DECISIONS TAKEN ON THE 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 027** 2002-10-28
DISCUSSED AT THE GRPE/ISO GROUP OF EXPERTS ON 24-25 OCTOBER 2002 IN VANCOUVER, CANADA	Replaces: Document GRPE/ISO **N 024**

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.
3. "Final modification column" – black text: agreed (closed)
4. "Final modification column" – red text: joint proposals from Powertech, Raufoss & Volvo
5. "Final modification column" – blue text: for information only
6. "Final modification column" – Text highlighted in yellow: indicates that the proposer agrees with the proposal.

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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.	N	1. SI unit – Pa, the use of bar is not encouraged 2. ECE uses MPa
General		EIHP2	i) ISO 11114-4 may have to be deleted as it is unlikely to be available – hydrogen compatibility should be discussed at the Vancouver Meeting.	i) -	Already discussed. See the decision recorded in GRPE/ISO N26.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
General			Reconsider terminology for working pressure, e.g. max. allowable working pressure.	P	ISO and GRPE are harmonized with their definition of working pressure. To ensure consistency with other standards on gas cylinders, it was decided that the tank shall be defined by the working pressure. *Working Pressure*: Settled pressure at a uniform temperature of 15 °C that the design of a *Hydrogen Component* is based on. SAE proposal for Class 1 and 2 components: All the other components in the system shall be rated according to the maximum allowable working pressure, which is based on the set pressure of the pressure relief valve. SAE is invited to forward its proposal to the GRPE ad hoc WG. It will be up to GRPE ad hoc WG to make this decision on the Class 1 and 2 components. Vote on accepting the SAE proposal: 4 in favour 6 against 5 abstention

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			Same comment as above.		In Annex 8, components downstream the pressure regulators shall be pressure tested at a pressure sufficient to accommodate the Maximum allowable working pressure (MAWP) of the system e.g. the set pressure of the pressure relief valve – See the UTC proposal for MAWP.
General			Check and change Class O to Class 0	Y	Added to Rev.10
General		Quantum	Some tests require a min cycle pressure of 2MPa others require 10% of service pressure. It should be 2MPa	P	1. Containers: Change all refs in Annex 7 to 2 MPa. 2. In Annex 8, retain existing wording as the tests have to be applicable to Class 0, 1 & 2 components.

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General		Quantum	Non metallic parts need to be defined. Should not be applicable for o-rings and valve seats in metallic valve assemblies.	P	Assume that the comment refers to Annex 8 and various foot notes referring to metallic and non-metallic “parts”. Ozone test clarified to be an ageing test (ozone deleted ozone from title) Add a general definition in Sect. 2.1 based on multifunctional component definition, i.e. a specific component can be a combination of non-metallic and metallic sub-components/parts.
General		Quantum	When non metallic parts tested the spec. is for rubber and not really suitable for other non metallic parts like Teflon etc.	-	See Annex 8 proposals (N22)

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General		Quantum	It would be very helpful to attach a list of already approved materials for high pressure hydrogen applications.	N	It would lead to a constant stream of amendments to the regulation, however see Annex 8 proposals (N22) for a new paragraph in Part 1 of the document (Pt.1: 6.1.3)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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		This item does not affect the harmonization of the EIHP and ISO requirements. Information for the GRPE ad hoc WG: ISO 7225:1994 *Gas cylinders — Precautionary labels* and the United Nations regulations for the transport of dangerous goods use a red sign to identify hydrogen. The OEM representatives do not like a red sign. The USA use a blue triangle to identify hydrogen Green labels follow the existing CNG practice. This decision has already been agreed at the GRPE ad hoc WG meeting in Nabern. See Annex 11 proposal towards the end of this document. (Annexes to be renumbered to take into account removal of Annex 9). Note: Possible liaison with NFPA and SAE may be desirable.

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General		PSA	Proposals for additional criteria concerning container(s) installed in a removable support See end of comments table	-	The concept of the use of a container installed in a removable support was discussed. However, as this concept does not affect the harmonization of the EIHP and ISO requirements, it was agreed that this proposal should be brought to the attention of the GRPE ad hoc WG.
General		Air Products	i) I only found comments on receptacles, but not nozzles. Is this intentional? ii) 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.	i) - ii) Y	i) Yes ii) Comment from N08: "Develop a general requirement in EIHP text covering the following points: Receptacle profile should be defined to avoid cross-connection with other fuel dispenser nozzles and to prevent filling a vehicle by a dispenser with a working pressure higher than the vehicle. Where appropriate compliance could be demonstrated by compliance with, e.g. ISO 17268" See Annex 8 proposals (N22) A3.2.5

