routinely. When we started using carbon fiber, we started doing strand tensile tests, but found it was hard to get repeatible results, even with our experienced technicians. We found that the certifications provided by the fiber manufacturers, where they often run the tensile tests on dry fibers, gave much better correlation to container performance. We have come to rely on the certifications, and this has been acceptable to our defense and aerospace customers, including government agencies.		
Annex 7 B2.2		Techno-Product Center	Brinell hardness test on the parallel wall at the centre of each container and liner. However it is sufficient if the tensile test that is prescribed to Annex 7-B1 carry out. Delete of Brinell hardness test on the parallel wall of container and liner.		
Ann.7: B4 Corrosion Test		Powertech	This test is covered under ISO 7866 for aluminium materials and do not need to be repeated here. Also, in ISO 7866 these corrosion tests only apply to “other” aluminium alloys not listed in the standard. In B4 all aluminium alloys are being forced to perform this corrosion test. Delete.		

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Ann.7: B4		Luxfer	Is no corrosion test required for steel? Proposed change: Reference NACE test in ISO 11439		
Ann.7: B5 Sustained Load Cracking Test		Powertech	This test is covered under ISO 7866 for aluminium cylinders and do not need to be repeated here. Also, these corrosion tests only apply to “other” aluminium alloys not listed in ISO 7866. In B5 all aluminium alloys are being forced to perform SLC tests. Delete.		
Annex 7 B6.3	ISO/CD 15869-1, clause D.21	Lincoln	These revised numbers (100C softening, 130C melt) should work for us, but I still question whether the melt temperature needs to be identified. This temperature is above any operating condition identified. Before specifying a melt temperature, consideration should be given to the benefits vs. the possibility of removing a viable material from consideration. Melt temperature is somewhat arbitrary, as well. Depending on the material and grade, melt temperature might not be meaningful. For example, some liner materials are "welded" at temperatures at least 100C greater than the melt temperature, and the plastic still has a relatively high viscosity (no flow without external load).		
Annex 7 B8.3		Luxfer	How can a minimum shear strength be defined? Surely this is dependant on the manufacturers design. Proposed change:		

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			Requirement: The test results shall be within the Manufacturers specifications.		
Annex 7 B9.2 iv)		Luxfer	Why conduct chemical resistance if we have the Acid Environment Test? Proposed change: Delete iv)		
Annex 7 B11		Luxfer	Does ISO 11114-4 adequately screen steels that are susceptible to hydrogen embrittlement? Proposed change: Reference ISO 9809 for high strength steels		
Annex 7 B11		Lincoln	I believe that ISO 11114-4 applies only to steels, therefore it would not be applicable to all materials.		
Ann.7: B11 Hydrogen Compatibility Test		Powertech	This test should not be applicable to all materials, only to steels that exceed the limits specified in ISO 9809 for hydrogen service. Aluminum alloys are immune to hydrogen embrittlement when exposed to hydrogen specified in ISO 14687 (see paragraph 2.4.5 Gas Composition). Modify requirement.		
Ann.7: B11		Quantum	Where can ISO 11114-4 be found, or is it not released yet?		

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Ann.7: B12			Delete B12 for Type 3 & 4 containers		
Ann.7: B12		Quantum	A LBB should not be required if the tank can prove LBB already between my minimum requirement (5 000 cycles) and my 3 times safety requirement (15 000 cycles).		
Annex 7 B12		Luxfer	This test is unnecessary if a design proves LBB performance in the Ambient Cycle Test. Proposed change: Remove B12 or combine with B17 for a total of three cylinder tests.		
Annex 7 B13.2		Luxfer	There is no valid reason to condition at -40C for 48 hours. Unnecessary time and expense Proposed change: Bring temperature of cylinder to -40C or below or adopt equivalent test in ISO 11119.		
Annex 7 B13.2		Luxfer	The temperature monitoring must be fixed at the surface. The requirement that the liquid stay below -40C means the chamber has to be around -100C. This is unrealistic and has not basis in reflecting any possible service conditions. Proposed change:		

