ISO/TC 197
Hydrogen technologies

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Compiled comments CD 16111 2016-09-29

Document type: Other committee document

Date of document: 2017-05-15

Expected action: INFO

Background: Here are the compilation and treatment of the comments from the CD ballot in 2016.

Committee URL: http://isotc.iso.org/livelink/livelink/open/tc197

Template for comments and secretariat observations

Date:2016-06-17	Document: ISO/CD 16111	Project: WG 25

MB/ NC[1]	Line number	Clause/ Subclause	Paragraph/ Figure/Table	Type of comment[2]	Comments	Proposed change	Observations of the secretariat
CA 2		General		te	The Working Group should include a rationale document as an annex to explain the rationale behind the selection of certain requirements, such as the reasoning for dividing the drop test between assemblies with 25 kg or less, and greater than 25 kg, why a blunt impact force of 1200 j, and why a fire duration of 20 minutes?	Include rational document as an annex. While this isn't the current policy for many standards, it is slowly being adopted (e.g. SAE J2579), and would save the Working Group from considerable delay in getting international acceptance.	WG25 proposes a revision of the standards. We started with an existing document already approved. We also used some others standards as reference for our testing method and we discussed the various technical choices to propose our revision. If a rational document is mandatory in ISO standard, we will do it. Today it seems not. However : 25kg appears as the limit transport of a tank by humans with a risk of drop. Over 25kg the risk of the tank is to be impacted by other objects. 20 min : is the reasonable time is case of fire to leave the room where the tank is. …
US 3		Introduction	1	Editorial	The following phrase is awkward and unnecessary : "Independently from the chemical of physical bounding nature of hydrogen with its absorbing material, …." Statement does not add value as the term metal hydride assemblies is defined in Clause 2.	Delete sentence from Introduction.	Done in DIS version
GB 4		New definition		Te	Missing definition	A definition for ...resistance pressure...(as noted in 5.7.2a)) should be added	Done
US 5		1		Ed/te	The note in the Scope does not fit with ISO Directives for writing International Standards.	Reformat note as a sentence that reads: "Guidance regarding systems larger than 150 L is provided in Annexes E, F, and G."	Will be removed from DIS version
GB 6		1		Te	The premise for drafting this standard was that its	The NOTE and Annexes E, F and G	Will be removed from DIS version

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					Scope would not be changed and as a consequence, there was no NWIP circulated for voting within ISO/TC 197. However, it is apparent that technical matters which are clearly outside the scope of the standard have been included, albeit in Informative Annexes. As a result, it is appropriate for the UK to submit a negative vote. However, if Annexes E, F and G are removed from the draft, the UK would approve its technical content. If Annexes E, F and G are not deleted, a NWIP should be raised in order to consider the change of Scope that has taken place in drafting ISO/CD 16111	should be deleted from the standard. Annexes E, F and G are not within the Scope of ISO 16111	
CA 7		1		ed	grammar	Replace “cover with “covered”	Done
US 8		2			Global Technical Regulation 13 is not reference in a normative section	Move to GTR 13 bibliography. Review other standards for applicability.	Will be removed from DIS version
GB 9		2		Te	Normative references outside the scope of the standard	Delete reference to ISO 11120 and UN Global regulation 13	Will be removed from DIS version (but not ISO11120)
JP3 10	27	2	Page 1	ed	ISO 10961 is not referred to in the document.	Delete	Done
JP1 11	9	2	Page 2	Ge	Normative Reference For the revision of ISO16111 which is excluded storage onboard for Hydrogen fueled vehicles, reference of GTR (UN Gloval Technical Regulation No.13) listed is not appropriate. Propose to delete this GTR from Normative Reference.	Delete “UN Global Technical Regulation No.13 (Hydrogen and fuel cell vehicles)” from Normal Reference. <Reason> As the scope says; “Storage MH assemblies intended to be used as fixed fuel-storage onboard hydrogen fuelled vehicles are excluded.”, reference of GTR (UN Gloval Technical Regulation No.13)	Will be removed from DIS version

