

GRPE/ISO N 030	2002-11-04
Comparison between the GRPE Draft Regulations and the ISO Draft Standards on liquid hydrogen fuel tanks for land vehicles as well as the compilation of comments received on both documents. Discussed at the GRPE/ISO group of experts meeting on 26-27 September 2002 in Montreal, Canada and revised in November 2002.	
GRPE Draft regulations: Uniform Provisions Concerning the Approval of : I. Specific Components of Motor Vehicles Using Liquid Hydrogen; II. Vehicles with Regard to the Installation of Specific Components for the Use of Liquid Hydrogen. Rev. 11 dated 29 August 2001.	ISO/DIS 13985-1 Liquid hydrogen – Land vehicle fuel tanks – Part 1: Design, fabrication, inspection and testing (2001-07-31) ISO/DIS 13985-2 Liquid hydrogen – Land vehicle fuel tanks – Part 2: Installation and maintenance (2001-07-31)
Replaces: Document GRPE/ISO N 017	

General consensus:

It was agreed that the members of the GRPE/ISO group of expert want to set the stage for global harmonization through references to ISO standards whenever possible. In some cases, these standards are under development and as an expediency, the GRPE draft regulation is to reference some existing standards such as EN standard. However, an annex is to be included in the GRPE draft regulations to identify the ISO standards that will replace the EN standards when they become available (see the ISO report, Part 3 that was distributed to the GRPE ad hoc group for the 4-5 June 2002 meeting).

As an example, the GRPE draft regulations will retain the reference to the EN 1251-2 version 3/2000 until the ISO/WI 21029-1 is published. In the meantime, Judith Ortenburger is to review ISO/WI 21029-1 and compare the design philosophy with the EN equivalent. ISO/TC197 will also contact the ISO/TC 220 Secretariat for a confirmation that the ISO/TC 220 will replace the EN equivalent when published.

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	General	General		Both documents are designed around a factor of safety of 3.0 with a proof factor of 1.3. It is unclear; however based on the comments below, if a vessel designed to the EIH document would meet the requirements of the ISO standard and vice versa. In some instances the ISO document is more conservative and in some cases the EIH document is more conservative. It is this reviewer's opinion that these differences must be rectified prior to either document moving forward. ISO/DIS 13985-1 also include requirements for inner tanks made of composite materials which are not covered in the EIH draft regulations. A decision should be made as to whether there is a need for such inner tanks.		6.2.1 will be modified in order to make other materials possible. <i>(See the proposed text under 6.2.1)</i>

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E	2.41		EIHP	A diagram of the ranges will enhance the understanding	Add after 2.41: Diagram of ranges (example)	Move the diagram to 2.10. In 2.10, the design pressure is to be replaced by the maximum allowable working pressure (MAWP). The EIH draft regulation definition for maximum working pressure is to be deleted. Change Maximum permissible operating pressure in the ISO 13985 draft standards to MAWP.
E	2.45					Isolation to be replaced by insulation in the EIHP draft regulations
C	4.3.1	ISO/DIS 13985-1, clause 7		There is no requirements for marking of the inner tank in ISO/DIS 13985-1.		The requirements of marking of the inner tank is to be limited to the serial number, name and address of inner vessel manufacturers, a mark confirming successful final acceptance tests. All the other markings previously listed in the EIHP draft are to be marked on the outer jacket. The ISO 13985 draft standard is to be modified accordingly. This marking is compatible with the ISO/TC220 draft standard.

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E	4.3.1		EIHP	Date of manufacturing is important not date of approval	Replace "Year and month of approval (e.g. 2000/01)" by "Year and month of manufacturing (e.g. 2000/01)"	Agreed
C	4.3.2	ISO/DIS 13985-1, clause 7.1		The marking requirements in the EIHP draft regulations differ from the marking requirements in ISO/DIS 13985-1.		The allowed orientation of the tank in the car is to be added as a marking requirement (double check if there is a similar requirements in the gaseous draft) The EIHP draft requirements for markings are to be incorporated in the ISO 13985 standard.
C	6.1.2	ISO/DIS 13985-1, clause 4.2		There is no reference to the hydrogen compatibility test in ISO/DIS 13985-1.		The ISO 13985 standard is to be changed to incorporate the hydrogen compatibility requirement.
C	6.1.3	ISO/DIS 13985-1, clause 4.2		There is no reference to the toughness requirements of materials in contact with cryogenic temperature in ISO/DIS 13985-1. Comment: ISO/MI 21028-1 Cryogenic vessels – Toughness requirements for materials at cryogenic temperature — Part 1: Temperature below -80 °C is currently in development in ISO/TC 220.		The ISO 13985 draft standard is to be changed to include the EIHP draft requirements on toughness requirements. The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.
E	6.1.3		EIHP	Typing error	Delete "NF" before EN 1252-1	Agreed

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E	6.2.1		EIHP	Currently the whole draft is made for steel tanks. There are no requirements for composite tanks available. Therefore we propose to open the scope also to other materials but then in cooperation with the technical service	Add the sentence: "For Hydrogen container(s) made from other material than metals, annexes 7A-1 and 7A-2 to this Regulation have to be applied analogously."	The performance of hydrogen containers made from materials other than steel shall be demonstrated to be equivalent to the requirements of Annex 7A of this regulations according to existing International Standards.
	6.3.3					The ISO 13985 draft standard is to be changed to include the EIHP draft requirements on oxygen compatibility. The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.
C	6.4.1.1	ISO/DIS 13985-1, clause 4.6.1.1.1		Ok ISO general requirements for pressure relief of the inner liner if it is metal. Only that the MPOP is established by manufacturer.		