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			Adopt criteria of equivalent test in ISO 11119		
Annex 7 B13.2		Luxfer	Why two cylinders for this expensive test? Proposed change: Test one unit only		
Ann.7: B13		Quantum	Why are two tanks required for this test? Temperature requirements should be applicable for the tank, not the fluid. Why a hold of the tank at –40 C for 48 hours?		
Annex 7 B13.2	15869-1.2 Annex D.11	Techno-Product Center	Number of cycles at 85C and at –40C is 1.5 times the number of filling cycles calculated in accordance with Paragraph 2.4.7. It is not 1.5times, and is 0.5 times the number of filling cycles correct?		
Annex 7 B14.2	ISO/CD 15869-1, clause D.17	Lincoln	A test pressure of 100% has been shown to be effective in the past. In addition, the time spent at 125% is a very small portion of the life of the container. The added pressure can add significant cost without benefit. As to requiring at least 5% hydrogen or 10% helium, this also adds expense without necessarily adding a benefit. We typically use a 2% helium mixture, and have demonstrated that we can locate problems easily (typically with an o-ring seal), and that we can locate such leaks at levels below the permeation requirement for the tank. This is possible by using equipment with an appropriate level of		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			sensitivity and sophistication. It would be better to define the procedural requirements of this section as performance related, i.e. able to find leaks at the appropriate levels.		
Annex 7 B15.2	ISO/CD 15869-3, clauses 10 ISO/CD 15869-4, clauses 10 ISO/CD 15869-5, clauses 10	Lincoln	i) Permanent expansion is specified for Types 2 and 3, Elastic expansion for Type 4. I think Type 3 would also be better served by using elastic expansion. Pehaps allow the manufacturer to determine which is appropriate? ii) I recall in the ISO document, we only allowed Option 2 for Type 1 tanks (i.e. Option 1 must be used for all Types 2, 3, and 4 containers).		
Annex 7 B 15.2		AGA AB	The Test Pressure is too low Reintroduce Design Presure B 15.2 The container shall be pressurized to $\geq$ 1.5times the Design Pressure instead of Working Pressure (see Annex 7 clause 5.4 in Draft 8)		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B15.3		Luxfer	The pass criteria for the Proof Test is inadequate. Proposed change: Adopt wording of Volumetric Expansion Test and Proof Test from ISO 11119		
Ann.7: B16.2 Burst Test - Procedure	ISO/CD 15869-1, clause D.15	Powertech	"If the rate exceeds ……. the Burst Pressure ratio, *or the time at pressure above the Working Pressure times the Burst Pressure ratio must exceed 5 seconds*." Equivalent or better than saying "hold at some pressure for 5 seconds". Change.		
Ann.7: B17		Luxfer	The definition of the number of cycles required is unclear. It can be assumed that the minimum number of cycles to be performed is 5000 but this is clear.		
Ann.7: B17		Luxfer	The requirement for 15000 cycles has not technical rationale. This imposes extra cost on manufacturers who are required to conduct this test as a batch test. Proposed change: Minimum number of cycles to be defined at 5000 with tests to continue to 10000 cycles. Cylinders can fail by leakage between 5000 and 10000 cycles. A diagram would assist understanding. See references.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B17.2		Luxfer	There is no acceptance of a design that is designed for less than 5000 filling cycles. Proposed change: Life definition for the cylinders needs to be reviewed and redefined.		
Ann.7: B18 Acid Environment Test	ISO/CD 15869-1, clause D.10	Powertech	Change title to “Environment Test”, since there are more solutions than just acids.		
Annex 7 B18.2	15869-1.2 Annex D.10	Techno-Product Center	Sulphuric acid is 30%, diameter of preconditioned exposure area is 150 mm, and lower pressure in pressure cycle is not more than 10% in EIHP draft. There are the differences with ISO 15869. Correct as follows: Sulphuric acid: 19%, Diameter: 100 mm, Lower pressure: not more than 2 MPa.		
Ann.7: B18.2 Acid Environment Test -		Powertech	Editorial – subsection f) should be section iv), and the other sections renumbered accordingly.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Procedure					
Ann.7: B18.2 iv)		Luxfer	Cycle testing is unnecessary. Surface of the fibers is already badly damaged by impact. Test is to determine effect of solutions and temperature on stress rupture not cycle life. No other test regime requires this. Proposed change: Remove cycle requirement.		
Ann.7: B19.2 Bonfire Test - Procedure	ISO/CD 15869-1, clause D.3.5	Powertech	Allowing a container to be tested using nitrogen, when the container will be used only for hydrogen, is wrong. Nitrogen has significantly different properties, including the fact it chills as it expands. Therefore performance of the container and PRD in a bonfire will not be the same as with hydrogen. Delete the use of nitrogen in bonfires.		
Annex 7 B19.2	ISO/CD 15869-1, clause D.3.5	Lincoln	Nitrogen may not give representative results in the bonfire test. Recommend using only hydrogen.		