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						listed is not appropriate.	
JP2 12	6	2	Page 2	ed	ISO 14687 consists of -1, -2 and -3, and the applicable standard to MH is ISO 14687-2.	Change" ISO 14682 "into " ISO 14687-2 Hydrogen fuel -- Product specification -- Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles"	Done
GB 13		3.5		Te/Ed	Unclear definition	The title of the definition and the definition itself do not seem to be related to each other. Redraft the definition so as to be clear	Done (?)
CA 14		3.5		te	The definition of "full flow capacity pressure" is unclear. Is it intended to mean the pressure at which the PRD activates?	Modify definition to be clearer as to intended meaning.	Done
GB 15		3.9		Te	Unnecessary definition	It is not clear why MDP should be used in place of MAWP and some reasoning should be included in the draft	Done
CA 16		3.9		ed	Definition is grammatically incorrect	Modify. Suggest "highest gas gauge pressure developed internal to an MH assembly at rated capacity under normal service conditions or normal operating conditions, whichever is greater"	Done
US 17		3.12		te	A new term for a bundle of MH assemblies is introduced, but not used in the document. It is unclear if such a configuration is permitted to be used, and if so, whether testing described in the document is to be performed on the bundled assemblies or a single assembly. How is the bundling piping tested? Since 5.5.1 requires that each assembly have at least one PRD, what is the	Delete 3.12	Done

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					purpose of the bundle?		
AER 18	P4, L9	3.2		te	Since hydrogen release form metal hydride is limited by a chemical reaction, its entire stored energy cannot be released suddenly in case of a rupture of a container shell	Rephrase definition as follows: “structural failure of the shell resulting in the sudden release of internal pressure”	Done
GB 19		4.3.2		Te	Clarification	Re-draft 4.3.2 to be : The minimum and maximum ambient shell temperatures for normal service conditions shall be a minimum of - 40 °C and a maximum of +65 °C. If the maximum and minimum shell temperatures are to be different from those specified, they shall be identified by the manufacturer	Done
CA 20		4.3.2		te	As an ISO standard, this document must account for global use. Therefore, a minimum service temperature of -40C should be mandatory or the MH Assembly shall require operation in a temperature maintained environment.	Reword to make -40C minimum service temperature” mandatory.	WG has discussed this question : -40°C should not be the mandatory temperature for all applications (why to design with the same constrains a tank for tropical countries than for artic ones). This is why WG consider that the minimum service temperature should be specified by the manufacturer, while at least all the MH Assembly should design for +65°C
JP4 21	18	4.6	Page 5	ed	ISO 14687 consists of -1, -2 and -3, and the applicable standard to MH is ISO 14687-2.	Change” ISO 14682 “into “ ISO 14687-2 .	Done
US 22		5.2.2	1	Editorial	“Appurtenances” is a term that will confuse many. Consider changing to a more common word.	Consider using “components” instead.	Done
US 23		5.3.1		Te	This section limits internal volume to 150 L, therefore, it is not appropriate to use ISO 11120 or 11515 for cylinder standards.	Remove reference to ISO 11120 and ISO 11515. Move Note 1 of 5.3.1 to informative Annex E as this information is outside the scope of this	