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	P	Proposal rejected as it does not allow for Class 1 fuel cells. However, a new definition is required: 2.1.24 "*Hydrogen System*": An assembly of *Hydrogen Components* and connecting parts fitted on motor vehicles using hydrogen, excluding *the Hydrogen Conversion System(s)*. The boundary between the *Hydrogen System* and the *Hydrogen Conversion System(s)* shall be defined by the vehicle manufacturer, but as a minimum requirement it shall be defined as the point(s) at which the *Working Pressure* is higher than the: i) Maximum operating *Pressure* of fuel cell system(s), ii) The inlet *Pressure* of the gas mixer (carburettor or injector(s)) for internal combustion engines or other combustion devices.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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 contain different batches of liners, fibres and matrix materials	P	See Change No.1
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.	N	The existing definition is less restrictive and need not define the actual method of production

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2.1.11		Volvo	"*Container*": Any ~~system~~ vessel used for the storage……	Y	
2.1.24			Define boundaries of the scope of this document.	P	See response to UTC comment on 2.1.4
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.	Y	See Annex 8 proposals (N22)
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.	Y	

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
2.1.47		UTC Fuel Cells	i) Generalise Working Pressure as a "nominal" condition that characterises general use of the equipment. ii) State <u>for tanks</u>, if it is a full charge at 15^0C. iii) Add definition of Maximum Allowable Working Pressure(MAWP) based on liquid H2 document.	i) P ii) - iii) -	See the previous discussion above. i) The document applies to other components than a cylinder: Different WP may be req'd for Class 0 components, e.g. downstream of a pressure reg. – see 2.4.2 Some "design" pressures are related to 85degC while others are higher. <u>*Working Pressure*:</u> Settled pressure at a uniform temperature of 15 °C that the design of a *Hydrogen Component* is based on. ii) Taken into account by "…that the design of a *Hydrogen Component* is based on" iii) Not necessary any changes can be based on WP

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2.1.47		AGA AB	Not sufficiently defined. It means that all pressures from zero to infinity can be working pressure Please use 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	P	See the decision recorded on the working pressure. The document applies to other components than a cylinder: Different WP may be req'd for Class 0 components, e.g. downstream of a pressure reg. – see 2.4.2 *Working Pressure*: Settled pressure at a uniform temperature of 15 °C that the design of a *Hydrogen Component* is based on.
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.	N	Comment from N08 Type 5 allows discussion to be initiated with the technical service, without it any new developments will be blocked outright. This can be used within a regulation but not within a standard. Retain Type 5 in EIHP. Option for Type 5 is not required in the ISO text.

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2.3.1			Reword to "*Hydrogen Components* shall be classified with regard to their *Working Pressure* and function as defined below:…" Check that Class is no longer used in the context of hydrogen systems.	Y	
2.3.2			Delete paragraph, and renumber 2.3.1 to 2.3	Y	
2.4.2		Quantum	Why is the service pressure of a H2 system defined by the vehicle manufacturer	N	The vehicle manufacturer defines the vehicle specification
2.4.4		RA	Delete 2.4.4 as it is a design requirement not an approval requirement.	Y	

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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.	Y	Added to Rev.10
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.	P	2.4.6.2 of the EIHP draft regulation: The average gas temperature shall be between –40 °C and 85 °C in normal conditions including filling and discharging.
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.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP

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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 new to the ISO group - we will want to consider this and the impact on our requirements.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP
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.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP

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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.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP
2.4.7		Luxfer	Delete reference to the monitoring system as this technology has yet to be proven.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP

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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.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP
2.4.7		JEVA (Japan/TC22)	Design number of filling cycles should be decided by manufacturers If the number is specified in this standard, the minimum requirements or numbers should be determined through discussions based on the statistical data of many types of vehicles.	-	Comment from N08: The EIHP philosophy is accepted based on Change No.2. ISO will harmonise with EIHP The number of filling cycles can be decided by the manufacturer
3.3		EIHP2	Add “or other *Hydrogen Components* directly fitted to the *Container*.	Y	