Ann.7: B20.3 Penetration Test - Requirement	ISO/CD 15869-1, clause D.18	Powertech	Not practical to collect small pieces of materials to weigh after gunfire. Purpose of gunfire is to determine if the container will rupture, so the wording should be changed to include the following simple statement “The container shall not rupture”.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 B20.3	ISO/CD 15869-1, clause D.18	Lincoln	Other standards, including ISO 15869, are removing the wording re pieces weighing less than 45 grams, relying on the "no evidence of fragmentation failure" for pass/fail. Experience shows that there is a clear distinction between what passes and what doesn't.		
Ann.7: B21		Quantum	This test is not really a flaw tolerance test. Defined flaws should be cut into the tank to simulate damage in service between the inspection cycle, where those flaws then would be detected		
Annex 7 B21		Luxfer	This test does not test the flaw tolerance of cylinders. Other standards apply defined flaws to prove the behavior of the cylinder when subjected to cut damage. The flaws that would be used in this test would have no effect on the performance on the cylinder unless the visual inspection rates were set unrealistically high. Proposed change: Adopt criteria in ISO 11439,		
Annex 7 B21.2		Lincoln	ISO 15869 allows the manufacturer to determine flaw sizes, but requires, at a minimum, 25mm long by 1.25 mm deep and 200 mm long by 0.75 mm deep flaws. These represent typical flaws found during inspection. Containers should be tolerant of such flaws given the frequency with which they occur.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 B21.2 and B21.3	15869-1.2 Annex D.8	Techno-Product Center	Flaw size shall be specialized. Acceptable criteria are no leak and rupture within the number of filling cycles in EIHP. Two flaws: 25mm length and 1.25mm depth, 200mm length and 0.75mm depth. Container shall not leak and rupture within the first 3000 cycles, but may fail by leakage after 3000 cycles.		
Annex 7 B22 & B23			Combine tests B22 & B23		
Annex 7 B22.2	ISO/CD 15869-1, clause D.4	Lincoln	Recommend conditions of 100C for 200 hours to harmonize with ISO 15869. No problems have been found in the field with containers that meet the ISO requirements.		
Annex 7 B22.2	15869-1.2 Annex D.12	Techno-Product Center	Test condition: 95C, 1000 hours There is the difference regarding holding temperature and time between EIHP and ISO 15869. Container shall be pressurized 1.25 times working pressure and held 100C for not less than 200 hours.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B23		Quantum	The way the tests are defined now they are very similar. High temperature creep test should be removed from the standard. Creep tests, if necessary could be simulated on parts of tanks to be more cost effective.		
Annex 7 B23		Luxfer	Why do we need B18, B22 and B23? B22 and B23 are effectively the same and B18 is effective stress rupture test. Proposed change: Remove B22		
Annex 7 B23.2		Lincoln	The accelerated stress rupture test was based on one which successfully screened out containers that had problems in the field. Adding humidity to the test changes the mechanisms acting on the composite.		
Ann.7: B24		Quantum	There is no gain in value to make the drop test so severe. I would be allowed to use a separate tank for each drop anyway. So besides adding cost, no value is added. It is also not clear what the cycle requirements are after dropping the tank.		
Annex 7 B24		Luxfer	Why is the drop test so severe? The requirements here are for 8 extreme drops. Equivalent standards (ISO 11439, NGV2 and B51)		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			require 3 drops. Proposed change: Adopt criteria in ISO 11439,		
Annex 7 B24		Luxfer	It is not clear what the cycle test requirement is after the drops. However it is unrealistic to expect a cylinder to perform as a new cylinder after undergoing these severe impact tests. Any cylinder that had received this damage would be rejected from service on visual inspection. It is reasonable to expect cylinders to have a good resistance to impact but they should be allowed to fail in a safe manner in cycle testing. This would simulate the unlikely situation where a cylinder was subjected to severe damage but the damage was not noticed. Proposed change: Adopt criteria in ISO 11439,		
Annex 7 B24.2	ISO/CD 15869-1, clause D.9	Lincoln	Change to a single drop from any orientation to harmonize with ISO 15869. This test is intended to address shipping damage. No indication that more than a single drop is needed to demonstrate fitness. Containers meeting the ISO requirements have a successful history, including the ability to sustain crash impacts. In addition, it is difficult to truly drop twice in the same place, particularly given the non-repeatability of secondary and tertiary impacts.		