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						International Standard.	
GB 24		5.3.1		Ed	Better English	In the second line delete ...cover... and add ...covered...	Done
GB 25		5.3.1		Te	Incorrect requirements	In the fifth line, delete ...9809-2... Shells conforming to the requirements of ISO 9809-2 can have a tensile strength of greater than 950 MPa	Done
US 26		5.5.1		Te	Re-sealable valves, e.g. spring loaded PRVs are not recommended for composite or aluminium containers, as a PRV addresses excess pressure, but not loss in strength of the container	Rewrite section, PRVs not allowed, at least for composite or aluminium containers.	Not clear for the secretariat. Why PRV can be used for steel containers and not aluminium containers
CA 27		5.5.1	1st para	te	The term “Competent Authority” is not defined	Provide a definition for Competent Authority	Done
US 28		5.5.3	1	Editorial	Missing a period after “shell”.	Add the period.	Done
US 29		6.2.2.3		Te	Data recording interval is too small for typical, conventional monitoring equipment.	Use a more reasonable data interval requirement such as 30 s.	Done
CA 30		6.2.2.4	2nd para	te	The working group should consider performing a more localized fire condition, such as that in the UN GTR 13 for hydrogen vehicle fuel systems. There have been multiple instances of localized fires causing CNG cylinder failures.	Using the UN GTR 13 localized fire test as the basis, modify the test requirements to accommodate the testing of non-cylindrical shapes.	Any Reference to UN GTR13 will be removed. However this “location of fire” should be discussed during WG meeting
CA 31		6.2.2.4	5th para	te	The type of fire source is not specified, nor are there any temperature requirements. Thus it is not possible to “….ensure the rate of heat input into the MH assembly is reproducible”. It will also not be possible to reproduce the fire test at another lab, ie there is no standard bonfire test method for labs to follow. The way it is worded now, different labs can have different rates of heat input.	Revise the bonfire test by including greater detail to ensure it can be reproducible between labs.	Should be discussed during WG meeting

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JP5 32	24-25	6.2.23	1st para,	Te	**Data monitoring and recording** For the description of "The temperature and pressure of the MH assembly shall be monitored remotely and recorded at intervals of 15μs." In the fire test, monitoring and recording at intervals of 15μs is seemed too frequent (we would like to know why 15μs?) According to our company's internal testing, at interval of 1s will be sufficient.	Change 15μs to 1s. <Reason> Intervals of 15μs is seemed too frequent (we would like to know why 15μs?) According to our company's internal testing, 1s interval will be sufficient.	Done , US comment recommend 30s. It seems convenient
CA 33		6.2.3	1st para	te	The requirement is to conduct burst tests to demonstrate compliance to 5.3.2b). In 5.3.2 b) the "… MH assembly shall withstand……, without leaking or bursting, a minimum shell burst pressure of 2 times ….". So there is no requirement to actually burst the shell – just take it to 2 times pressure. This being the case, the statement in 6.2.3 that "All bursts shall occur in the same manner for all tests performed" cannot be met as there is no requirement to actually burst the assembly.	Specify in 6.2.3 that the assembly is to be pressured to burst. This also requires specification of a maximum rate of pressurization, and well as location of the pressure transducer relative to the pressure source and assembly being tested.	
CA 34		6.2.3	1st para	te	The statement "All bursts shall occur in the same manner…." requires a more detailed description, otherwise it is open to interpretation as to the "same manner" is. For example, if one assembly splits open on one side, and the next one splits open on an end, is that the same manner? Or if one splits open, but the next one has some fragmentation, but it burst at a much higher pressure than the first one, is that considered acceptable? Or does it even matter if the bursts occur in the same manner – what possible correlation does that have to a failure at working	Revise the burst test requirement to be in line with burst requirements in other ISO cylinder standards, such as ISO 11439.	

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					pressure?		
GB 35		6.2.4.1.2		Te	Missing justification	What is the justification for carrying out a blunt impact test rather than a drop test for cylinders of greater than 25 kg	
CA 36		6.2.4.2	Line 6	te	"Impact can be conducted by dropping a suitable weight…..". There is no statement regarding whether it is acceptable to allow the impactor to rebound and strike again.	Clarify whether it is acceptable to have multiple rebound impacts.	Nothing is mandatory regarding this point. However we can consider the test finished when the tank does not move any more without any system to prevent any multiple rebounds
US 37		6.2.4.3		Te	Dropping a container on a steel apex is not necessary or reasonable.	Remove the requirement for dropping on a steel apex.	This point is in the current version. Apex is similar to step stair. It seems reasonable to consider this drop test more efficient to test the resistance.
GB 38		6.2.4.3		Te	Missing requirements	Requirements related to the thickness and flatness of the steel plate onto which the cylinder is to be dropped should be included	
GB 39		6.2.4.5		Te/Ed	Improved clarity	In the last line of 6.2.4.5 delete ...must... and add ...shall... The remainder of the standard shall be checked so as to ensure that ...shall... is used everywhere in place of ...must... etc.	
US 40		6.2.4.6		Te	The ISO 11515 Working Group has determined the 1200 J impact is unreasonable and greater than intended; a proposal has been submitted to reduce the energy to 488 J and increase the diameter of the impactor to 110 to 120 mm	Modify the impact energy to 488J and the impactor diameter to 110 to 120 mm.	
GB 41		6.2.4.6		Ed	Confusing indent identifications	In 6.2.4.6 there are several a)'s and b)'s and so referring to them cannot be clear. Make the identifications run on alphabetically from each other (i.e. a), b), c), d) etc)	
GB 42		6.2.4.6		Te	Incorrect normative reference	The blunt impact test requirements have been taken from ISO 11515.	