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4.2		Swagelock	With regard to marking in general, Part I , section 4.2 states that all "Specific Components" shall have a space large enough to accommodate the approval mark. I do not believe that this is practical for many of the fittings used in these systems. Unlike the ECE R110, a fitting is specific component that would be marked in this standard.	-	This comment has political implications affecting the ECE type approval procedure, i.e. should all components be marked with an ECE type approval mark Pass onto the GRPE Ad-hoc Working Group
6.1.3 (New paragraph proposed in N022)		RA	Reword new paragraph 6.1.3 to: "Material compatibility with the service conditions defined in Paragraph 2.4 of this Regulation shall be demonstrated either by the material tests in Annex 7 and Annex 8 to this Regulation, or by documented material properties provided by the material manufacturer."		"Material compatibility with the service conditions defined in Paragraph 2.4 of this Regulation shall be demonstrated either by the material tests in Annex 7 and Annex 8 to this Regulation, or by a previously approved test certificate." The exception can only be included in the EIHP draft regulations and not in the ISO standard.

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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.	P	Reword to: 6.1.4 All *Hydrogen Components* that are designed for uni-directional flow shall have the flow direction clearly indicated.
6.1.5		AGA AB	Components must be designed to the Design Pressure and not to the Working Pressure Reintroduce Design Pressure as of Draft 8 Clause 2.1.15		Comment from N08: No support for this proposal at the meeting For info.: The clause refers to the marking of components with their nominal rated value.

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6.2.2		Lincoln	As in 2.2, removal of this section is recommended.	N	Comment from N08: Type 5 allows discussion to be initiated with the technical service, without it any new developments will be blocked outright. This can be used within a regulation but not within a standard. Retain Type 5 in EIHP. Option for Type 5 is not required in the ISO text.
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.	-	See Change No.5
6.2.3		Volvo	Assembly concept needs to be considered further to ensure that the present definition does not result in uncontrolled releases	Y	See Change No.5
6.3			Reword similar to 6.4 etc	Y	

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6.12		Powertech	Use of “alternatively” and “can” should be reworked	Y	Change Section 6 as appropriate (see Annex 8 proposals)
6.13 iii)		UTC Fuel Cells	Why the isolation requirement for electrical equipment (other than the power bus)?	Y	This requirement relates to personal safety, i.e. risk of electrocution, hence it is not appropriate in requirements dealing with hydrogen storage. Delete
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.	N	Not necessary any changes can be based on WP

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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.	-	B14.3 would be changed to use leak test gas. Definition: Leak Test Gas: Gas mixture containing at least 5 % hydrogen or 10 % helium or a demonstrated detectable amount of helium or hydrogen gas. The requirements included in the new Annex 8 (N22) - definition of Leak Test Gas - are to be moved to the body of the ISO standard and the EIHP draft regulations. Check inert.
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.	-	i) Delete ”venting”
14.1.15		Lincoln	Not clear how this is applied.	N	See definition

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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!	i) N ii)N	i) Not necessary any changes can be based on WP ii) 1.5 x pressure test is carried out on the same component that has been subjected to all service simulation tests
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.	P	"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, in such a manner that it shall ..."
14.3.2.1		TUV	Delete “line” Proposed change discussed TUV/Volvo immediately after June meeting	Y	

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14.3.2.5		TUV	Delete “line” Proposed change discussed TUV/Volvo immediately after June meeting	Y	
14.4.8			Reword to: “Class 0 metallic *Rigid Fuel Lines* shall be seamless and shall elongate by at least 14% before rupture.”	Y	
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 25?mega?Ohm for minimum total resistance.	i)P ii)N	i) Add “…., e.g. chassis. ii)) Not necessary even for direct chassis/ground contact. Also too may variations to consider, e.g. tyres, rain, puncture, etc.

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14.8.4		UTC Fuel Cells	Suggest use of SAE J2578 or IEC 60079 for methods of protecting ignition sources from flammable gas	N	Earlier versions referred to IEC 60079, however, it was dropped during the preparation of Rev. 8 to harmonise with ECE R110.
14.10.2			Retitle: Containers Subjected To Direct Impact Damage	Y	
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). Comment: Prescriptions of prEN/ISO 11114-4 would be mandatory also for cylinders according to ISO 9809-2:2000.	-	See the decision taken and recorded in GRPE/ISO N26.

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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?		Craig Webster confirmed that D2344-84 has now been replaced with the following designation: D2344/D2344M-00^{E1}, and a new test method title, where E1 (actually E should be the symbol for epsilon) denotes that an editorial change was later made to D2344/D2344M-00. Specifically, this editorial change was a revision to the title of the test method.
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???		Craig Webster confirmed that ASTM G154-00 is the replacement for ASTM G53 (and is already referenced in ISO 15869).