Ann.7: B24.2	ISO/CD	Powertech	Multiple drops may be excessive – the purpose of the drop test is to		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Drop Test - Procedure	15869-1, clause D.9		consider the effect of handling damage – how many times would a container be dropped before it was installed on a vehicle? The drop test requirements in ISO 15869 come from ISO 11439 and other national CNG tank standards. These drop test requirements were implemented after a failure of an EDO design due to drop damage. There have not been any incidents since. Change drop test requirements to those in draft ISO 15869.		
Annex 7 B24.3	15869-1.2 Annex D.9	Techno-Product Center	Acceptable criteria are no leak and rupture within the number of filling cycles in EIHP. Container shall not leak and rupture within the first 3000 cycles, but may fail by leakage after 3000 cycles.		
Annex 7: B25 Permeation Test		Faber	The requirement must be changed in order to keep it accordance with ISO/CD 15869 and in case reduce it to 0.25 ml of hydrogen per hour per liter water capacity of the tank, if ISO takes the same decision. We suggest to keep the value of 0.5 ml of hydrogen per hour per liter water capacity of the tank.		
Ann.7: B25		Luxfer	What is Ncm3? Proposed change: Leak rate of 0.25 ml/l/h		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B25		Quantum	The tank should not have to remain in the chamber for the entire 500 hours if checked periodically like once a day in an enclosed chamber.		
Ann.7: B26		Quantum	Does the boss torque test make sense if there is no torque applied to the boss during installation of the tank?		
Ann.7: B27		Quantum	1 hour fill time on a smaller tank for hydrogen cycle test is realistic but not for a large volume, high pressure tank with the compressor technology available today.		
Ann.7: B27 Hydrogen Gas Cycling	ISO/CD 15869-1, clause D.14	Powertech	The requirement to pressure cycle to 1.25 times working pressure is an excessive requirement and difficult to perform. Cycle testing to working pressure was specified in CNG standards and draft ISO 15869. This is intended to be an accelerated test with rapid fill and venting to determine if there are any design problems in type 4 tanks not covered by other hydraulic tests. Because of the rapid filling and venting it was not considered necessary to perform 15,000 cycles under these conditions – any design flaw would become visually obvious. This is also the reason it was not necessary to go to 1.25 times working pressure – the test was already accelerated enough. Change to cycling to working pressure.		
Ann.7: B27.3		Luxfer	Why is only the boss/liner interface examined? Proposed change:		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			Liner shall be visually examined for damage and design rejected if the liner exhibits visual damage		
Annex 8 & 9		Air Products	The order of tests in Annex 8 did not match the order in annex 9. This made reading awkward.		
Annex 8		Quantum	The excess flow limiter has to withstand 1 000 cycles. In real life it is built as a safety device that goes thru very little cycles. It should be maximum 100 cycles.		
Annex 8A Provisions Regarding the Approval of Pressure Relief Devices		Powertech	Delete requirements and refer to ANSI/IAS PRD-1 standard, with a note that the PRD must meet the pressure cycle requirements consist with Paragraph 2.4.7. Problems with Annex 8A are as follows: The mercurous nitrate test in para. 2.1.3 was changed in PRD-1 for an equivalent test involving ammonia exposure, since mercurous nitrate posed a significant health risk. The creep test duration in para. 2.1.1 is inadequate – it should be 500 hours to be consistent with PRD-1 and ISO 15500-13. There is no activation test.		
Annex 8A 5			The EIHP draft regulation requires the PRD to be held at test pressure and 95C for 24 hours with no evidence of extrusion, and that brass components be tested per ASTM B154.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			Comment: The combined temperature and pressure requirements may cause failure of PRDs which have proven successful in the field. The ASTM B154 test contains environmentally harmful test agents, and has been replaced by testing in a moist ammonia-air environment in other standards.		
Ann. 8A		Luxfer	Are only temperature triggered PRD's allowed? Proposed change: Redefine requirements.		
Annex 8 A2.1.3		Lincoln	Recommend using the moist ammonia test rather than Mercurous Nitrate Test in order to avoid environmental problems with mercury compounds.		
Annex 8D			A connect / disconnect test should be specified for receptacles in accordance with the test defined in ISO 17268		
Annex 8F, Item 3		UTC Fuel Cells	Why EN's in global document		
Annex 8G Provisions Regarding the		Powertech	There should be a requirement that flexible hoses are electrically conducting, i.e. a maximum resistance requirement.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Approval of Flexible Fuel Lines					
Annex 8G, Item 2.5.4.2		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.		
Annex 8G, Item 2.5.4.3		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.		
Annex 8G, Item 4.5.4.2		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.		
Annex 8G, Item 4.5.4.3		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.		
Annex 8H		Quantum	The endurance test for fittings should not be required because of the connection test in Annex 9		