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						However, there is currently a NWIP to amend the blunt impact test in ISO 11515. Thus it is recommended that any amendment that is made to the blunt impact test in ISO 11515 should be considered for inclusion in this standard	
CA 43		6.2.5		te	High temperature metal hydrides will experience significant hydrogen diffusion rates at 300-400degC. ISO 16111 may benefit by adding a clause to highlight this and ensure the designers have calculated this and ensured that the hydrogen cannot diffuse into locations where it can cause a safety risk.	Add a statement warning designers about the significance of hydrogen diffusion at high temperatures	
CA 44		6.2.5.1		ed	Confusing statement in row 3 of Table 1	Reword to “Maximum Service Temperature or Maximum Operating Temperature; whichever is higher”	Done
CA 45		6.2.5.2		te	In cases where high temperature (300-400degC) steel shell designs are used it may not be feasible to achieve leak rates in line with the equation in 6.2.5.2.1 due to leak rates through metal valve seats and diffusion through steel.	Add a note indicating that the leak rate criteria does not include hydrogen diffusion through metal shells or seats.	
US 46		6.2.6		te	The hydrogen cycling and strain measurement test (6.2.6) has been changed in a way that is unacceptable. The original test required the systems to be periodically vibrated to accelerate any shifting or movement of the storage media that could result in overstressing the shell walls. Two different vibration sequences were included, one for small systems that was equivalent to what’s in the IEC standard for micro fuel cells and fuel cell cartridges, and a second for larger systems that was based on a vibration sequence used in a battery standard to represent cargo transport (air and road I believe) of battery systems. The current CD only requires the small systems to be vibration tested, no vibration requirement for systems larger	Reinstate vibration requirements for all systems. In metal hydride systems the pressure exerted on the walls of the pressure vessel used for containment can be dominated by force exerted from the expansion of the media on going from the dehydrogenated phase to the hydrogenated (hydride) phase. Mg to MgH2 has about to 35% volume expansion. Additionally, especially the case for the intermetallic or interstitial hydrides, the material undergoes decrepitation where the	The negative or positive effect of vibration (during the hydrogen cycling) on the strain of the shell and then on the resistance of the shell is not yet proved. The decrepitation is a real phenomenon and cycling test should be absolutely considered. But the compaction which could be induced by vibration and which could increase the effect of decrepitation on the shell is not obvious. Some WG members consider that this vibration could have positive effects on the strain by breaking the internal arrangement of the