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Annex 7: A2.6 iv)		Luxfer	Circular reference with A6	Y	Rephrase 1st sentence to: "Manufacturing data, including tolerances where appropriate, shall be provided, such as:" Delete Para.A2.6 iv) and check renumbering Delete Para.A2.6 vi) and check renumbering
Annex 7: A2.7	ISO/CD 15869-1, cl 6	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 supply a new label if the original is lost or damaged.	N	This information may be added in addition to the label and it is not necessary to state this in the regulation.
Annex 7: A2.7			Transfer Annex 7: A2.7 to a new Annex 7: A4.3 and change references	Y	Agreed.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: A2.7		RA	Reword somehow to avoid misinterpretations. It says, “Marking shall be made either by labels incorporated into resin coatings, labels attached by adhesive, low stress stamps used on the thickened ends of Container Types 1 and 2, or any combination of the above.” This may be misinterpreted to allow for “adhesive, low stress stamps”.	Y	Replace “labels attached by adhesive” with “adhesive labels”
Ann.7: A2.7.vii		RA	Follow ECE R110: i) Change to “"DO NOT USE AFTER YYYY/MM", providing the year and month of expiry 1/” ii) Introduce note 1/, “The expiry date shall not exceed the approved Service Life of the Container. The expiry date may be applied to the Container at the time of dispatch, provided that it has been stored in a dry location without internal pressure. Rationale: It will inevitably take some time from manufacturing to delivery, and this opens up for avoiding an unwanted time-penalty to containers that are properly stored.	Y	It will inevitably take some time from manufacturing to delivery, and this opens up for avoiding an unwanted time-penalty to Containers that are properly stored. The EIHP is to harmonize with ISO.
Annex 7: Table 7A.3			Modify: i) Ref B1 applies to plastic liner only. ii) Delete rows with refs to B3, B4, B5	Y	ii) Delete references to B3, B4, B5 and include reference to the material tests of ISO 9809 and ISO 7866. The same apply to the tensile test for metallic materials.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7: Table 7A.3			Under “Applicable To Material” column, add a new column “Coating” and mark with “X” on row corresponding to test B9.	Y	
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.	-	See the decision that was recorded in GRPE/ISO N26. No proof that any damage can occur to resin.
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.	N	Many aluminium containers are in industrial service with tapered threads without problems
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.	Y	Comment agreed. It was agreed that bosses could be made of stainless steel. It was agreed that EIHP is to harmonize with ISO 15869-5, clause 5.5.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 A3.2.2 A3.2.3	ISO/CD 15869-5, clauses 5.5	Lincoln	Applicability to Type 4 bosses should be reviewed. Type 4 bosses could safely be made from other steels and aluminum.	Y	Comment agreed. It was agreed that EIHP is to harmonize with ISO 15869-5, clause 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.	Y	Comment agreed. It was agreed that EIHP is to harmonize with ISO 15869-5, clause 5.5.
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.	N	Comment from N08: No support for this proposal at the meeting

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.		The minimum *Burst Pressure* Ratio must be chosen such that the calculated stress in the fibres at the minimum *Burst Pressure* Ratio times *Working Pressure* divided by the calculated stress in the fibre at *Working Pressure* meets the stress ratio requirements for the fibres used.
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.	N	Comment from N08 on related proposals by AGA: No support for this proposal at the meeting
Annex 7: Table 7A.5			Transfer stress ratio definition to Section 2 of the main reg.	N	Only used in Table 7A.5, therefore it is defined there within a note

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 A3.3 Tab. 7A.5 Note 2	ISO/CD 15869-3, clauses 6.3 ISO/CD 15869-4, clauses 6.3 ISO/CD 15869-5, clauses 6.3	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 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.	Y	EIHP is to harmonize with the latest version of ISO standards.
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 against the ISO standard due to the low safety factors.	Y	EIHP is to harmonize with the latest version of ISO standards.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7: Table 7A.5 Note 2		AGA AB	A Burst Pressure ratio of 1.8 is not acceptable and shall be deleted	Y	EIHP is to harmonize with the latest version of ISO standards.
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.	Y	EIHP is to harmonize with the latest version of ISO standards.
Annex 7: A3.3 Tab. 7A.5 Note 3	ISO/CD 15869-3, clauses 6.3 ISO/CD 15869-4, clauses 6.3 ISO/CD 15869-5, clauses 6.3	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 "structural" fiber can meet the burst requirements with the "non-structural" fibers are removed.	Y	"For *Container* designs using hybrid reinforcement, i.e. two or more different structural fibre types, consideration shall be given to the load share between the different fibres based on the different elastic modulii of the fibres……"