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E	6.4.1.1		EIHP	Inconsistency to definitions	Replace "...≤ 110% of the design pressure..." by "...≤ 100% of the design pressure..." and "...> 110% of the design pressure..." by "...> 100% of the design pressure..."	The normal operating range of the inner tank is between 0 MPa and the maximum allowable working pressure. The permissible fault range of the inner tank is between maximum allowable working pressure and 136% of MAWP for steel inner tanks. <i>For other materials, an equivalent level of safety should be applied.</i>
C	6.4.1.2	ISO/DIS 13985-1, clause 4.6.1.1.1		O.K.		
E	6.4.1.2		EIHP	Inconsistency to definitions	Replace "...the maximum of the normal operating range..." by "...110% of the normal operating range..."	In the EIH draft regulation, change that the primary pressure relief device for the inner tank shall limit the pressure within the tank to not more than "110 % of the maximum allowable working pressure" instead of "maximum of the normal operating range".

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C	6.4.1.3	ISO/DIS 13985-1, clause 4.6.1.1.1b		Difference. EIH says secondary relief shall limit pressure within maximum permissible fault range which is not to exceed 90% of the yield strength of the vessel while ISO/DIS 13985-1 says no greater than 136% maximum permissible operating pressure. Depending on the materials selected and margins these could conflict.		It was agreed that 136% of MAWP for steel inner tanks should be used as the upper limit of the permissible fault range. <i>For other materials, an equivalent level of safety should be applied.</i>
C	6.4.1.3 6.4.1.5	ISO/DIS 13985-1, clause 4.6.1.1.1a		Difference. EIH says burst disc shall have sufficient safety margin for the inner tank, which according to 6.4.1.1 should not exceed 90% of the yield strength of the vessel. ISO/DIS 13985-1 specifies between 120% and 150% of maximum permissible operating pressure. Again, depending on materials selected and margins these could conflict.		It was agreed that the secondary pressure relief device shall operate not below 110% of the set pressure of the primary PRD and not more than 136% of the maximum allowable working pressure (to replace 6.4.1.3 of the EIH draft regulations) 6.4.1.5 of the EIH draft regulation is to be deleted. 4.6.1.1.1 of the ISO 13985-1 standard is to be revised accordingly.

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	6.4.1		GM	The possibility to install the secondary pressure relief device within the inner tank should be defined.	Add to 6.4.1.3: The secondary pressure relief device may be installed within the inner tank. Add to 6.4.1.6: In case the secondary pressure relief device is a burst disc and is installed within the inner tank, an appropriate exhaust vent in the outer jacket is required.	No change is required Shall be included in 14.4.2
E	6.5.3		GM	The lines ... shall be compatible with the criteria defined in 6.4.1.1 – The reference clause should be checked: 6.4.1.6 may be the better one	Change 6.4.1.1 into 6.4.1.6	6.4.1.1 is the correct reference. It shall ensure the correct dimensions of the lines (diameter)
E	14.1.11 Annex 10					New requirements applicable to the marking of public service vehicles were added. Justification: Authorities in Europe are insisting on that marking. This was decided in the last GRPE ad hoc WG meeting and not yet integrated.
C	14.3.1	ISO/DIS 13985-1, clause 4.4.2		O. K.		
C	14.3.1	ISO/DIS 13985-2		The EHP documents specifically disallows the placement of the tank in the engine compartment of an internal combustion engine. There is no specific restriction in ISO/DIS 13985-2.		It was agreed that the tank could be placed in the engine compartment.

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E	14.3.1		EIHP	There is no need to forbid container installation in engine compartment	Delete "it shall not be installed in the internal combustion engine department"	It was agreed that the tank could be placed in the engine compartment.
C	14.3.2			No corresponding ISO statement.		Check the wording for clarity. (Done)
C	14.3.3	ISO/DIS 13985-2, clause 4.1		O.K. ISO/DIS 13985-2 seems to cover this.		This cannot be integrated in the ISO 13985 standard on the fuel tank.
C	14.3.4	ISO/DIS 13985-2, clause 4.1		The accelerations to which the fuel tank will be submitted are different. The EIHP draft regulations also include different requirements based on the category of vehicles.		The accelerations and the definition of the vehicle categories will be included in the ISO 13985 standards. Dieter Stoll to provide the definitions of the vehicle categories M1 – M3, N1 –N 3). These definitions will then be integrated in the text of both the GRPE draft regulations and ISO 13985 draft standard.
C	14.3.5			No comment without documents referenced in EIHP.		The reference to the EC directives in the GRPE draft regulations is to be deleted. To be checked with the authorities in GRPE ad hoc WG There is no need to include this requirement in the ISO 13985 standard.

