ISO/TC 197
Hydrogen technologies

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ISO DIS 19881 Collated Comments 2017-09

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Template for comments and secretariat observations

Date:2017-09-22	Document: DIS 19881	Project: WG 18

MB/ NC[1]	Line number	Clause/ Subclause	Paragraph/ Figure/Table	Type of comment[2]	Comments	Proposed change	Observations of the secretariat
FR 1 001				ge	The tests are performed at 85°C and at pmax but the protocol for the use include reaching this maximum pressure and temperature. In this case, it will be better to perform to perform the tests at higher pressure and temperature in order to avoid to be obliged to scrap the cylinders if by mistake these temperature and pressure are exceeeded"		
GB 002				ge	The need for this standard is fully understood and agreed but the existing DIS requires significant work to enable it to be implemented in a satisfactory manner. It is requested that this standard does not progress to FDIS until appropriate changes have been made		
US 01 003		01		ge	Scope does not indicate for land vehicles only.	…containers intended only for the storage of compressed hydrogen gas for land vehicle operation.	
US 02 004		01		ge	Consistency with terminology throughout document.	Change all references from "fuel cell vehicles" to "hydrogen fuelled vehicles"	
GB 005		01		te	This needs to be amended to define what is included/excluded and give the limits on operating conditions. As drafted it is unclear.	Expand to include different cylinder types covered, temperature limits etc.	
GB 006		01	a)	te	It is stated that cylinders are to be permanently mounted. Can they be removed or substituted?	Previous comment clarifying the meaning of “permanently mounted” needs to be incorporated into the text	
FR 2 007		02		ed	The list should be presented per ISO rules		

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FR 3 008		02		ed	Is it possible to list standards that are not ISO standards?		
US 03 009		02		te	Currently, all standards are referenced by date. While this ensures technical changes are not made without knowledge, it risks that referenced standards become obsolete or withdrawn as new editions are published. It is recommended that dates are removed, and if specific technical requirements are needed, they be placed directly in ISO 19881.	Delete the dates from all referenced standards	
GB 010		03.01		te	This is not in keeping with ISO rules. Standards should specify technical requirements.	Remove in accordance with ISO rules	
US 04 011		03.05		ge	Should include a definition for “container category”. Note: Term is often used but never defined. Use is more specific than the “Webster’s definition” so, should be defined in the standard.	Container category classification of containers based on usage and approach to regulation and approval Note—Requirements for the categories are given in 4.1.2. Category A and Category B containers are intended to provide a sufficient level of safety for the intended application, but test methods, and records are different to facilitate regulatory compliance.	
GB 012		03.05		te	Why do we need 3 different categories of container?	Add clarification for different categories and give examples.	
DE 013	1	03.05		Te	Category B contains the restriction of Type 4 containers only	Delete the restriction of the container type	

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GB 014		03.06		te	These definitions are not in keeping with those typically found in the TC58 standards. e.g. ISO 10439, ISO 10286	Align with ISO TC58 definitions	
US 05 015		03.11		ed	Clarify that while full wrap covers the domes, it does not cover the end boss	…including the domes, but not over the end boss.	
US 06 016		03.14		ed	Reference to Clause 12.3 is incorrect, should be 11.3.	…leak test gas in Clause 11.3.	
US 07 017		03.14		te	First – requirements cannot be put in definitions. Second – specifying a blend with a minimum of 10% of H2 or He is not necessary technically, and inconsistent with the stated requirements of 11.3, which allows “an acceptable alternative”. Specifically, 2% mixtures of He are known to be easily detectable in a leak test, and 95%/5% mixtures of N2/H2 are known to be detectable, and are common, since any leakage of this gas mixture in air will not result in a combustible mixture	Modify definition: Gas for testing leaks that consists of dry hydrogen, or dry helium, or blends that contain these gases at a detectable level.	
DE 018		03.14		Te	Typical test gases for leak tests consist of 95% N2 and 5% H2.	Please reduce minimum hydrogen content to 5%.	
GB 019		03.23		te	ISO 19078 applies to CNG cylinders, the pressures and stresses in these containers will be different to those in the containers described here. Further manufacturers recommendations could vary significantly	Definition to be modified accordingly	
GB		04.01.1	note	te	Is this appropriate for a technical standard? Is it feasible for a manufacturer to be able to certify	Remove note.	