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: A4.2.1		Quantum	The recording of the winding parameters should be left to the discretion of the manufacturer.	-	See below
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	P	*i) When Composite Containers* are fabricated from a *Liner Over-wrapped* with continuous filament windings, the filament winding operations shall be computer or mechanically controlled. During winding the principal parameters shall be monitored and kept within specified tolerances, and documented in a winding record. These principal parameters are: ii) Delete xii)
Ann.7: A5.1.1		Luxfer	Definition of batch of liners and containers to be moved to 2.1 Definitions	P	See Change No.1

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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?	-	Plastic liner softening test deleted
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.		A5.1.2 ii) Clarify "….then the pressure cycle test can be reduced to one *Container* from every 5 *Batches* of production with the Container selected from the first of the 5 batches." A5.1.2 iii) Clarify "….then the pressure cycle test can be reduced to one *Container* from every 10 *Batches* of production with the Container selected from the first of the 10 batches."
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.	-	See Change no. 1 that was agreed.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	Y	See Change No.1
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 one batch is rejected. Remove clause	P	Add at the end of Para.5.1.2 vi): "The *Manufacturer* shall demonstrate that *Containers* produced since the last *Batch* test meet all *Batch* test requirements."
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	Y	
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.	Y	Hydrogen compatibility: Fiber manufacturer: Delete all Fiber material: Type 4 only Resin material: Type 4 only

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	Y	EIHP is to harmonize with ISO 15869. Both EIHP and ISO are to include the following changes: Fiber manufacturer and fiber material change: boss torque test, permeation and hydrogen gas cycling would not have to be performed. Add note: Changing boss features including threads, height, or others not affecting the boss/liner or boss/composite interfaces does not affect permeation, boss torque, or hydrogen cycling.
Annex 7: Table 7A.8		Quantum	What is the definition of process change?	-	Note to Table 7A.8: Any deviation of the parameters specified in A2.6 is considered to be a process change.
Annex 7: Table 7A.8		Luxfer	What is the definition of a design change in metallic container or liner material? Is change of material supplier a design change? Proposed change: Define change limits required for these tests.	-	Luxfer withraw its comment.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Luxfer withraw its comment
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.	Y	A7: Add introductory sentence from ISO plus the following sentence: Any major design changes that is not covered in Table 7A.8 shall be subjected to a full approval testing. EIHP is to consider adding a clause in the document to give precedence to the requirements of the regulations over the documents that are referenced in the regulations.
Ann.7: B1		RA	Material test of fibres for type approval. Should be included, e.g. strand test.	Y	Retain B1 for old B1.2.2 & B1.2.3 (liner and fibre tensile tests) B1.2.2: Replace “carried out “with “tested”

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866
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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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 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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866
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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866
Ann.7: B4		Luxfer	Is no corrosion test required for steel? Proposed change: Reference NACE test in ISO 11439	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866
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.	-	Comment from N08: EIHP to harmonise with ISO Remove this section of the EIHP draft regulation with the incorporation of ISO 9809-1 and ISO 7866

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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).	Y	Comment from N08: EIHP to harmonise with ISO
Annex 7 B8.3		Luxfer	How can a minimum shear strength be defined? Surely this is dependant on the manufacturers design. Proposed change: Requirement: The test results shall be within the Manufacturers specifications.	N	Proposals follow ISO text

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 B9.2 iv)		Luxfer	Why conduct chemical resistance if we have the Acid Environment Test? Proposed change: Delete iv)	P	Add "This test is not necessary if a test is undertaken in accordance with Paragraph B18 of this Annex."
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		See the decision that was recorded in GRPE/ISO N26.
Annex 7 B11		Lincoln	I believe that ISO 11114-4 applies only to steels, therefore it would not be applicable to all materials.		See the decision that was recorded in GRPE/ISO N26.
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.		See the decision that was recorded in GRPE/ISO N26.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B11		Quantum	Where can ISO 11114-4 be found, or is it not released yet?		See the decision that was recorded in GRPE/ISO N26.
Ann.7:B11.1 & 2			B11.1 No. of samples to be tested: 3 B11.2 Hydrogen compatibility testing shall be carried out in accordance with recognised industry practice	Y	B11.1: 3 samples where tests are required. B11.2 See the decision that was recorded in GRPE/ISO N26.
Ann.7: B12			Delete B12 for Type 3 & 4 containers	-	Comment from N08: Change ISO15869 to 15000 cycles. EIHP2 B12.3 will adopt final sentence of ISO 15869–1.2 Cl.D16, modified for EIHP pressure cycle concept
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).	-	Comment from N08: Change ISO15869 to 15000 cycles. EIHP2 B12.3 will adopt final sentence of ISO 15869–1.2 Cl.D16, modified for EIHP pressure cycle concept