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					than 120 ml internal volume. During development of the original version of ISO 16111, Frank Lynch, a long time expert with metal hydride systems and the person that has probably designed more MH systems than anyone else, objected to the test in the original 2008 standard because he didn't think the vibration sequence was adequate (not strong enough) and thought it should be empirically developed for each system design (i.e., couldn't be standardized). This draft completely removes the requirements for the larger systems which present greater hazard if they fail.	particles break about from this stresses developed in this expansion so the average particle size reduces down into the micron range. This phenomenon can continue for many cycles and is material dependent (the Japanese showed data for an AB2 based system with decrepitation and thus wall stress increase was still occurring after ~100 cycles). Both the volume expansion and the particle size reduction can lead to increased stress on the shell walls. Also with gas flowing in and out of the vessels and with normal vibration from transport and etc., the particles may move and a variation of packing density created, this is also material and system design dependent. The vibration sequences were therefore included to accelerate any potential compaction of the storage media that could lead to increase wall stress, through normal operation and transport. The sequences were applied in the non-charge state when the material is most dense (i.e., more void volume in the system) when they would be most apt to move. For a simple analogy, cereal boxes include statement to the effect that the box was full at the time of filling, but settling may have occurred during transport. The test is trying to accelerate that settling. Take a vial and pour powder in to partially fill it, tap the sides, bottom, drop it on the desk from a few millimetres and watch the change in height of the powder. These effects can lead to dramatic changes in wall	particles. Due to the lack of evidence and probably there is no evidence, because the final result could be depending on the internal architecture of the MH assembly (MH Assembly is not always a simple box), We consider vibration test only for volume <120ml, in order to not affect the various tests for this kind of tank, but not for the bigger one. However this aspect will be again discussed in the next WG meeting. Probably a solution should be the following way : for this test 5 or 6 tanks are used in the current standard . In the revised standard 3 tanks could have vibrations and 3 not. In that way independently of the internal structure of MH Assembly the worst situation could be considered.

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						stress if allowed to happen in a metal hydride system.	
AR 47	P18, L9	6.2.6.1		ed	According to CD, hydrogen cycling and strain measurement test needs to be repeated in case of any design change only for MH assemblies greater than 120 ml.	Change self-reference from “(see 5.3.1)” to “(see 5.3)”, so that the two HM assemblies sizes are considered.	Done
AR 48	P19, L 4-5	6.2.6.3		te	This passage of the CD mention a maximum cycling number to be provided by the manufacturer, but the rest of the document refers to service life in terms of maximum quantity of years that the MH assembly can be used (P24, L19; P25, L3; P35, L23).	Avoid to mention a maximum cycling number in 6.2.6.3, or redefine 4.5 so that the manufacturer can declare service life as a maximum cycling number or a maximum elapsed time from fabrication.	
US 49		8.1	Title and paragraph 1	Editorial	“Material safety data sheets” and “MSDS” does not conform with the Globally Harmonized System (GHS) for Hazard Communication.	Change “Material safety data sheets” to “Safety data sheets” and “MSDS” to “SDS”.	Done
US 50		Annex B		Te	Many fuel container standards have revised the environmental test to separately test fluids and temperature. The currently used tests in other standards are more rigorous, yet easier to conduct.	Modify environmental test IAW ISO 11439 or ANSI/CSA NGV2.	Hydride storage always works under intensive thermal conditions (endo/exo thermic), it seems not appropriate to modify the existing testing conditions proposed in ISO16111-2008 in this revision, for one proposed for gaseous storage.
AR 51	P35, L39	Annex C		ed	In material type and properties the symbols "Re" and "Rg" are used, but these abbreviations are not defined within the document.	Revise and define abbreviations	Done
US 52		Annex E		Te	This annex addresses >150L, while section 5.3.1 expressly limits volume to 150L.	All guidance regarding >150 L should be included in this informative Annex, as ISO/TC 197 had decided to include this information in this revised International Standard, even though it is outside of this standard’s scope. More information regarding the reason for this Annex is needed to provide clarity to the reader.	Annex removed from dis version
JP6 53	16-17	Annex F		te	See JP1	Delete “or the UN Global Technical Regulation No.13 (Hydrogen and fuel cell vehicles)”	Will be removed from DIS version

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CA 55		Annex G		ed	grammar	Replace “when volume is higher of 150l” with when its volume is higher than 150l,”	Will be removed from DIS version
CA 54		Annex G		ed	grammar	Replace “move” with “moved”	Will be removed from DIS version
GB 1			Figure 1	Te	Missing dimension	In the right hand view, there is no dimension give for the width of the wedge. The width of the wedge should be related to the diameter of the cylinder under test.	

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