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020					against “all” regulation?		
US 08 021		04.01.2		te	Need to clarify that the category A application is for cylinders and not included in category B. Remove category C and include into category A with clarification regarding the cycle life criteria to remain aligned with HGV-2 and to avoid unnecessary category distinction. Revise to clarify the interaction between this document and the GTR. If this comment is accepted, need to remove Category C throughout document. Also need to add the number of cycles for Category A hydrogen powered industrial trucks.	Rewrite 4.1.2 to read as follows: a) Category A containers are intended to be used for hydrogen fueled vehicle applications that are outside the scope of Category B. b) Category B containers are intended to be consistent with the UN GTR No. 13 for hydrogen fueled vehicles of ECE category 1-1 and 1-2. Additional qualification testing may be required to comply with the UN GTR No. 13. NOTE—The UN GTR No. 13, when adopted by a regulatory authority within its jurisdiction for a given class of vehicles, would supersede the requirements of this ISO standard. It is not intended that the requirements of this ISO Standard would be imposed in addition to the UN GTR No. 13 requirements.	
GB 022		04.01.2	4th para	te	Regulatory compliance is not appropriate for standards.	Delete text referring to regulatory compliance	
FR 5 023		04.01.3		te	Why do we limit lifetime to 25 years?		
US 09 024		04.01.4		te	Need to consider how these various category tanks are identified and controlled to avoid the usage of a certain category tank for the incorrect application	Add criteria to confirm category tank and application	
US 10 025		04.02.2	Item b	te	The pressure after fill represents a “normal” condition. This should be clarified. Also, the	Modify item b as follows: normally up to 125 percent of the nominal working	

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					possibility of highly infrequent rise to 150% is possible under multiple fault conditions is possible. What temperature – tank or ambient?	pressure immediately after filling~~, regardless of temperature~~ and infrequently up to 150 percent under dispenser fault conditions. See ISO 19880-1.	
US 11 026		04.03		ge	Need explanation of the various categories.	Include a note to refer to the rationale in Annex D (D.3, D.4 and D.5)	
GB 027		04.03	b)	te	What is the rationale for the three values for b)? What determines which is to be used?	Clarify	
US 12 028		04.04.1		ed	Not clear for the reason for indicating “low of” and “high of”	Eliminate “low of” and “high of”	
GB 029		04.04.1		te	These are ranges. It is unlikely that a settled temperature would be at 85°C. If the permitted temperature range is -40°C to 85°C it is unreasonable to assume that settled temperatures at extremes are achievable.	Clarify	
GB 030		04.04.3		te	The clause suggests that temperatures can go above 85°C. Specific limits of time and temperature need to be defined.	Define limits.	
GB 031	2	04.07	2nd para	te	Is it appropriate to include regulations?	Change to “The vehicle manufacturer or system integrator shall be responsible for the protection of the container valves, pressure relief devices and connections. If this…..”	
GB 032		06.02		te	This is a performance based standard, therefore appropriate criteria and test methods need to be specified.	Include appropriate criteria in normative text	
US 13		06.03.1		te	Lead and bismuth are limited to 0.003 %. The	Consider removing the requirement for lead and	