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Comment from N08: Change ISO15869 to 15000 cycles. EIHP2 B12.3 will adopt final sentence of ISO 15869–1.2 Cl.D16, modified for EIHP pressure cycle concept
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.	Y	Delete iv)
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: Adopt criteria of equivalent test in ISO 11119	N	The specification of –40 is given by the vehicle manufacturer and shall be followed.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 B13.2		Luxfer	Why two cylinders for this expensive test? Proposed change: Test one unit only	Y	
Ann.7: B13		Quantum	i) Why are two tanks required for this test? ii)Temperature requirements should be applicable for the tank, not the fluid. iii) Why a hold of the tank at –40 C for 48 hours?		ISO and EIHP are to harmonize as follows: i) One tank is enough ii) The text should be modified so that it is clear thatthe tank surface and the fluid temperatures are to be monitored. iii) EIHP is to replace iv) with the equivalent ISO text.
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?	?	Comment possibly based on misinterpretation of original filling/pressure cycle definition, it is intended to be 1.5 x filling cycles, i.e. 7500.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 7 B14.2	ISO/CD 15869-1, clause D.17	Lincoln	i) 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. ii) 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 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.	i) Y ii) Y	Comments from N08: i) EIHP to harmonise with ISO See Leak Test Gas comment ISO to harmonise with the EIHP text.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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).	i) Y ii) -	Comment from N08: ISO to harmonise with EIHP
Annex 7 B 15.2		AGA AB	The Test Pressure is too low Reintroduce Design Pressure 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)	N	Comment from N08 on related proposals by AGA: No support for this proposal at the meeting

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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	P	This comment applies to B15.2, not B15.3. The text in B15.2 has been changed at the Munich meeting, ref. "GRPEISO-N09-proposals.doc".
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.	Y	
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.	-	See Change No.2

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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.		15000 same as ISO for batch (ISO has 45000 for type approval), we have an option for lower cycle life.
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.	N	An option for lower cycle life is included
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.	Y	

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	Y	Harmonise with ISO
Ann.7: B18.2 Acid Environment Test - Procedure		Powertech	Editorial – subsection f) should be section iv), and the other sections renumbered accordingly.	Y	Added to Rev.10

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	N	The text follows ISO, and v) should maybe also read (added text underlined): "Pressurise to 1.25 times Working Pressure and hold at that pressure for a minimum of 24 hours until the elapsed exposure time, i.e. pressure cycling and pressure hold, to the environmental fluids equals at least 48 hours,
Ann.7: B19		RA	Hydrogen or nitrogen or air or … This is if there are no significant differences in the pressure development vs heat input during fire. It is the PRD that must take care of initiation and flow capacity for the intended gas, i.e. hydrogen.	-	Reword 2nd sentence of B19.2 to: "The *Container* shall be pressurised to *Working Pressure* with hydrogen or a gas with a higher thermal pressure build up."
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.	-	Reword 2nd sentence of B19.2 to: "The *Container* shall be pressurised to *Working Pressure* with hydrogen or a gas with a higher thermal pressure build up."

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Reword 2nd sentence of B19.2 to: "The *Container* shall be pressurised to *Working Pressure* with hydrogen or a gas with a higher thermal pressure build up."
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".	Y	Harmonise with ISO wording
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.	Y	See above comment
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	Y	Comment from N08: EIHP to harmonise with ISO

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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		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,	Y	Comment from N08: EIHP to harmonise with ISO
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.	Y	Comment from N08: EIHP to harmonise with ISO

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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	i)Flaw size shall be specialized. ii)Acceptable criteria are no leak and rupture within the number of filling cycles in EIHP. iii)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.	i) Y ii)- iii) P	Comment from N08: i) EIHP to harmonise with ISO ii)- iii) EIHP to harmonise with ISO
Annex 7 B22 & B23			Combine tests B22 & B23	Y	Comments from N08: i) Delete test B22 high temp. creep test from both documents. ii) Harmonise EIHP with ISO for B23 by removing humidity requirements
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.	-	Comment from N08: Delete test B22 high temp. creep test from both documents.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	Comment from N08: Delete test B22 high temp. creep test from both documents.
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.	Y	Comments from N08: i) Delete test B22 high temp. creep test from both documents. ii) Harmonise EIHP with ISO for B23 by removing humidity requirements
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	Y	Comments from N08: i) Delete test B22 high temp. creep test from both documents. ii) Harmonise EIHP with ISO for B23 by removing humidity requirements