Annex 9 Clause 3.1		Air Products	Leak test gas should be pure He or H2 (With proper safety precautions) 1 bubble in three minutes is ~ 5 Ncm3/hr. A 10% mixture might only leak 0.5 Ncm3, and allow a device that should have failed to pass. Also, these tests are type tests, and piece tests. Any		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			incremental costs added by using pure H2 or He can be amortized over many pieces.		
Annex 9 Clause 3.5		Air Products	Standard temperature in the ISO tanks standard is 15°C. 15°C should be used here as well.		
Annex 9 – 4 Pressure Test		Powertech	A hydrostatic proof test of 3 times the working pressure should be a requirement.		
Annex 9 Clause 4		Powertech	Minimum hydrostatic strength for class 0 components should at least match cylinder burst pressure ratios per Table 7A.5 Recommend 3.0 X maximum		
Annex 9 Clause 4.1		Air Products	(1.5) x Working pressure is insufficient for any components that may come in contact with the fueling system. The tank standard is 2.3 x, so at the very least, the receptacle, and the piping connection to the receptacle should have a factor of at least 2.3. SAE J2600 calls for 3 x 1.25 X Working pressure. This is much closer to the requirements of current piping codes. More to the point, We always try to design inherently safe systems. An accidental filling of a 250 bar vehicle from a 350 bar station should not exceed the design burst pressure of any part of the system.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 9 Clause 4.1		UTC Fuel Cells	Equipment (other than the fuel tank) should be selected and tested based on MAWP. The MAWP should be selected by the system design but establishing a minimum relative to working pressure is OK, particularly for the class 0 tank system where margins are established by the tank requirements. Proposal: Suggest testing at 1.3 x MAWP		
Annex 9 Clause 5.2		Powertech	Soak time of 3 hours is excessive – recommend a soak time of 2 hours for components to optimize testing Change to 2 hour soak		
Annex 9 Clause 6.4, 6.5 & 6.6		Air Products	10 Ncm3/hr is slightly harsh. We picked 20 Ncm3/hr for SAE2600 based on the following two criteria. 1 Vehicle parked in a garage, and 2 the minimum leak required to sustain a flame. Criteria 1 turned out to allow a very large leak. We calculated that a 84,000 Ncm3/hr in a garage would never exceed the 1% number. Criteria 2 was our governing criteria. Michael Swain of the University of Miami measured the minimum sustainable flame flow as 3.5 Ncm3/min. We multiplied 3.5 to get per hour, and divided that number by 10 to be on the safe side, and rounded down to get 20 Ncm3/hr. I guess you could argue that we should have divided by 20, and I would not want to argue this point too much.		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 9 Clause 7		Air Products	Is proper maintenance allowed during cycle testing? I didn't notice a requirement that the receptacle be connected and disconnected with each cycle. Did I miss this, or is it covered elsewhere?		
Annex 9 Clause 7.3		Powertech	Prohibit the use of air for cycle testing due to the possibility of creating an explosive mixture in the system in the event that a hydrogen leak test follows the cycle test. Change to nitrogen or hydrogen		
Annex 9 Clause 7.5		Powertech	Soak time of 3 hours is excessive – recommend a soak time of 2 hours for components to optimize testing Change to 2 hour soak		
Annex 9 Clause 7.6		Powertech	Soak time of 3 hours is excessive – recommend a soak time of 2 hours for components to optimize testing Change to 2 hour soak		
Annex 9 - 13		Quantum	The minimum pressure during cycle is specified as atmospheric pressure. This will lead to interpretations. A better value would be		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
			2Mpa as you minimum pressure.		
Annex 9 Clause 13.1		Air Products	Soft goods may need more than five seconds for the hydrogen to impregnate the material and cause explosive decompression. We did not have any good number for rates of hydrogen permeation, so we based our soak time of 168 hours on the maximum amount of time we thought a component was likely to go unused.		
Annex 9 Clause 14		Air Products	A device with a destructive harmonic at 14 hz would survive this test, but should be rejected. A range of frequencies is more appropriate. We used: "The receptacle and protective cap shall be secured in a test apparatus and vibrated at each integer frequency from 5 to 60 Hz for eight minutes at each frequency. The amplitude of the vibration shall be at least 1.5 mm from 5 to 20 Hz, 1.2 mm from 20 to 40 Hz, and 1 mm from 40 to 60 Hz. The tests shall be conducted once in the axial direction, once in one radial direction. If the device is not radially symmetrical including the actuator, then a second orthogonal radial direction test is required."		
Annex 9 Clause 14		Powertech	Replace or add an additional vibration test more representative of vehicle vibration conditions Replace with or add the following test: “Vibrate at 2 +/- 0.1 G and sweep frequency from 20 to 2000 Hz at a rate of 0.5 octaves per minute in each of 3 orientation axes.”		