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033					traditional limits for “other” elements for alloy 6061 is typically 0.05%. The value was reduced to 0.0003 when it was thought that lead and bismuth were the factors in sustained load cracking, which has now been attributed to excess silicon. Given that excess silicon has been shown to be issue with sustained load cracking, would it not be appropriate to revisit the limit?	bismuth to be limited to 0.003%, vs. 0.05%.	
US 14 034		06.03.1		te	Given that excess silicon alloys are known to be a problem with sustained load cracking, it would be best to exclude them rather than recommend against them.	…Excess silicon 6xxx series aluminium alloys with yield strengths above 250 MPa (e.g. 6351 and 6082 ~~should~~ shall not be used in fuel containers of liners.	
JP 035		06.03.1		te	Material properties At the moment, the material property specifications shall not be indicated concretely like "a maximum tensile strength of 950 MPa for chrome-molybdenum steel" In the document of UN GTR13, there is the indication below. **Material compatibility and hydrogen embrittlement** "...the SGS working group recommended that Contracting Parties continue using their national provisions on material compatibility and hydrogen embrittlement and recommended that requirements for these topics be deferred to Phase 2 of the gtr activity." Several countries have been conducting their research towards GTR13 Phase 2. In the latest research in Japan, the acceleration limits of fatigue crack growth don't exist on chrome-molybdenum steel which have a extremely high tensile strength in hydrogen environment. In this case, it is impossible to apply design by analysis to cylinder design. ISO 9809-1 seems not to cover the conditions of high pressure hydrogen gas.	The following red letters should be deleted. Steels shall be aluminum killed and produced to predominantly fine grain practice. ~~Steels shall have a maximum tensile strength of 950 MPa for chrome-molybdenum steel and 880 MPa for carbon-manganese steels. For all other steels,~~ the container manufacturer shall demonstrate that exposure to high-pressure hydrogen under the service conditions provided in Clause 4 will not cause any harmful corrosion, deformation, or deterioration of the material.... ~~The following limits shall not be exceeded in the cast analysis:~~ (should be deleted including the table) ~~NOTE 950 MPa is the accepted maximum value per ISO 9809-1.~~	

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GB 036	3	06.03.1	3rd para.	te	The restricted alloys are not clear.	Change to “Aluminium alloys 6351 and 6082 shall not be used.”	
US 15 037		06.05		ed	Clarification of intent, that hybrid fiber reinforcement is allowed.	“Structural reinforcing filament material types shall be glass fiber, aramid, fiber, or carbon fiber, or mixtures thereof. If…”	
GB 038	2	06.06	2nd para.	te	Delete note and add required Tg criteria to normative text		
DE 039		07.03.1		Te	Simulation of composite reinforcement sufficient Additional simulation of the liner results in an increased simulation effort.	Delete liner	
GB 040		07.03.1	1st para.	te	Why is B not included? Stress analysis must be included for all categories of cylinders	Change to “The stress analysis is applicable to all categories.”	
GB 041		07.03.2		te	What is the rationale for the values of stress ratio’s used?	Add explanation/justification.	
GB 042		07.03.3		te	Further explanation is required.	Add explanation/justification.	
GB	3	08		te	Permit taper threads for aluminium alloy cylinders?		

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043							
GB 044		09.01 , 9.2		te	It is not the role of an ISO standard to specify conformity assessment, this is the role of national regulations.	Remove – see ISO rules	
GB 045		09.03		te	This section needs to be amended. Standards must specify what should be done, but not who does it. This is the duty or regulations.	Amend as necessary – see ISO rules	
GB 046	3	10.01		te	The un-acceptable defects need to be specified.	Add specific requirements.	
DE 047		10.03		Te	What is the reason to conduct the tensile testing at -50°C, at ambient temperature, and at 85°C? Container temperatures are restricted from -40°C up to +85°C.	Please provide rationale	
GB 048		10.03	3rd para.	te	As the Secretariat replied previously the value of -50°C “is based on an allowance for lower temperatures which may occur during rapid defueling during vehicle operation”. If this is the case then should the upper value of 85C also be increased i.e. to accommodate the maximum temperature during filling		
US 16 049		10.08		ed	Clarify wording	Add a comma after “9809-1”.	
GB		11.01	a)	te	There is no specific requirement within the standard for the manufacturer to specify limits.	Minimum requirements to be specified	

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050							
GB 051	3	11.02		te	Delete reference to CGA Pamphlet	Delete reference to CGA Pamphlet	
GB 052	3	11.02		te	30s is considered to be insufficient time and particularly for large containers.	Give consideration to a longer period, e.g. 1minute for “portable” containers and 2 minutes for larger containers.	
GB 053		11.03		te	The hazards associated with the release of gas must also be highlighted.	Add suitable **“WARNING NOTICE”**	
GB 054		12.04.2.2		te	1 burst test in 10 batches is too few e.g. resin control and cure can change from batch to batch	Increase the frequency of burst testing	
GB 055		12.04.2.3		te	How would it be possible to test containers that may already have been installed? Is it practical to recall and test cylinders?	Reconsider requirements	
GB 056	3	12.05.2.1	b)	te	What determines the relevant number of test cycles? Why are there 3 different options for Category B cylinders? Change kPa on last line to MPa	Clarify. Change kPa on last line to MPa	
GB 057	2	12.05.2.3		te	Every 10th batch is too few.	Increase frequency – 12.4.2.2	