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	Y	Comment from N08: Harmonise EIHP with ISO for B23 by removing humidity requirements
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.	Y	Comment from N08: Harmonise EIHP with ISO for B23 by removing humidity requirements
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) require 3 drops. Proposed change: Adopt criteria in ISO 11439,		See the agreed Change No.3 (Doc. N26)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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,		See the agreed Change No.3 (Doc. N26)
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.		See the agreed Change No.3 (Doc. N26)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B24.2 Drop Test - Procedure	ISO/CD 15869-1, clause D.9	Powertech	Multiple drops may be excessive – the purpose of the drop test is to 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.		See the agreed Change No.3 (Doc. N26)
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.	N	
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.	N	Both EIHP and ISO are harmonized at 1 ml/hr/l.

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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		Luxfer	What is Ncm3? Proposed change: Leak rate of 0.25 ml/l/h	P	1ml/HR/L harmonises with ISO Retain EIHP units as these relate to a gas at NTP – if necessary define “N”.
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.	N	Harmonised with ISO B25.2ii – replace “leakage” with “permeation”
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?	N	Yes, it does. The boss torque test verifies that the Container is still OK after being subjected to twice the installation torque of valves or PRDs. It is not concerned with the tank installation itself.

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Ann.7: B26.2		RA	Include line before section iii): "For type approval, the following tests shall also be conducted:" For batch tests on the other hand, there is no need to describe the tests to follow this one, as this is given by Table 7A.6.	P	iii) For type approval, the following tests shall also be conducted: a) b)
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.	-	Harmonise with ISO by stating a 5min maximum filling time and removing the cycle time

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	Y	EIHP to harmonise with ISO
Ann.7: B27.3		Luxfer	Why is only the boss/liner interface examined? Proposed change: Liner shall be visually examined for damage and design rejected if the liner exhibits visual damage	P	EIHP to harmonise with ISO by changing text in B27.2.iii) and B.27.3 from “liner/end boss interface“ to “liner and liner/end boss interface“.
Annex 8 & 9		Air Products	The order of tests in Annex 8 did not match the order in annex 9. This made reading awkward.	-	See Annex 8 proposals (N22)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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.	-	See Annex 8 proposals (N22)
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.	-	See Annex 8 proposals (N22)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
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. 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.	-	See Annex 8 proposals (N22)
Ann. 8A		Luxfer	Are only temperature triggered PRD's allowed? Proposed change: Redefine requirements.	-	See Annex 8 proposals (N22)
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.	-	See Annex 8 proposals (N22)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 8D			A connect / disconnect test should be specified for receptacles in accordance with the test defined in ISO 17268	-	See Annex 8 proposals (N22)
Annex 8F, Item 3		UTC Fuel Cells	Why EN's in global document	-	These were appropriate standards, but are now deleted. Reference is made to ASTM without a European or Japanese equivalent, however where non-ISO standards are referred to equivalent national standards are permitted.
Annex 8G Provisions Regarding the Approval of Flexible Fuel Lines		Powertech	There should be a requirement that flexible hoses are electrically conducting, i.e. a maximum resistance requirement.	-	See Annex 8 proposals (N22)
Annex 8G, Item 2.5.4.2		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.	-	See Annex 8 proposals (N22)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 8G, Item 2.5.4.3		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.	-	See Annex 8 proposals (N22)
Annex 8G, Item 4.5.4.2		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.	-	See Annex 8 proposals (N22)
Annex 8G, Item 4.5.4.3		UTC Fuel Cells	State requirement relative to MAWP. Value appears too low.	-	See Annex 8 proposals (N22)
Annex 8H		Quantum	The endurance test for fittings should not be required because of the connection test in Annex 9	-	See Annex 8 proposals (N22)
Annex 8I		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.	-	See Annex 8 proposals (N22)

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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 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 incremental costs added by using pure H2 or He can be amortized over many pieces.	-	See Annex 8 proposals (N22)
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.	-	See Annex 8 proposals (N22)
Annex 9 – 4 Pressure Test		Powertech	A hydrostatic proof test of 3 times the working pressure should be a requirement.	-	See Annex 8 proposals (N22)
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	-	See Annex 8 proposals (N22)