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E	14.4.1.3		GM	The clause requires desired breaking positions in the refuelling line. This requirement should be changed.	The automatic shut off valve shall be installed to ensure that the tearing-off of the valve cannot occur under any circumstances. A test e.g. N-Cap test shall be implemented.	New text: In the event that the container is displaced, the first isolating device and if applicable, the line connecting it to the container shall be protected in such a manner that the shut-off function remains operational and the connection between the device and the container cannot be ruptured.
E	14.4.1.6		GM	The crucial point shall be the cut off of the fuel supply line during the refuelling procedure. This cut off can be done either by the valve, which should be mounted directly on or within the container, or by an automatic shut off valve somewhere in the fuel supply line.	An automatic shut off valve for the fuel supply line shall be operated such that the fuel supply is cut off during the refuelling procedure. This cut off of the fuel supply line can be secured either by the directly on or within the container mounted valve or by an additional automatic shut off valve in the fuel supply line.	Target of these requirement is to close the valve if the engine is not running. Obviously the text is not clear enough. Therefore change the text into: When the propulsion system is switched off, irrespective of the position of the ignition switch, the fuel supply to the propulsion system shall be switched off and remain closed until the propulsion system is required to operate.

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E	14.4.1.7.		EIHP	See 14.4.1.6		Obviously the text is not clear enough. Therefore change the text into: When another H ₂ conversion system is switched off, irrespective of the position of the activation switch, the fuel supply to the respective conversion system shall be switched off and remain closed until the respective H ₂ conversion system is required to operate.
C	14.4.2	ISO/DIS 13985-2 clause 4.2		ISO/DIS 13985-2 does not specify rollover protection. ISO/DIS 13985-2 does specify relief at 120% with reset pressure defined. The Annex 7B requirement in the EIHP document which references Paragraph 6.4.2 of the EIHP document requires also a 120% setting but has no reset requirement.		In the GRPE draft regulation, the example (e.g. vehicle rolling over) is to be removed. GRPE draft regulation: 6.4.1 and 6.4.2 : The pressure relief valves shall, after discharge, close at a pressure higher than 90% of the set pressure of the pressure relief valve. They shall remain closed at all lower pressures. ISO 13985 is to use the same wording.

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C	14.4.1	ISO/DIS 13985-2, clause 14.5.2 and 14.5.3		ISO/DIS 13985-2 specifies only a single automatic shut-off valve between the tank and the remainder of the vehicle system while the EIHDP document requires multiple normally closed valves to protect the system. The EIHDP document could allow for a valve to be placed in-between the tank and the relief vent. The EIHDP document does not address check valves (non-return valves).		The ISO 13985 draft standard is to be revised to reflect the GRPE draft regulations requirements. The GRPE draft regulations do not allow the valve to be placed between the tank and the relief vent and address check valves. (see 6.5.1, 6.5.2, 14.4.2.12 and 14.4.1.2) No change required.
E	14.4.2.1		EIHP	See 6.4.1. from GM	Add at the end: In case the secondary pressure relief device is a burst disc and is installed within the inner tank, an appropriate exhaust vent in the outer jacket is required.	See 6.4.1.
E	14.4.3.6		GM	The requirements for the pressure test of the gas tight housing cannot be fulfilled.	The pressure test should be changed into a leakage test without overpressure.	The test pressure is to be replaced from 0,01 MPa to 0,5 kPa.
C	14.5	ISO/DIS 13985-2, Clause 4.4		ISO/DIS 13985-2 specifies piping strengths while the EIHDP document does not. ISO/DIS 13985-2 specifies that vacuum-jacketed or insulated lines to prevent heat soak while the EIHDP document tends to concern itself with structural rigidity and mounting issues.		6.3 of the GRPE draft regulations already cover these issues. No change required.

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E	14.8.2		EIHP	Hazardous zone 1 according to IEC 60079-10 will limit the possible solutions. In IEC 60079-10 it is foreseen to evaluate of the actual situation and according to the results different measures are allowed. This is common practice and should therefore be the same in an ECE regulation.	Replace in the first sentence "applicable for the hazardous zone 1" by "evaluated" and add at the end of the first sentence "if applicable".	Agreed. The new text is to be: Electric or electronic equipment in the gas tight housing shall be evaluated according to IEC 60079-10 "Electrical apparatus for explosive gas atmospheres- Part 10 Classification of hazardous areas" from 12/1995 and comply with EN 50014 to EN 50021, if applicable. The last sentence is to be deleted: If not, the gas tight housing shall be monitored by a Hydrogen sensor and in case of detecting Hydrogen all electric or electronic equipment shall be switched off.
C	14.9	ISO/DIS 13985-2, Clause 4.9		No differences.		
E	14.9.1.		EIHP	A boil off management system should be mandatory according to the discussion in the ad hoc working group on 19.2.2002	Delete "...vent off in a safe way or shall be..."	Agreed. In addition, 14.2.2.10 and 14.2.2.11 are to be deleted. Boil off management system is to be moved to a new paragraph identified as 14.2.1.11 now that the boil off management system is mandatory. 14.2.2.12 is to be renumbered as 14.2.2.10.