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US 17 058		16.01.2		te	Need to consider how these various category tanks are identified and controlled to avoid the usage of a certain category tank for the incorrect application	Revise 16.1.2 a) i d as follows: number of **design** cycles ~~used in the test program (Category B containers only)~~	
GB 059		16.02		te	Dispatch as identified in 16.2 is not dispatch i.e. it is an inspection requirement	Rename section	
GB 060		17		te	Quality assurance requirements are not appropriate for an ISO standard. The following text is used by ISO/TC 58 ***Inspection and testing*** *The following text on inspection and testing is applicable for standards for design and manufacture of an ISO/TC58 product or for periodic inspection:* *Assessment of conformity to this international standard shall be carried out in accordance with the applicable regulations of the countries of use.* *Tests and examinations performed to demonstrate compliance shall be conducted using instruments calibrated before being put into service and thereafter according to an established programme.*	Modify text accordingly	
GB 061	3	18.01		te	Incorrect term – see text above	Replace “Independent inspection or test agency” with “Inspector” and add a definition for inspector in 3.	
GB 062		18.01	Table 4	te	What is the justification for having reduced testing for category B containers? Category B should be removed.	Remove.	
CA		18.03.11.2		te	Tolerance required for temperature. It is impossible	“…placed in an enclosed chamber at 15C ±2C, …”	

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063					to hold the environment at exactly 15C. To use 15C as a nominal value is not reasonable since permeation rate is temperature sensitive so what deviation from 15C is acceptable? EC 79 uses ±2C, HGV2 uses 20C±5C which is probably too broad. Permeation rates at 15C would vary from those at 25C. Suggest the EC 79 value.	OR "…placed in an enclosed chamber at 15C ±5C, …"	
US 23 064		18.03.11.2	3	te	"….and monitored for 500 hours to establish a steady state permeation rate." This is not clear. "Steady state" is not defined. Does the test only last 500 hours regardless of whether "steady state" is reached? Or must there be 500 hours AND steady state reached?	Eliminate the "steady state" term. Just require permeation at the end of 500 hours to be below the maximum allowable. If there is concern that there is a rising value occurring even at the 500 hour mark, then increase the length of the test to 1,000 hours, at which time still cannot exceed the permeation limit.	
CA 065		18.03.11.2	Procedure	Te	The statement that a container shall be "….monitored for 500 hours to establish a steady state permeation rate" is unclear. What is the definition of steady state? Does the test only last 500 hours regardless of whether "steady state" is reached? Or must there be 500 hours AND steady state reached?	Either steady state should be defined as something like "less than 1% change in permeation rate over any 24 hour period", or the test should simply be a 500 hour test period, and the rate of permeation measured at the end of 500 hours shall be less than 6.0 Ncc of hydrogen per hour per liter water capacity.	
US 24 066		18.03.12.2		te	The torque should be applied in each direction (insertion and removal).	"…to twice the installation torque specified for the fittings, in both the clockwise and counter-clockwise directions. The container…"	
US 25 067		18.03.13.2		ed	The reference to clause 5.4 should be to clause 4.4.	"…as specified in Clause ~~5.4~~ 4.4."	
US 26 068		18.03.13.2		te	Considering the size of some fuel tanks, and the shortage of hydrogen gas cycle test facilities worldwide, manufacturers should be allowed to either use subsize tanks for this test (same diameter, but shorter length), or be allowed to insert filler material into tanks to reduce volume. The purpose of the test is to determine the combined effect of permeation, stress, and temperature has on the liner material, especially in the vicinity of end bosses. This can be accomplished with representative subsize tanks.	"Manufacturers may use tanks of reduced volume for this test, either by reducing the length of a design such that the end dome stresses are not affected, or by using a filler material inserted into a tank to reduce the internal volume."	