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 9 - 15		Quantum	The test scope needs to be defined.		
Annex 9 Clause 16		Air Products	This test was not required but seems necessary, is it covered by 7? Also, if this test were included, I would think 15,000 would be more appropriate than 25 cycles.		
Annex 10		Air Products	I'm not much of an expert in this area, but I would think you should just require a SIL III or even IV certification in accordance with IEC61508		

LUXFER REFERENCES

Hydraulic proof pressure test from ISO 11119

Procedure:
This test requires that the hydraulic pressure in the cylinder be increased gradually and regularly until the test pressure p_h is reached. The cylinder test pressure shall be held for a sufficiently long period (at least 30 s) to ascertain that there are no leaks and no failure. If leakage occurs in the piping or fittings, the cylinders may be re-tested after repairing such leakages.

Where cylinders are subjected to autofrettage the hydraulic proof pressure test may be part or immediately follow the autofrettage process.

Criteria:
The cylinder shall be rejected if there are leaks, failure to hold pressure or visible permanent deformation after the cylinder is depressurised.

NOTE Cracking of resin is not necessarily a sign of permanent deformation

Hydraulic volumetric expansion test from ISO 11119

Procedure:
This test requires that the hydraulic pressure in the cylinder increase gradually and regularly until the test pressure, p_h, is reached. The cylinder test pressure shall be held for a sufficiently long period (at least 30 s) to ascertain that there are no leaks and no failure. If leakage occurs in the piping or fittings, the cylinders may be re-tested after repairing such leakages.
The total volumetric expansion of each cylinder under the test pressure, p_h, and the permanent volumetric expansion of the cylinder after the pressure is released shall be recorded. The elastic expansion (i.e. total expansion less permanent expansion) under test pressure can then be established for each cylinder.
Where cylinders are subjected to autofrettage the hydraulic proof pressure test may be part or immediately follow the autofrettage process.
Criteria:
The cylinder shall be rejected if either:
a) it shows an elastic expansion at the test pressure, $p_{h,}$ in excess of 110 % of the average elastic expansion for the batch at manufacture, or

b) it shows a permanent expansion at zero pressure in excess of 5 % of the total expansion.

Environmental cycle test from ISO 11119.

Procedure:

One cylinder, as wrapped and without paint or removable protective coating, shall be tested as follows.

Condition cylinder and contained pressurising medium for 48 h at atmospheric pressure, at a temperature between 60 °C and 70 °C and at a relative humidity greater than or equal to 95 %.
The hydraulic pressurising medium external to the cylinder under test shall commence the cycle testing at ambient temperature. Hydraulically apply 5 000 cycles from a pressure approximately equal to atmospheric pressure to two-thirds of the test pressure (p_h). The cylinder skin temperature shall be maintained at between 60 ºC and 70 ºC by regulating the environmental chamber and the cycling frequency. The cycling frequency shall not exceed 5 cycles per minute.
Release pressure and stabilise cylinder at 20 °C approximately.

