

Comparison LH2 ISO EC and draft GTR

	#1: ISO #2: EU Reg #3: BMW		ISO 13985 #1	EU Regulation #2 EU 79/2009 and EU Komm. 406/2010	BMW Proposal #3 GTR Draft - LH2 Part	
Issue	Page	Paragraph/ figure/table	Content	Content	Content	Remark
Fuelling system interface (fuelling receptacle)	#1: V #2: - #3: -	Introduction - -	Fuelling system system interface referred to ISO 13984	Not regulated	Not contained	Fuelling system system interface only as a recommendation.
Scope	#1: P. 1 #2: P. 5 #3: P. 17 + 35	1. Article 2 A.5. + B.2.	LH2 Tanks and components	LH2 + CGH2 Tanks and components for LH2 and CGH2-systems,	LH2, complete vehicle	Type approval on component and vehicle level vs. Performance based tests on vehicle level.
Material compatibility	#1: P. 5 + 12 #2: P. 40 #3: P. 45	4.4 + Annex B 406: Annex 3, Part 2, 3. GTR B.5.2.2.	General requirements, ref. To ISO 21028-1 Annex B (informative) has to be updated.	General requirements, ref. EN 1252-1	t.b.d. after CGH2 is defined.	General requirements ISO and EU are similar. Common basis for material requirements has to be found. Annex B (informative) in ISO 13985 has to be updated.
Design	#1: P. 5 #2: P. 39 #3: P. 12 + [60]	4.5. Design 406: Annex 3, Part 2, 2.1. GTR A.3.3.2.4. + B.7.2.	ISO 21029-1:2004	EN 1251-2	Approve design/construction of vessel by providing a calculation according to valid regional legislation for pressure vessels.	Design requirements of ISO and EU are similar. Design requirements should be extracted from ISO and EU and moved to Annex B. 7.2 <i>Type approval requirements for liquefied hydrogen storage</i> . To be discussed: What is the minimum requirement in the GTR (no design only performance requirement)?

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type-approved components	#1: P. 6-8 #2: P. 41-43, 47-55 #3: -	4.7 and 5.5. Annex III -	Requirements applicable to tank accessories are specified in Clause 4.7, Clause 5.5 and Annex D specify the type tests	Very similar to ISO 13985 for the tank accessories, which are covered in Clause 5 and Part 3. The requirements for the other liquid hydrogen fuel system components are covered in Part 3.	No component requirements. (However: Functionality of components is tested on system level: e.g. Vacuum loss test)	Requirements of ISO and EU for tank accessories are similar. Other liquid hydrogen fuel system components are only covered in the EU. All of these component requirements should be extracted from ISO and EU and moved to Annex B. 7.2 <i>Type approval requirements for liquefied hydrogen storage.</i>
Type tests for the tank/whole system.	#1: P. 7f + 13 #2: P. 14 #3: P. 42ff	5. + Annex C Annex II GTR B.5.2.	Inner tank burst pressure test Thermal autonomy test Maximum filling level test Pressure test Leak test Additional tests (dimension, welding, visual)	Burst test Bonfire test Maximum filling level test Pressure test Leak test Additional tests (dimension, welding, visual)	Baseline Initial Burst Pressure test (hydraulic) Bonfire test Boil-off test Proof pressure test Leak test Vacuum loss test	All three documents follow a concept of 5 basic tests that verify basic properties of a LHSS and the essential safety measures (e.g. PRD). ISO and EU reg. have additional test to supervise the quality of the production processes (e.g. welding), which should be extracted from ISO and EU and moved to Annex B. 7.2 <i>Type approval requirements for liquefied hydrogen storage..</i> In the BMW LH2 draft the Vacuum loss test on system level is suggested to show the proper operation of the pressure relief devices. These properties of LHSS are covered by component tests in ISO and EU reg.
Burst test	#1: P. 8 + 13 #2: P. 44 #3: P. 44	5.2. + Annex C.1 406: Annex 3, Part 2, 6.3.7. GTR B.5.2.1.	No details, ref. to ISO 21029-1:2004	Test acc. Procedure, pass criteria: (MAWP + 0,1 MPa) x 3,25	Test acc. Procedure, pass criteria: (MAWP + 0,1 MPa) x 3,25	ISO 21029-1:2004 not available probably no difference between 3 docs
Thermal autonomy test	#1: P. 8 + 13 #2: - #3: -	5.3. + Annex C.2 - -	Test acc. Procedure, pass criteria: PRD open after >= 5 Minutes Tank shall not burst	Not regulated	Not contained	ISO: Test of insulation performance of the tank and of PRD
Bonfire test	#1: - #2: P. 44 #3: P. 46	- 406: Annex 3, Part 2, 6.3.8. GTR B.5.2.4.1	Not contained	Test acc. Procedure, pass criteria: PRD open at any time Tank shall not burst	Test acc. Procedure, pass criteria: PRD open at any time Tank shall not burst	EU reg. and BMW LH2 Draft: Test of PRD are similar.

