ISO Report

Following the 9th meeting of the SGS, it appears that there are still a large number of safety concerns that need to be addressed before the draft GTR can move to the next stage of approval (**see Annex A**). They are summarized below:

- GH$_2$ Container: The provisions for the GH$_2$ container use a new performance based approach that has not been properly validated. Indeed, the only testing done using the new performance based approach has been done by Powertech Labs using an earlier version of the draft GTR text. Further, this new performance based approach has the following weaknesses:
  - Open to any type of containers, even those not on the market
  - No distinction is made between the type of containers and fibre
  - The container could be designed to a baseline number of filling cycles that could vary from 11 000 cycles to 5500 cycles without any mechanism to withdraw the container once the number of filling cycles are exceeded, if designed to the reduced number of filling cycles.
  - Only the burst pressure ratio is used to assess the residual strength after testing. This does not provide the required confidence level that the container is safe for all types of containers.
  - A low burst pressure ratio is used for all types of containers, irrelevant of the type of fibre
  - Some new test procedures are not stringent enough or not properly defined, namely the hydraulic extreme temperature pressure cycling, hydrogen gas pressure cycling test and fire test. Also, there is confusion about the permissible permeation rate
  - Some tests (boss torque test and penetration tests), which are included in ISO and the EC Regulation No 79/2009, have not been included in the draft GTR
- Components: Critical components are not addressed properly. The testing done on the fuel system does not allow assessing the suitability of the TPRD, shut-off valves, etc. These components need to be subjected to additional testing that is yet to be determined.
- Leakage: Up to 4 % hydrogen is allowed in passenger compartment. 4 % is the lower flammability limit (LFL) of hydrogen in air. Some margins should be allowed so that actions are triggered before the 4 % limit is reached. In stationary applications, most of the standards require that an action be triggered when 1 % of hydrogen in air is reached.
- LH$_2$ Container: The provisions of the LH$_2$ container use a new approach that has not been validated.

On top of these safety related issues, there are a number of requirements in the HFCV GTR that are not harmonized with the Japanese Regulations and the EC Regulation No 79/2009, which could lead to a reduction of the safety level compared to the existing regulation. At their meeting on 9-12 March 2010, AC.3 agreed in principle that the GTR should not lower the current stringency level of safety already addressed by existing national legislations and that experts of the SGS group should concentrate their efforts on technical matters.

Lastly, there are a number of safety provisions that will only apply to countries that have a type approval system. They include material requirements, components requirements, batch tests, routine tests and overpressure protection of the low pressure system. This will possibly lead to a lower safety level in those countries that use the self-certification system. In the interest of safety and harmonization, these provisions should be made mandatory for all.

	ISO Comments on the container		
No.	**Paragraph/figure/table**	**Recommendation**	**Comment/Justification**
1	A.5.1.3 b) ii) b) (6) P.25	Remove this item from the draft GTR. This is a misleading statement. The Powertech testing was not performed according to the current version of B.5.1.3, but on a previous version of the GTR text that has been substantially changed since then.	The Powertech report does not provide any evidence in support of the statement that tanks that have passed the NGV2 and EIHP r12b tests have failed the tests proposed the tests shown in B.5.1.3.
2	A.5.3.1.8 Recommended features for design of a hydrogen fuel system P. 30	All these requirements are general requirements that should be considered as mandatory. They shall be moved to B.5.1.	All these requirements can easily be verified by a visual inspection.
3	B.5.1 P. 37-42	The provisions for the GH_2 container use a new performance based approach that has not been properly validated. Indeed, the only testing done using the new performance based approach has been done by Powertech Labs using an earlier version of the draft GTR text.	This subject should be further discussed in a task force meeting.
4	B.5.1 Types of tanks P.37	It is recommended that the GTR recognizes that there are currently 4 types of tanks used for the storage of gaseous hydrogen (Type 1 – Metal containers; Type 2 – Hoop wrapped composite containers with a metal liner; Type 3 – Fully wrapped composite containers with a metal liner; Type 4 – Fully wrapped composite containers with no metal liner.)	It is virtually impossible to safely cover any new design of tanks without reassessing the testing program. A new technology may have failure mode that have not been planned in the testing. A re-evaluation of the test program should be done before allowing new types of tanks. Also, by keeping the types of tanks, the testing program can be adjusted based on the known failure mode. Some tanks could be exempted from some tests.