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GRPE/ISO N 030		2002-11-04	
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GRPE Draft regulations: Uniform Provisions Concerning the Approval of : I. Specific Components of Motor Vehicles Using Liquid Hydrogen; II. Vehicles with Regard to the Installation of Specific Components for the Use of Liquid Hydrogen. Rev. 11 dated 29 August 2001.		ISO/DIS 13985-1 Liquid hydrogen – Land vehicle fuel tanks – Part 1: Design, fabrication, inspection and testing (2001-07-31) ISO/DIS 13985-2 Liquid hydrogen – Land vehicle fuel tanks – Part 2: Installation and maintenance (2001-07-31)	

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	14.9.1		GM	What does the expression "shall be rendered harmless.." mean ? Does it mean that the hydrogen concentration of the rendered exhaust must be outside of the ignition range of hydrogen in air? What is the limit for the allowed hydrogen concentration?	Definition of "harmless" is necessary	Leave text as it is.
E	14.9.2.		EIHP	A boil off management system should be mandatory according to the discussion in the ad hoc working group on 19.2.2002	Delete "If present the boil off system and.."	Agreed
E	14.9.3		GM	According to the fact that the boil off management system only works during parking, the driver is probably not near his vehicle, so that the driver cannot respond to the warning system.		The sentence is to be changed as follows: At start-up and during the operation of the vehicle, a warning system shall be activated to warn the driver in the event of the boil off management system failure.
E	14.9.4		EIHP	A boil off management system should be mandatory according to the discussion in the ad hoc working group on 19.2.2002	Delete whole paragraph	Agreed
E	14.14.2		GM	The reference to annex 10 in this clause should be checked, because annex 10 doesn't exist.	Change "annex 10" in "annex 9"	Agreed

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Replaces: Document GRPE/ISO N 017

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	14.15	ISO/DIS 13985-2, clause 6.3		More stringent than ISO/DIS 13985-2. ISO may want to consider adoption of more specific language.		ISO 13985 is to harmonize with the GRPE draft regulations. In 14.15, the text is to be changed as follows: Recommendations for periodic requalification by inspection or testing during the service life shall be provided by the vehicle manufacturer on the basis of use under service conditions specified herein. These recommendations shall comprise as a minimum: <ul style="list-style-type: none"> • Check of the mandatory marking of the container • Visual inspection of the outer jacket • Inspection-Test of the pressure relief devices • Inspection-Test of the automatic shut off valve • Check of the gas tightness of the receptacle
E	14.15		EIHP	The frequency of periodic inspections is differing from country to country as well as from vehicle category to vehicle category	Change "at least every 36 month" into "at a frequency in accordance with national requirements"	See above decision.
E	Annex 2	3.6				Recommended requalification plan is to be added to the documentation to be provided by the manufacturer.

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Replaces: Document GRPE/ISO N 017

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-1 2.2.1.1	ISO/DIS 13985-1, clause 5		Difference. EIHP specifies a mechanical stresses at 1.3x(Pdesign + 0.1 Mpa), control of materials, and testing per Annex 7A – 2. ISO/DIS 13985-1, clause 4.3.2 specifies a 4:1 factor of safety in design of the inner vessel (25% of UTS in any plane normal to the wall). ISO/DIS 13985-1 specifies qualification test including pressure cycling tests and burst tests. The test requirements in the ISO document are much more involved and would tend to lead to a more conservative design. In particular the ISO document addresses impact damage to the vessel which is not addressed in the EIHP document.		It was agreed that the ISO 13985 draft standard would be changed to use the GRPE draft regulation approach. This approach is also being used by ISO/TC 220 in their draft standards. In the GRPE draft regulation, Pdesign is to be replaced by MAWP. Prest = 1,3 (MAWP + 0,1) The pressure cycling test is to be removed from the ISO 13985 draft standard.
E	Annex 7A-1, 2.2.2.1		EIHP	If outer jacket has an additional safety device, it shall be allowed that the outer jacket is designed according to the set pressure of these additional safety device.	Delete “.but at least 0.05 MPa” at the end of the sentence.	Agreed. Impact test could not be found in the ISO 13985 draft standard. Glenn Scheffler and Dieter Stoll are to exchange information on crash tests.
C	Annex 7A-1 2.2.2.2	ISO/DIS 13985-1, clause 4.4.3		Difference. EIHP specifies resisting an outer pressure of 0.1 MPa. ISO/DIS 13985-1 specifies a minimum collapsing pressure of 200 kPa differential pressure.		ISO 13985 is to harmonize with the GRPE draft regulation (0,1 MPa).