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Maximum filling level	#1: P. 7 #2: P. 44 #3: -	4.7.7. + 5.4. 406: Annex 3, Part 2, 6.3.9. -	Test acc. Procedure, pass criteria: Tank shall be prevented from being overfilled, no safety device activated	Test acc. Procedure, pass criteria: Tank shall be prevented from being overfilled, no safety device activated	Not contained (Boil-off test instead)	ISO and EU are similar. Safety device should not be activated even in most critical situation which is after max. refuelling
Boil-off test	#1: - #2: - #3: P. 45	- - GTR B.5.2.3.2.	Not contained (Maximum filling level test instead)	Not regulated (Maximum filling level test instead)	Test acc. Procedure, pass criteria: In normal operation no safety device activated, even after refuelling	see above
Proof / pressure test	#1: P. 8 + 16 #2: P. 43 #3: P. 45	6.2. + Annex D.4 406: Annex 3, Part 2, 6.3.1. GTR B.5.2.3.1	Test acc. Procedure. Test Pressure: 1,3 (MAWP + 0,2 MPa) No visible plastic deformation	Test acc. Procedure. Test Pressure: 1,3 (MAWP + 0,1 MPa) No visible plastic deformation	Test acc. Procedure. Test Pressure: 1,3 (MAWP + 0,1 MPa) No visible plastic deformation	All: Test performed hydraulically Difference: ISO Test is performed at different pressure, ISO specified a maximum outer pressure of 0,2 MPa while EU and GTR takes into account a 0,1 MPa maximum outer pressure.
Leak test	#1: P. 9 #2: P. 43 #3: P. 45	6.3. 406: Annex 3, Part 2, 6.3.2. GTR B.5.2.3.2	Test acc. Procedure. Test with 10 % helium mixture. No detectable leak (max. 10exp-8 cm³/s at 20°C)	Test with 10 % helium mixture. No explicit requirement for tank	Test acc. Procedure. Max. rate: 150 ml/min (same as CGH2)	Very different requirements, open if it's type approval/self-certification or quality issue
Vacuum loss test New LH2 Draft!	#1: - #2: - #3: P. [28 + 46]	- - GTR B.5.2.3.3	Not contained Issue covered by component tests	Not regulated Issue regulated by component type approval	Test acc. Procedure.	Functionality test for first and second pressure relief device
Additional tests	#1: P. 8ff #2: P. 43 #3: P. 45	5.5 + 6.4.ff. + Annex D.4 406: Annex 3, Part 2, 6.3.1. GTR B.5.2.3.1	Basically component tests und inspection of production process (e.g. welding)	Basically component tests und inspection of production process (e.g. welding)	No additional tests (except Vacuum loss test, see above).	See the comments above applicable to the components and type tests.
Definition MAWP:	#1: P.11 #2: P.36 #3: -	Annex A 406: Annex 3, Part 1, 3.2. -	see Annex A	see Figure 3.2	same usage as in EU reg.	Definition in ISO and EU reg. differs

Remark: Comparison table has no claim to be complete.