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US 27 069		18.03.13.2		ed	Clarify wording	"… The fill rate shall not exceed 60 g/s, and the maximum allowable gas temperature shall not be exceeded. The…"	
GB 070		18.03.13.2		ge	Cycling with hydrogen is a specialised process. Are such facilities readily available?		
DE 071		18.03.13.2		Te	The splitting of the second 500 cycles into 250 cycles at -30°C and 250 cycles at 50°C leads to much tougher requirements on the test environment (cooling chamber needed).	The second 500 cycles should be conducted completely at 50°C according to HGV2.	
CA 072		18.03.13.2		ed	Same as comment for 18.3.7.2 "….to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)"	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
CA 073		18.03.13.2		ed	Clause 5.4 doesn't exist. They must mean Clause 4.4	"….as specified in Clause ~~5.4~~ 4.4."	
CA 074		18.03.13.2	Procedure	Te	The requirement that "The fill rate shall not exceed 60 g/s and the maximum allowable gas temperature. The defueling rate shall be specified by the container manufacturer and shall not allow the gas temperature to be lower than the minimum allowable gas temperature as specified in Clause 5.4", can result in an exceedingly long test when larger volume containers are involved. There also may not be any test facilities capable of conducting such a test when larger container volumes are involved. Consideration needs to be given to allowing the internal container volume to be reduced. Since temperatures are controlled by the fueling and defueling limitations, then the hydrogen	"Each cycle shall consist of filling and venting of the container. The fill rate shall not exceed 60 g/s and the maximum allowable gas temperature. The defueling rate shall be specified by the container manufacturer and shall not allow the gas temperature to be lower than the minimum allowable gas temperature as specified in Clause 5.4. *The testing may be conducted on a container with a reduced internal volume*. *Alternatively, the length of a design may be reduced such that the end dome stresses are not affected.*	

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					gas cycle test examines the combined effects of permeation and stress on the liner and liner/end boss interface. The effect of temperature is therefore considered even if the volume of the container is reduced.		
CA 075		18.03.14.3	Acceptable results	Te	"All containers shall either fail by leakage or exceed 45 000 pressure cycles." This number of cycles is far too excessive (what container in service will possibly go 45,000 cycles, representing tens of millions of miles) and needlessly time consuming in test labs (especially where Type 4 designs are involved). If a container does not fail within the number of cycles allowed under 18.3.2.3 (or 4.3), then the point has been proven that the design has LBB performance exceeding its design life (considering that one is cycle testing to 1.5x WP, rather than the 1.25x WP in normal service)	"All containers shall either fail by leakage or exceed ~~45 000 pressure cycles~~ the maximum number of filling cycles *for the design category*."	
CA 076		18.03.2.2		ed	Same as comment for 18.3.7.2 "….shall be pressure cycled, 2 (± 1) MPa to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)"	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
CA 077		18.03.2.3		Te	"(e) Category A containers exceeding a number of cycles that is 1 500 times the service life in years, or Category B containers exceeding 22 000 cycles, or Category C containers exceeding a number of cycles that is 2 250 times the service life in years, are permitted to fail by leak or rupture." 22,000 cycles is an excessive cycle life requirement. It represents safety factor on safety factor. It unfairly penalizes Type 3 designs as they have more limited pressure cycle lives compared to Type 4 designs. But fatigue life is over-rated. No container has ever failed in CNG service due to fatigue cracks. No container in CNG service has even experienced fatigue cracks. There is too much emphasis on fatigue life in the standards	Delete (e). Item (e) actually does not appear to makes sense – if a container completes the (a), (b) or (c) requirements, why is there any need to complete the (e) requirement?	