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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		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.	-	See Annex 8 proposals (N22)
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	N	i) Not necessary any changes can be based on WP ii) See Annex 8 proposals (N22)

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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 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	-	See Annex 8 proposals (N22)
Annex 9 Clause 6.4, 6.5 & 6.6 Probably refers to 5.4		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.	-	See Annex 8 proposals (N22)
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?	-	See Annex 8 proposals (N22)

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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 7.3		Powertech	i) 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. ii) Change to nitrogen or hydrogen	-	See Annex 8 proposals (N22)
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	-	See Annex 8 proposals (N22)
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	-	See Annex 8 proposals (N22)

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Paragraph/ Annex	Related clause in ISO drafts	Organisation	Comments/Proposed Modification	Agreed	Final Modification Or Reason For Rejection
Annex 9 - 13		Quantum	The minimum pressure during cycle is specified as atmospheric pressure. This will lead to interpretations. A better value would be 2Mpa as you minimum pressure.	-	See Annex 8 proposals (N22)
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.	-	See Annex 8 proposals (N22)
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."	-	See Annex 8 proposals (N22)

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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 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.”	-	See Annex 8 proposals (N22)
Annex 9 - 15		Quantum	The test scope needs to be defined.	-	See Annex 8 proposals (N22)
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.	-	See Annex 8 proposals (N22)
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	N	This is a standard ECE text.

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.

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.

****

Change No.1

2.1.5 "*Batch*": A *Batch* shall be a production quantity of successively produced *Finished Containers* having the same nominal dimensions, design, specified materials of construction, process of manufacture, equipment for manufacture and, where appropriate, conditions of time, temperature and atmosphere during heat treatment.

A5.1.1 General

The *Manufacturer* shall conduct batch testing on *Finished Containers* that are representative of normal production. The *Finished Containers* to be tested shall be randomly selected from each *Batch*. A *Batch* shall not exceed 200 *Finished Containers* plus those *Finished Containers* to be used in destructive tests, or one shift of successive production, whichever is greater.

With reference to Table 7A.6, the following batch tests are required:

- **i) One *Finished Container* shall be subjected to the ambient temperature pressure cycle test at the frequency given in Paragraph A5.1.2 of this Annex,**
- **ii) One *Finished Container* shall be subjected to the burst test. If a *Finished Container* passes the ambient temperature pressure cycle test the same *Container* may be subjected to the burst test,**
- **iii) Include the text of the A5.1.1 iii) from revision 9**
- **iv) If an exterior environmental protective coating is used, e.g. organic coating/paint, one *Finished Container* or test sample that is representative of the *Batch* shall be subjected to the coating batch test.**

If more *Containers* than required are subjected to the tests, all results shall be documented.

All *Containers* represented by a batch test that fail to meet the specified requirements shall follow the procedures specified in Paragraph A5.2 of this Annex.

Table 7A.6 - Batch Tests

Test and Annex Reference		Applicable To *Container* Type				Specified Design Value	Test Value
		1	2	3	4		
	Add the tensile test and charpy impact test with reference to ISO 9809 and ISO 7866 B1 for non metallic materials						
B10	Coating Batch Test	X	X	X	X		
B14	Leak Test				X		
B16	Burst Test	X	X	X	X		
B17	Ambient Temperature Pressure Cycle Test	X	X	X	X*[1]		
B26	Boss Torque Test				X		

Notes:
*[1] - Test to be performed between the Boss Torque Test (B26) and the Leak Test (B14)

B6.1 Sampling

The test applies to *Container* Type 4.
The test applies to plastic materials only.

Number of *Liners* to be tested for type approval: 1.

B6.4 Results

The softening and melting temperature values shall be presented in a test certificate, e.g. Table 7A.3 of this Annex.

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*”.*

****

Change No.5

Note: Changes 3 & 4 are referred to in Doc. N08.

2.1.x *"Container Assembly"*: A bundle of two or more *Containers* with integral interconnecting fuel lines that are protectively encased inside the bundle, excluding any other *Hydrogen Components* which may be attached to or fitted inside the bundle.

In Chapter 14 change all references to "*Container*" to "*Container Assembly*".

Change all references to "*Container* or assembly referred to in Paragraph 6.2.3 of this Regulation " to "*Container* or *Container Assembly*".

6.2.3 At the request of the *Manufacturer*, a *Container Assembly* shall be type approved as one *Container* if the *Container Assembly* including interconnecting fuel lines fulfils the provisions laid down in Annex 7 to this Regulation and Paragraphs 6.9 or 6.12 of this Regulation as appropriate.