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<p>ISO/DIS 13985-1 Liquid hydrogen – Land vehicle fuel tanks – Part 1: Design, fabrication, inspection and testing (2001-07-31)</p> <p>ISO/DIS 13985-2 Liquid hydrogen – Land vehicle fuel tanks – Part 2: Installation and maintenance (2001-07-31)</p>	

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-1 2.2.3	ISO/DIS 13985-2		There is no requirements for the outer supports in ISO/DIS 13985-2.		ISO 13985 is to harmonize with the GRPE draft regulation
C	Annex 7A-1 2.2.4	ISO/DIS 13985-2		There is no requirements for the inner supports in ISO/DIS 13985-2.		ISO 13985 is to harmonize with the GRPE draft regulation
E	Annex 7A-1, 2.2.4 and 2.2.5		EIHP	The performance of the outer supports can be also proofed by crash tests	Renumber 2.2.4.2 into 2.2.5, 2.2.4.1 is now 2.2.4, renumber 2.2.5 into 2.2.6 Change in 2.2.5 (new) "2.2.4.1" into "2.2.3 and 2.2.4"	Agreed.
C	Annex 7A-1 2.3			No equivalent ISO specification for EIHP "Design temperature". In addition the design temperature as specified is in conflict with the specification temperature in clause 14.1.7 of the EIHP draft regulation.		ISO 13985 is to harmonize with the GRPE draft regulation. There is no conflict between 14.1.7 and 2.3 of Annex 7A.
C	Annex 7A-1 2.4.1 and 2.4.2	ISO/DIS 13985-1, clause 4.4.2		Ok. EIHP "Chemical compatibility" is similar to ISO/DIS 13985-1.		No need for change

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-1 2.4.3	ISO/DIS 13985-1, clause 4.2		There is no requirement for the compatibility of materials with atmosphere enriched with oxygen in ISO/DIS 13985-1. Comment: ISO/WDI 21010 <i>Cryogenic vessels – Gas/material compatibility</i> is currently in development in ISO/TC 220.		The ISO 13985 draft standard is to be changed to include the GRPE draft requirements on oxygen compatibility. The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.
C	Annex 7A-1 3.1-3.3	ISO/DIS 13985-1, clause 4.4.2		Ok. EIH "Materials" is similar to ISO/DIS 13985-1.		No need for change
C	Annex 7A-1 3.4	ISO/DIS 13985-1		There is no reference to the toughness requirements of materials in contact with cryogenic temperature in ISO/DIS 13985-1.1 Comment: ISO/WDI 21028-1 <i>Cryogenic vessels – Toughness requirements for materials at cryogenic temperature – Part 1: Temperature below -80 °C</i> is currently in development in ISO/TC 220.		The ISO 13985 draft standard is to be changed to include the GRPE draft requirements on toughness requirements. The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-1 4.	ISO/DIS 13985-1, clause 6		<p>Difference. Manufacturing and mounting of the Container. EIH specifies in 4.1 appropriate equipment, manufacturing equipment, certified personnel, a manufacturing and inspection plan, quality assurance with traceability of parts and materials. 4.7 calls out inspection and testing of containers per Annex 7-2. Annex 7-2 is design validation by calculation and manufacturing operations per prEN 1251-2 "Cryogenic vessels – Transportable vacuum insulated vessels of not more than 1000 liters volume – Part 2 Design Fabrication and Testing". While we don't have this specification to examine, we did have ISO/CD 21029-1 with the same title. The ISO document, ISO/CD 21029-1 does specify batch tests with radiographic inspection but the protocol and the criteria appear different from what ISO/DIS 13985-1 specifies.</p> <p>ISO/DIS 13985-1 gives specific instructions on non-destructive testing of batch lots using radiographic, ultrasonic or acoustic means. Void size specifications are given.</p> <p>The EIH requires a 24 hour holding time at 20 °C for insulation while the ISO/DIS 13985-2 requires a time specified by the manufacturer (marked holding time) at 65 °C.</p>		<p>ISO 13985 is to adopt the same approach as the GRPE draft regulation.</p> <p>The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.</p>
	Annex 7A-1 5.2.1 6:3.2.2					<p>Paragraph 5.2.1 is to be removed from the GRPE draft regulations. The requirements on the rated holding time is to be removed from ISO 13985 draft standard.</p> <p>For the same reason, 6.3.2.2 was removed from Annex 7A-1.</p>

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	Annex 7A-1, 5.2.1, 6.3.9		GM	If the thermal autonomy test during normal operation (Annex 8A, 3) will be deleted, then the clauses 5.2.1 and 6.3.9 must be deleted too.		Agreed
E	Annex 7A-1, 5.2.3		EIHP	Thermal autonomy should be 5 minutes (see also comments to Annex 8A, 2.2.4.4)	Change "15 minutes" into "5 minutes"	Agreed
C	Annex 7A-1 5.2.3 Annex 8A 2	ISO/DIS 13985-1, Clause 4.5		The EIHP document in paragraph 5.2.3 requires a 15 minute fire resistance test while the ISO/DIS 13985-2 requires a 30 minute fire exposure test.		It was agreed that ISO 13985 would change its requirements to reflect the GRPE draft regulations requirements.
E	Annex 7A-1, 5.42 and Annex 8A, 4.1		GM	In Annex 7A the maximum filling volume is defined to 95 % of the water volume of tank under all circumstances and regardless of the fuel condition and the maximum operating pressure of the inner tank. Therefore the sentence "at the end of the filling procedure" in Annex 8A, 4.1 is unnecessary.	Delete: "at the end of the filling procedure" in Annex 8A, 4.1	Agreed New text of 8A, 4.1: The level of hydrogen shall never exceed 95% of the water volume of the inner tank. During all the tests done for the homologation, the maximum filling level between tests shall not vary by more than 10% of the remaining vapour volume of the tank