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					(and not enough on the causes of actual in-service failures!).		
US 18 078		18.03.2.3	e)	te	Document does not need to specify how the containers are destroyed – too prescriptive.	Category A containers that do not fail within a number of cycles that is 1 500 times the service life in years or Category B containers exceeding 22 000 cycles shall be destroyed.	
DE 079		18.03.2.3	Note	Te	The containers are specified to withstand a maximum temperature. If the fluid temperature rise above the ambient temperature it has to be limited to the specified max. temperature of the container	Change text to: It is acceptable for the pressurizing fluid to rise above the ambient temperature as long as the temperature of the test chamber and the fluid do not exceed the maximum specified temperature of the container.	
GB 080		18.03.2.3	Note:	te	A maximum temperature should be specified.	Add max. temperature	
CA 081		18.03.3.2.2		Te	Pendulum Impact Pre-Conditioning – The angle of the pyramid needs to be specified, otherwise the pyramid could be very pointed or very flat. Delete the specification that "…its distance from the axis of rotation of the pendulum shall be 1 m." This is because the length is a function of the angle (maximum height) of the pendulum when released. The 30J force is a function of the length of the connecting rod, the mass of the pendulum, and the angle (maximum height) applied on release.	Insert the requirement that the angle of the pyramidal faces shall be 45 degrees. Delete the 1 m requirement, as it is just one of the variables required to achieve 30J force.	
US 19 082		18.03.3.2.3	2	te	"Apply an amount of the test fluid to the glass wool sufficient to wet the pad evenly across its surface and through its thickness for the duration of the test, and sufficient to confirm that the concentration of the fluid is not changed significantly during the duration of the test." The methanol and nitrate fluids evaporate relatively quickly. It is not possible to ensure the pads are evenly wetted or the concentration has not changed for the duration of	Apply an amount of the test fluid to the glass wool sufficient to wet the pad evenly across its surface and through its thickness ~~for the duration of the test, and sufficient to confirm that the concentration of the fluid is not changed significantly during the duration of the test~~ *immediately prior to the start of pressure cycling*. Reapply the test fluid as needed to maintain pad saturation.	

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					the test. It is better simply to state an amount of chemical to be applied at the start of the test.		
GB 083		18.03.3.2.3 Environmental fluids for exposure		te	It refers to "percent solution by volume". This is simpler expressed as an explicit ratio of units. For example "19 percent solution by volume" is simply "190 ml/l" or "190 mL/L". This is in line with modern practice and guidance within ISO and the SI authority relating to values where the numerator and denominator are the same quantity.	Replace "19 percent solution by volume" with "190 ml/l". Go through the draft and replace all values expressed as percent by volume with values expressed as ml/l.	
CA 084		18.03.3.2.4		te	The para requires pressure cycling followed by a minimum 24 hour pressure hold "…until the elapsed exposure time (pressure cycling and pressure hold) to the environmental fluids equals 48 hours." With a variable pressure cycle rate (albeit with a maximum pressurization rate specified), it's not reasonable for the standard to require the pressure cycling and pressure hold durations to total exactly 48 hours.	"…until the elapsed exposure time (pressure cycling and pressure hold) to the environmental fluids ~~equals~~ totals a minimum of 48 hours."	
CA 085		18.03.3.2.4		ed	Same as comment for 18.3.7.2 "….shall be pressure cycled, 2 (± 1) MPa to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)"	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
CA 086		18.03.4.2	(b) and (e)	ed	Same as comment for 18.3.7.2 "….shall be pressure cycled, 2 (± 1) MPa to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)"	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
CA 087		18.03.5.2		te	Statement "…at pressures in excess of 150 percent of the nominal working pressure (±1 MPa) exceeds 350 kPa per second…" is awkward. No need for a tolerance on an absolute value. If the pressure exceeds 150 percent of nominal working pressure, the procedural requirements are	"…at pressures in excess of 150 percent of the nominal working pressure ~~(±1 MPa)~~ exceeds 350 kPa per second…"	