Stabilise the cylinder and the contained pressurising medium until the temperature is between – 50 ºC and – 60 ºC.
The hydraulic pressurising medium external to the cylinder under test shall commence the cycle testing at ambient temperature. Apply 5 000 cycles from a pressure approximately equal to atmospheric pressure to two-thirds of the test pressure (p_h). The cylinder skin temperature shall be maintained at between – 50 ºC and – 60 ºC by regulating the environmental chamber and the cycling frequency. The cycling frequency shall not exceed 5 cycles per minute. The fluid shall also be selected to ensure that it functions at the temperatures specified in the various cycle tests.
Release pressure and stabilise the cylinder at 20 °C approximately. Hydraulically apply 30 cycles from a pressure approximately equal to atmospheric pressure to the test pressure (p_h).
On completion of these tests the cylinder is subjected to the burst test in **8.5.4**.

Parameters to monitor and record:
— temperatures during each part;

— humidity during 1st part of test;

— test medium used;

— number of cycles, achieving upper cyclic pressure, at each stage;

— minimum and maximum cyclic pressures;

— cycle frequency ;

— burst pressure;

— description of failure.

Criteria:
The burst pressure, p_b, shall be not less than 1,4 times the test pressure, p_h, of the composite cylinder design

Ambient Cycle Test Criteria.

	1st part	2nd part
Number of Cycles	5000	10000
Criteria	No leakage/burst = Pass	
	No leakage or burst Pass 1st part	Leakage = Pass Burst = Fail

Figure 1 — Criteria for ambient cycle test

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PROPOSAL FOR ADDITIONAL CRITERIA CONCERNING CONTAINER (s) INSTALLED IN A REMOVABLE SUPPORT

2.1. DEFINITIONS

Insert a new definition :

2.1.48 *"Frame/rack"* : A resistant and removable structure of a vehicle providing the housing and protection to one or several containers and various components related to the *hydrogen system.*

14.2 INSTALLATION OF A HYDROGEN CONTAINER ON-BOARD A VEHICLE

14.2.1 *Container (s)* shall be permanently installed on-board the vehicle and may only be removed for maintenance. *Container (s)* shall not be installed in the internal combustion engine compartment.

Insert the following paragraphs :

14.2.2. Notwithstanding paragraph 14.2.1, it is acknowledged that the container(s) is/are installed in a permanent way within a *frame/rack* which can be removed from the vehicle.
In this case, the separation of the hydrogen circuit can only be carried out in a section of the circuit where the working pressure is lower than or equal to 1.0 Mpa.

14.2.2.1. The installation and removal operations for this *frame/rack* must be sufficiently simple to avoid accidental misuse.

14.2.2.2. The *frame/rack* must protect the container (s) and associated equipment from shocks during normal handling operations necessary to their installation, removal and storage.

14.2.2.3. At the time of disconnection of the hydrogen circuit, the volume of hydrogen released into the atmosphere should not be greater than [xx] cm^3 nor be released near a source likely to ignite it.

14.2.2.4. The connection of the hydrogen circuit between the *frame/rack* and the vehicle may be carried out automatically or manually using fittings that require no tools.

14.2.2.5. The part of the connector fixed to the vehicle cannot be of the same type as the connections used normally on the vehicle for connection at the filling stations.

14.2.2.6. The fittings used for the connection between the *frame/rack* and the vehicle must be approved according to the requirements of annex 8D.

14.2.2.7. The implementation of the *hydrogen system* and in particular the opening of the *container(s) automatic valve(s)* should not be possible when the hydrogen circuit is not connected.

14.2.2.8. The disconnection of the hydrogen circuit must be made impossible if the power supply to the *container(s) solenoid valve(s)* is not cut off.

14.2.2.9. A partial or total electrical failure of the connectors between the *frame/rack* and the vehicle must be signalled to the driver if he tries to use the *hydrogen system.* Furthermore, if the failure is likely to be a safety hazard, then the *hydrogen system* should not be able to operate.
Particular information must be provided in this respect in accordance with item 3.2. of appendix 10.

14.2.2.10. The criteria of paragraph 14.2.3. also apply to the *frame/rack* fixings.
If the dynamic tests carried out on the assembly consisting of the *frame/rack* fixings, the *frame/rack* and the elements contained within the *frame/rack* show that they meet the requirements of paragraph 14.2.3., then the requirements of this paragraph and those of paragraph 14.3.2. are considered as being met.

Renumber the former paragraphs 14.2.2, 14.2.2.3, 14.2.4, 14.2.5, and 14.2.6 to respectively 14.2.3, 14.2.4, 14.2.5, 14.2.6, and 14.2.7.