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-1 6.	ISO/DIS 13985-1, clause 6		Difference. EIH ¹ "Tests and Inspection" specifies a pressure test to 1.3x(P _{design} + 0.1 Mpa) by hydraulic or other means. Verification tests include a 10% He fluid leak tests, verification of inner vessel dimensions, visual inspection, and Destructive and non-destructive tests of welding seams per 7A-2. ISO/DIS 13985-1 gives specific instructions on non-destructive testing of batch lots using radiographic, ultrasonic or acoustic means. Void size specifications are given. The comparison should be made in more detail; however, this effort has been delayed. Additional comments are to be provided as soon as possible ¹ .		ISO 13985 is to harmonize with the GRPE draft regulation. The GRPE draft regulation will keep the reference to the EN standard. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.
E	Annex 7A-1, 6.1		EIHP	The reference to paragraphs should be corrected	For the approval samples of the container shall be subjected to the tests according to 6.3.7 to 6.3.9 of this annex and shall be witnessed by the Technical Service. A crash test according to 6.3.10 shall be....	Agreed
E	Annex 7A-1, 6.3.8		EIHP	Head line should be corrected in order to be in line with annex 8A	Thermal autonomy test under fire	Agreed
E	Annex 7A-1, 6.3.9		EIHP	Head line should be corrected in order to be in line with annex 8A	Thermal autonomy test during normal operation	Delete whole paragraph in GRPE
C	Annex 7A-1 7	ISO/DIS 13985-1		There is no equivalent requirements in ISO/DIS 13985-1.		The GRPE draft regulations is to be left as it is. ISO/TC 197 is to decide if they want to incorporate this optional item.

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Replaces: Document GRPE/ISO N 017			

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7A-2			The comparison should be made with the applicable parts of ISO/CD 21029-1 <i>Cryogenic vessels — Transportable vacuum insulated vessels of no more than 1000 l volume - Part 1: Design, fabrication, inspection and testing</i> currently in development in ISO/TC 220. However, this comparison is a fairly extensive effort. It will be performed as soon as possible. .		ISO 13985 is to adopt the same approach as the GRPE draft regulation. The GRPE draft regulation will retain the reference to the EN 1251-2 version 3/2000. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards. Annex 7A-2 is to be deleted and the references are to be included directly in Annex 7A (was Annex 7A-1). To comply with this agreed change, the following sentence was added in Annex 7A, paragraph 2.1: "The design validation of the container by calculation shall be done in accordance with EN 1251-2:2000."
E	Annex 7A-2		EIHP	prEN 1251-2 is now published as EN 1251-2	Replace "prEN 1251-2" by "EN 1251-2" and "3/1999" by "3/2000"	Agreed.
E	6.4.1.2 /Annex 7 B, 4.1		GM	Design pressure definition of the primary safety valve should be the same: 6.4.12: 110 % of the normal operating range – Annex 7B: maximum working pressure of the tank		GRPE to be revised according to the new definition of MAWP

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Replaces: Document GRPE/ISO N 017

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C	Annex 7B	ISO/DIS 13985-1, Clause 4.6.1		The reference pressure for the two documents is different. The ISO/DIS 13985-1 document references the maximum permissible operating pressure while the EHIP document references the maximum working pressure. ISO/DIS 13985-1 allows the primary relief to be 110% of the maximum permissible operating pressure while the EHIP document requires that it not be greater than the maximum working pressure. The set pressures for the secondary relief are not specified in the EHIP document and the flow capacities are not specified.		GRPE draft regulation is to be revised according to the new definition of MAWP. GRPE draft regulation: Set pressure is defined as MAWP As agreed in 6.4.1.1 also in Annex 7B there must be 100% only. ISO 13985 is to harmonize with the GRPE draft regulations The GRPE draft regulation will include a reference to EN 13648-3 <i>Cryogenic vessels-safety devices for protection against excessive pressure – Part 3 Determination of required discharge — Capacity and sizing for flow capacities (see 6.4.1.4- editorial change ?)</i> . However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.

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GRPE/ISO N 030

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ISO/DIS 13985-1 Liquid hydrogen – Land vehicle fuel tanks – Part 1: Design, fabrication, inspection and testing (2001-07-31)
ISO/DIS 13985-2 Liquid hydrogen – Land vehicle fuel tanks – Part 2: Installation and maintenance (2001-07-31)

Replaces: Document GRPE/ISO N 017

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 7B, 1 and 2					ISO 13985 is to adopt the same approach as the GRPE draft regulation. The GRPE draft regulation will retain the reference to the EN standards. However, the EN standards and the ISO equivalent are to be included in the Annex of ISO/EN equivalent standards.
E	Annex 7B, 1		EIHP	Issue dates are missing	Add "5/2002 and delete pr	Agreed
E	Annex 7B, 4.2		EIHP	It should be aligned with 6.4.1.1	Change "yield strength" into "90% of the yield strength"	New text : Secondary device of the inner tank: between the Maximum Allowable Working Pressure (MAWP) and 136% of the Maximum Allowable Working Pressure (MAWP)
C	Annex 7C	ISO/DIS 13985-1 Clause 4.6.4		The EIH document calls out specific test procedures for valves while the ISO/DIS 13985-1 document only specifies a single leakage test.		ISO 13985 is to harmonize with the GRPE draft regulations
E	Annex 7C, 1		EIHP	PrEN is now released	Delete "pr" add at the end "from 03/1999"	Agreed
E	Annex 7 C		GM	One given test procedure for hydrogen valves is the operational test. The specified test procedure in Annex 8 B is applicable for pressure relief devices.	A procedure: operational test for hydrogen valves should be specified.	Operational test is only for pressure relief valves. The endurance test on Annex 8B is to be changed as per the text shown at the end of this table.