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					triggered.		
GB 088	3	18.03.6	2nd para.	te	To clarify what is required, a diagram should be added.	Add diagram of test arrangement.	
CA 089		18.03.6	Flaw tolerance test	Te	A useless test – it has never been shown to do anything to any container design that that I have tested over the last 20 years. The amount of damage is insignificant. If it is decided not to delete this test, then there is a need to better define the flaw dimensions - it provides the lengths of the flaws (25 mm and 200 mm), but where is this length measured? On the outside surface, or on the bottom of the cut between where the required depth begins and ends (i.e. ignoring the radius on the edge of the cut caused by the use of a cutting wheel)?	Delete. If not deleted, specify that the specified cut depth shall extend for the entire specified length of the flaw. Industry should develop a meaningful alternative test to address the reduction in laminate thickness.	
CA 090		18.03.6.2	(b) and (d)	ed	Same as comment for 18.3.7.2 "….shall be pressure cycled, 2 (± 1) MPa to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)"	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
GB 091	1	18.03.6.2	a)	te	The geometry of the flaws need to be defined more precisely. Comment previously accepted but change not implemented	Define the flaws more specifically. See ISO7866 Annex E as an example.	
US 20 092		18.03.6.2	a) and c)	te	It provides the lengths of the flaws (25 mm and 200 mm), but where is this length measured? On the outside surface, or on the bottom of the cut between where the required depth begins and ends (i.e. ignoring the radius on the edge of the cut caused by the use of a cutting wheel)?	Use the bottom of the cut, because otherwise one could measure the surface as 200mm, but only, say, 10 mm of the length could be at the required depth.	
US 21		18.03.7.2	b)	ed	"… shall be pressure cycled, 2 (± 1) MPa to at	"… shall be pressure cycled, 2 (± 1) MPa to ~~at least~~	

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093					least 125 percent of nominal working pressure (±1 MPa) ….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)'	125 percent of nominal working pressure (±1 MPa) ...".	
CA 094		18.03.7.2	Procedure b)	Ed	"….shall be pressure cycled, 2 (± 1) MPa to at least 125 percent of nominal working pressure (±1 MPa)….". It can't be "at least 125 percent" if one is allowing +/- 1 MPa. Simply say "125 percent (+/- 1 MPa)'	"….shall be pressure cycled, 2 (± 1) MPa to ~~at least~~ 125 percent of nominal working pressure (±1 MPa)….".	
DE 095		18.03.8		Te	For what reason is the permissible ambient temperature range restricted between -7°C and +43°C?	Please delete the following sentence: Testing shall be conducted with ambient temperatures between -7°C and 43°C.	
GB 096		18.03.8.2.1	1st para.	te	Understand that the container is qualified with a particular PRD and this needs to be made clear in the text	Incorporate texting stating that the container is qualified with a particular PRD	
GB 097		18.03.8.2.1	2nd para.	te	The dangers associated with using hydrogen in the fire test need to be emphasised and highlighted.	Add further **WARNING**, bold text etc.	
US 22 098		18.03.8.2.2	3	ed/te	The meaning of "pressure compensated for ambient test temperature" is not clear. Does this mean that the contained mass in the tank should be correct? Or that the tank should be at a given pressure?	"Containers shall be pressurized with hydrogen to nominal working pressure (±1 MPa), pressure compensated for ambient test temperatures, <u>such that the proper mass of gas is contained,</u> and placed…"	
CA 099		18.03.9.2		te	Tolerance required for temperature, unless we agree the temperature is a nominal value. Suggestion is for this to be a limit, i.e. a minimum of 85C.	"…while at a minimum temperature of 85C."	
GB		18.04	2nd para.	te	It is not the duty of the inspector to define test requirements, these should be included in the	Add specific requirements.	

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100					standard.		
CA 101		18.04	Table 6	te	Permeation test should be required for a boss material/geometry change subject to Note 10.	"X (10)" in Permeation test and Boss Material or Geometry box	
GB 102		18.06		te	For clarity, the requirements should be combined with those of 18.4.	Move to 18.4	
US 28 103		18.06.2	2	te	Regarding the "note", investigation shows the added nickel delays the transition from austenite (face centered cubic) to another crystalline structure. However, this occurs at a strain significantly above the working strain in a container. Evidence has not been presented that high nickel content significantly affects results at the working strain compared with lower nickel alloys. Therefore, while >12% nickel is acceptable, that high a level is unnecessary.	Revise 2nd paragraph by removing reference to 12% nickel: "Stainless steels SUS316L, AISI316L and AISI316 having ~~>12 percent nickel composition and~~ <0.1 percent magnetic phases by volume are suitable for hydrogen service."	
US 29 104		18.06.3	2	Ed	There is only one "alloy" cited, the differences are the heat treat.	Change to one of the following: "A suitable aluminium alloy for hydrogen service is AA6061." "A suitable aluminium alloy for hydrogen service is AA6061 in the T6, T62, T651 or T6511 heat treats."	
FR 4 105		All doc		ed	Some tables do not have a title		
FR 6 106		All doc		te	Are we sure that all requirements are not in contradiction with the regulation regarding vehicle fuel containers?		
GB		Annex A		te	It is not ideal for an ISO standard to quote CGA	Option to Remove Annex A and update 5.1.4 and	