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JUSTIFICATION :

The field of automotive hydrogen has not yet reached sufficient maturity to be comparable to other fuels used in the field of transport.
In particular, the lack of refuelling stations will be a major obstacle to the development in the future public domain as well as in the restricted field of the first captive fleets.

It is likely that the first projects will be confronted, in addition to the obstacles relating to filling, storage problems of vehicles and their maintenance in installations that would have to be modified to enable them to accommodate hydrogen propelled vehicles. The required structures exist or will exist at the Manufacturers but not necessarily at all of them and at potential partners.

Under these conditions, it seems appropriate to consider solutions making it possible to overcome these difficulties without decreasing the level of safety that the compliance with construction rules of the regulation project implies.

Our proposal aims at making possible the storage of hydrogen for the vehicle to be filled, maintained and repaired, separately in relation to the vehicle (thermal or electric).
This principle which must be equivalent from the point of view of the operational safety in relation to a vehicle designed without *frame/rack,* we are suggesting introducing the complementary requirements, expressed in the first part of this document which we submit for examination to the ad hoc group of the GRPE.

Among the advantages of this proposal, we see, in addition to the facility of filling and maintenance of the *frame/rack* which would be treated as the equivalent products by the professional networks already in place, the possibility of checking at regular interval the entire high pressure system.
This possibility, although not strictly necessary must be regarded as an advantage accompanying the development of a new energy source, considered currently as not risk free.

Finally, the vehicles thus "unburdened" would be free to operate in areas that would otherwise be prohibited to them if equipped with their hydrogen reserve.

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Annex 11

PROVISIONS REGARDING HYDROGEN IDENTIFICATION MARKS FOR PUBLIC SERVICE VEHICLES

The sign consists of a sticker that shall be weather resistant.

The colour and dimensions of the sticker shall fulfil the following requirements:

Colours:

Background: green (ISO???)
Border: white (ISO???)
Letters: white (ISO???)
Either the borders and letters or the background shall be retro-reflective.

Dimensions:

Border width: 5 mm
Sticker width: 125 mm (across flat sides)
Sticker height: 125 mm (across flat sides)

Font size:

Font height: 25 mm
Font thickness: 5 mm

The words shall be in upper case characters, centralised to suit the dimensions.

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Change No.2

2.1.x *"Filling Cycle"*: A pressure increase of more than 25% of the *Working Pressure* of the *Container* due to an external source of hydrogen.

2.1.45 "*Usage Monitoring And Control System*": A system that counts the *Filling Cycles* and prevents further use of the vehicle when a predetermined number of *Filling Cycles* is exceeded.

2.4.7 Filling Cycles

This section is only applicable to Class 0 *Hydrogen Components*.

2.4.7.1 General

The number of *Filling Cycles* for the *Hydrogen Components* approved in accordance with this Regulation and its Annexes shall be 5000 cycles except as permitted in Paragraphs 2.4.7.2 & 2.4.7.3 of this Regulation.

2.4.7.2 Extended Number of *Filling Cycles*

The vehicle manufacturer may specify an extended number of *Filling Cycles* for the *Hydrogen Components* based on the design lifetime mileage of the vehicle and range with maximum fuel capacity, but shall not be less than 5000 cycles, i.e.:

Design lifetime mileage of the vehicle, L
Range with maximum fuel capacity, R

Number of *Filling Cycles* = L/R but not less than 5000

2.4.7.3 Reduced Number of *Filling Cycles*

Provided that a *Usage Monitoring And Control System* is installed as part of the *Hydrogen System,* the number of *Filling Cycles* for *Hydrogen Components* approved in accordance with this Regulation and its Annexes shall be specified by the vehicle manufacturer and may be less than 5000 cycles and may vary with different applications based on the design lifetime mileage of the vehicle and range with maximum fuel capacity. The *Usage Monitoring And Control System* shall prevent any further use of the vehicle when the specified number of *Filling Cycles* is exceeded, until the *Hydrogen Components* that have exceeded that value are replaced with new *Hydrogen Components*.

The safety concept of the *Usage Monitoring And Control System* shall be approved in accordance with Annex 10 of this Regulation.

Capitalise/change to italics all references to *Filling Cycles* throughout the document.

Replace references to “pressure cycles” with “3 times number of *Filling Cycles* in accordance with Paragraph 2.4.7 of this Regulation*”.*

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