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Replaces: Document GRPE/ISO N 017

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E	Annex 7D		GM	For the heat exchanger no welding quality system or approval of the welding process is required.	The requirements for the welding process and seams as given in clause Annex 7A-4 for the container should also be applicable for heat exchangers.	Agreed, new text in the GRPE draft regulation: The manufacturing and mounting of the heat exchanger is to be certified according Annex 7A-1, 4.3 – 4.5 ISO 13985 is to be revised accordingly
E	Annex 7E, 1		EIHP	Issue date is missing	Add at the end "from 12/2001"	Agreed
C	Annex 7F	ISO/DIS 13985-1		We could not find a parallel requirement in the ISO/DIS 13985-1 or -2 documents.		ISO 13985 is to be revised accordingly
E	Annex 7H, 1		EIHP	Issue date is missing	Add at the end "including amendment AC from 02/2001"	Agreed
E	Annex 7 H; Annex 8 B, 12		GM	Applicable test procedures for flexible fuel lines: Is the pressure cycle test equivalent to the endurance test?		No change required. Is different, see Annex 8B, 5 and 12
E	Annex 7 I; Annex 8 B, 11		GM	Applicable test procedures for fittings and screwed connections: Is the connection test equivalent to the endurance test?		No change required. Is different, see Annex 8B, 5 and 11

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<p>GRPE Draft regulations: Uniform Provisions Concerning the Approval of : I. Specific Components of Motor Vehicles Using Liquid Hydrogen; II. Vehicles with Regard to the Installation of Specific Components for the Use of Liquid Hydrogen. Rev. 11 dated 29 August 2001.</p> <p>ISO/DIS 13985-1 Liquid hydrogen – Land vehicle fuel tanks – Part 1: Design, fabrication, inspection and testing (2001-07-31)</p> <p>ISO/DIS 13985-2 Liquid hydrogen – Land vehicle fuel tanks – Part 2: Installation and maintenance (2001-07-31)</p>		

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 8A 1.	ISO/DIS 13985-1, clause 5.4		<p>Difference. EHIP "inner tank burst test" specifies a hydraulic water test to destruction as follows: Either: 3.25x (maximum working pressure + 0.1 Mpa) or 1.5 x Rm/Rp (maximum working pressure + 0.1 Mpa) Where Rm=minimum ultimate tensile strength and Rp=minimum yield strength There is no differentiation between possible liner types. However ISO/DIS 13985-1 specifies for different liner types:</p> <ul style="list-style-type: none"> • Welded metallic inner vessels: 3 x max possible permissible operating pressure • Seamless steel inner vessels: 2.25 x max possible permissible operating pressure • Glass: 3.65 x max possible permissible operating pressure • Aramid: 3.1 x max possible permissible operating pressure • Carbon: 2.35 x max possible permissible operating pressure <p>EHIP document has no section with the text equivalent to ISO/DIS 13985-1, clause 5 that specifies pressure cycling tests as part of the approval for a new design.</p>		<p>The whole EHIP draft is currently made for steel tanks only. For other materials the whole paper should be revised and not 1 test only. In order to open the paper for other materials in general the following text is added to Annex 8A, 1.1.</p> <p>The performance of hydrogen containers made from materials other than steel, shall be demonstrated to be equivalent to these requirements according to existing International Standards.</p>

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Replaces: Document GRPE/ISO N 017

Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
C	Annex 8A, 2.	ISO/DIS 13985-1, clause 5.5		Difference. EIHDP Thermal autonomy under fire is less stringent. EIHDP: 15 minutes under fire (at least 650 C) not to exceed 1.1 x the maximum working pressure ISO/DIS 13985-1: 30 minutes under fire (at least 900 C) not to exceed 1.2 x the maximum working pressure.		It was agreed that 1,36 of the MAWP is to be used in both the EIHDP draft regulations and the ISO draft standard. Both the GRPE draft regulation and the ISO 13985 draft standard are to use a 590 °C test (consistency with the LPG and natural gas regulations 67 and 110).
E	Annex 8A, 2.1.1.		EIHDP	15 minutes for the thermal autonomy under fire is too long. Remark: a conventional fuel tank is 2 minutes exposed to fire according to ECE R 34.	Replace "...be greater than 15 minutes.." by "...not less than 5 minutes..."	Agreed
E	Annex 8A, 2.1.2.		EIHDP	Criteria is missing for safety against bursting	Add at the end "...and the tank must not burst."	Agreed. Add at the end "... and the tank shall not burst."
E	Annex 8A, 2.2.4.1		EIHDP	Inconsistency in the requirement	Replace text of the paragraph by: "The tank is filled with liquid hydrogen so that the quantity of liquid hydrogen measured by the mass measurement system shall be half of the maximum allowed quantity that may be contained in the inner vessel."	Agreed in principle. Replace text of the paragraph by: "The tank is filled with liquid hydrogen so that the quantity of liquid hydrogen measured by the mass measurement system shall be half of the maximum allowed quantity that may be contained in the inner tank."
E	Annex 8A, 2.2.4.4		EIHDP	15 minutes for the thermal autonomy under fire is too long. Remark: a conventional fuel tank is 2 minutes exposed to fire according to ECE R 34. The second sentence is not necessary	Replace "15 minutes" by "5 minutes". Delete second sentence.	Agreed