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107					Pamphlets, replace with ISO standards where possible to do so	10.4	
US 30 108		D.1.09	1	Te	The accelerated stress rupture test was originally developed to screen for a condition that was resulting in laminate failures in the field. However, this failure was noted as being related to manufacturing stresses, more likely shear stresses than stress ratio issues. A single test of this nature does NOT give meaningful confidence that stress rupture issues are addressed. Analysis can confirm that stress ratios are met. Stress ratios are set to give high reliability under sustained load based on studies of long-term testing with a large number of test specimens.	Reconsider the content of this paragraph.	
US 31 109		D.1.14			The statement “because the plastic liner does not carry any of the wall stress, thus these designs are inherently leak before break” is not correct. It is correct that failure of the liner will cause a leak, and will not result in rupture. It is also correct that the fatigue life of the reinforcing fibers is significantly greater than the required life of the container, and therefore leak before break is not an issue.	Reword the last sentence: “This test does not apply to Type 4 designs because a failure of the plastic liner, which is non-loadsharing, will not result in rupture of the container, and because the fatigue life of the reinforcing fibers is significantly greater than the required life of the container.”	
US 32 110		D.3		te	If U.S. comment to 4.1.2 is accepted, this language must be revised. Incorporate information from D.5 and delete D.5.	Revise as follows: Category A containers are containers that are intended to be used hydrogen fuelled vehicle applications that are outside the scope of Category B. For heavy duty applications, the 750 cycles per year is based on the extreme condition of assuming 2 empty-to-full fuelings per day for continual full-day service. Transit authorities have required up to 25 years of life x 750 cycles = 18 750 cycles total. The robustness of this specification is assured by recognition that 18 750 cycles x 320 km (200 mi) /fueling cycle exceeds 6 million km (3.5 million mi) driven.	

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						For hydrogen powered industrial trucks, the 1 095 cycles per year is based on the extreme condition of assuming 3 empty-to-full fuelings per day for continual full-day service, which is a very realistic possibility for industrial truck applications.	
US 33 111		D.4		te	If U.S. comment to 4.1.2 is accepted, this language must be revised.	Category B containers are intended to be consistent with the UN GTR No. 13 for hydrogen fueled vehicles. Pressure cycles are greater than or equal to 5 500 and less than or equal to 11 000.	
US 34 112		D.5		te	An informative explanation of why it is necessary to conduct non-linear structural analysis of Type 2 and Type 3 containers would be helpful.	Rewrite D.5 to read: D.5, Design considerations for Type 2 and Type 3 containers Analysis of Type 4 cylinders is relatively straightforward because the composite stresses are linear with pressure. Analysis of Type 2 and Type 3 cylinders is more complicated because of non-linear behavior of the metal liner, specifically as it is subjected to autofrettage pressure. It is critical that stress ratio requirements are met to ensure high reliability in regards to stress rupture (see ISO/TR 13086-1 for additional information). Stress ratios are not an issue with Type 1 containers, as they do not have composite reinforcement. A thick liner, in combination with a high autofrettage pressure, can result in sufficient pre-stress on the composite such that the fiber is loaded in excess of the allowed stress ratio (see ISO/DTR 13086-3 [under development] for additional information). Type 2 designs are not likely to experience an excessive pre-stress condition if the liner burst pressure does not exceed 150 % of nominal container working pressure, and the autofrettage pressure does not exceed 165 % of the nominal working pressure. Type 3 designs are not likely to experience an excessive pre-stress condition if the liner burst pressure does not exceed 30 % of nominal container working pressure, and the autofrettage pressure does not exceed 165 % of the nominal working pressure.	

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						It is important to accurately calculate stresses in order to ensure stress ratio requirements are met, particularly when the liner thickness or autofrettage pressure exceed the values noted above.	

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