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	Annex 8A, 2.2.4.5		EIHP	It is not necessary to measure the pressure	Delete "...and the pressure in the tank is fallen to 0,01MPa.."	Agreed.
E	Annex 8A, 2.2.4.5		EIHP	Criteria is missing for safety against bursting	Add at the end "...and the tank must not burst."	Agreed. Add at the end "... and the tank shall not burst."
C	Annex 8A 3.	ISO/DIS 13985-1, clause 5.6		Difference. EIHP Thermal autonomy during normal operation is specified for 24 hours before a safety device is opened. ISO defines this as "holding time" and does not specify a time, but a procedure for measuring the time. ISO conditions are more stringent with a test temperature of 65 C as opposed to the EIHP temperature of 20 C.		Whole test is to be deleted.
C	Annex 8A 4.	ISO/DIS 13985-1		There is no equivalent requirement in ISO/DIS 13985-1.		ISO 13985 is to harmonize with the GRPE draft regulations.
E	Annex 8B, 3.2.2		GM	The external leakage test shall be performed at the minimum operating temperature. If the minimum operating temperature is at liquid hydrogen temperature then the test should be performed at liquid hydrogen temperature and not at liquid nitrogen temperature.	Delete "or at liquid nitrogen temperature"	GM withdrew its comments. No change is required.

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	Annex 8B, 4.5		GM	The position (closed or opened) shall be defined.		Annex 8B 4.5 is to be changed as follows: A non-return valve in closed position shall not leak with a rate exceeding 500 cm ³ /hour of air during the test. In case the filling unit includes a non-return valve then this valve shall not leak at a rate exceeding 10 cm ³ / hour during the test.
E	Annex 8B, 5.2		GM	All equipment which works at cryogenic temperature shall be tested with liquid hydrogen or gaseous hydrogen at the temperature of liquid hydrogen and at the maximum working pressure of the component	Change: liquid nitrogen in liquid hydrogen	GM withdrew its comments. No change is required.
E	Annex 8B, 7.1		EIHP	Leakage test is not applicable for all components	Add after 3 and 4 above "..., if applicable.."	Agreed.
E	Annex 8B, 10.		EIHP	Wrong reference to tests	Replace "...paragraphs 5,6 and 7.." by "...paragraphs 3 and 4..."	Agreed.

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Code ¹	Clause in EHIP draft regulation	Clause in ISO draft standards	Name of expert/ Organization	Comments	Proposed change	Observations on each comment submitted
E	Annex 9					<p>Change were introduced in Annex 9. The new text is now in line with the already published annexes of ECE 13 and ECE 13H.</p> <p>In addition, as they are some definitions in Annex 9, these definitions were deleted in section 2 of the regulation itself so that the text of the annex remains unchanged compared with other ECE regulations.</p>

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5. Endurance test (continued operation)
- 5.1 A hydrogen carrying component shall be capable of conforming to the applicable leakage test requirements of paragraphs 3 and 4 of this Annex, after being subjected to the number of operation cycles specified for that component in Annex 7B to 7I to this Regulation.
- 5.2 The appropriate tests for external leakage and seat leakage, as described in paragraph 3 and 4 of this Annex are to be conducted immediately following the endurance test.
- 5.3 The component shall be securely connected to a pressurized source of dry air or nitrogen and subjected to the number of cycles specified for that specific component in Annex 7 to this Regulation. A cycle shall consist of one opening and one closing of the component within a period of not less than 10 ± 2 seconds.
- 5.4 The component shall be operated through 96 % of the number of specified cycles at a temperature of 20 °C ± 5 °C and at the MAWP of the component. During the off cycle the downstream pressure of the test fixture should be allow to decay to 50 % of the working pressure of the component.
- 5.5 The component shall be operated through 2 % of the total cycles at the maximum material temperature (see Paragraph 14.1.7 of this Regulation) after 3 hours conditioning a this temperature and at MAWP. The component shall comply with Paragraph 3 and 4 of this Annex at the appropriate maximum material temperature (see paragraph 14.1.7 of this regulation) at the completion of the high temperature cycles.
- 5.6 The component shall be operated through 2 % of the total cycles at the minimum material temperature but not less than the temperature of liquid nitrogen (see Paragraph 14.1.7 of this regulation) after 3 hours conditioning at this temperature and at the working pressure of the component. The component shall comply with paragraph 3 and 4 of this Annex at the appropriate minimum material temperature (see paragraph 14.1.7 of this regulation) at the completion of the low temperature cycles.

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