5	B.5.1.1.1 Baseline Initial Burst Pressure p.38-39	The initial burst pressure test should retain the commonly used burst ratio that are based on the type of fiber as follows: • Metal: 2,25 X working pressure (WP) • Glass: 2,4 WP for type 2, 3,4 WP for type 3 and 3,5 WP for type 4 • Aramid: 2,25 WP for type 2, 3,0 WP for type 3 and 3,0 WP for type 4 • Carbon: 2,25 WP for WP greater than 35 MPa • Carbon: 2,0 x WP for WP of 35 MPa and higher Also stress ratio should be considered (see SGS-6-11 clause 5.1.5).	These burst and stress ratios have a long history and should not be discarded just for the sake of using a more performance-based approach that use the same burst pressure ratio for all types of tanks. The Powertech validation testing program does not provide the confidence that the new testing approach will detect all tanks that would fail in service. The number of samples that were tested to prove this concept was limited to one tank. Further, according to the report, this tank has had numerous failures in vehicle service and routine testing and would have probably failed any test. This subject should be further discussed in a task force meeting.
6	B.5.1.1.2 Baseline initial pressure cycle life p.39	The container could be designed to a baseline initial pressure cycle life that could vary from 11 000 cycles to 5500 cycles without any mechanism to withdraw the container once the number of filling cycles are exceeded, if designed to the reduced number of filling cycles.	A harmonized baseline initial pressure cycle life should be agreed to.
7	B.5.1.1.2 Baseline initial pressure cycle life p.39	The baseline initial pressure cycle life should be specified in a clause separate, which can then be referred to, when required. Right now all the provisions in the draft GTR are based on a 5500 cycles and have not been adjusted to take into account that the baseline initial pressure cycle life can be established at 11 000 cycles.	Place the requirement for showing compliance to LBB behaviour in a separate clause and leave only the baseline initial pressure cycle life requirement in B.5.1.1.2. Express all the requirements in the draft GTR in terms of a factor or percentage of the baseline initial pressure cycle life (changes to be made to Clauses B.5.1.2.4, B.5.1.2.6, B.5.1.3.2 and B.5.1.3.3).
8	B.5.1.1.2 Baseline Initial Pressure Cycle Life P. 39	This part of the test which is intended to demonstrate LBB behaviour is not clear. The pass/fail criteria for the LBB test is not well described. Also, the 22 000 cycles is required for a 5500 baseline initial pressure cycle life. It should be set at 44 000 cycles for 11 000 baseline initial pressure cycle life. The requirements should be expressed in terms of a factor of 4 of the baseline initial pressure cycle life .	This subject should be further discussed in a task force meeting.

9	B.5.1.2 Figure B.5.1.2 P.39	The percentages of cycles in the figure are not consistent with B.5.1.2.4 and B.5.1.2.6.	To be consistent, the following changes should be made: • 80 % # cycles 15C-25C should be changed to 60 % # cycles • 10 % # cycles -40C should be changed to 20 % # cycles • 10 % # cycles+85C should be changed to 20 % # cycles
10	5.1.2 Verification test for Performance Durability P. 39	A boss torque test should be included for composite tanks with non load sharing liners.	The boss torque test has historically been used for composite tanks both used for the transport of gases (ISO 11119) and onboard applications. Further since the OEMs rely on the integrity of the tank especially when the vehicle is parked (no warning in case of leakage), the need for this test should be reconsidered and discussed in a task force meeting.
11	B.5.1.2.6 Extreme temperature pressure cycling P. 40	We suggest the following changes to the test: The storage system will be pressure cycled from less than 2 MPa to NWP at -40C for 20 % of the baseline pressure cycle life specified in B.5.1.1.2 and from less than 2 MPa to 125 % NWP at 85C and 95 % relative humidity for 20 % of the baseline pressure cycle life specified in B.5.1.1.2. The test should be done in accordance with test procedure B.6.2.2.2.	These changes are requested to bring the document in line with ISO/TS 15869, which are more representative of service conditions. The number of cycles should be discussed in a task force meeting.
12	B.5.1.2.7 Residual strength burst test P. 40	Only the burst pressure ratio is used to assess the residual strength after testing. This does not provide the required confidence level that the container is safe for all types of containers.	This subject should be further discussed in a task force meeting.
13	B.5.1.3 Verification test for expected on-road performance P. 41-42	Further discussion would be required on this test. OICA has not provided a justification for the change in procedure as requested in Geneva (action item 14). The current version of the GTR is less stringent than the earlier version proposed by OICA. • 5 % of cycles done at -40 C and 50 C as opposed to 25 % of cycles • Static hold at 55 C as opposed to 85 C Further there should be a discussion on the need to examine the plastic liner and the liner/end boss interface for evidence of deterioration or damage at the end of the test as it is requested in ISO/TS 15869.	This new test procedure has not been validated. The Powertech report was intended to validate the SAEJ2579 test program. The verification test for expected on-road performance specified in B.5.1.3 of the current version of the draft GTR is substantially less stringent than the test done by Powertech: • 5 % of cycles done at -40 C and 50 C as opposed to 25 % of cycles in the Powertech testing • Static hold at 55 C as opposed to 85 C in the Powertech testing This subject should be further discussed in a task force meeting.

14	B.5.1.3.3 Leak/permeatio n test P. 41	It is still unclear what should be the allowable permeation rate.	Before a permeation rate is specified, the SGS should thoroughly examine this question. This subject should be further discussed in a task force meeting.
15	B.5.1.3.5 Residual strength burst test P. 42	Only the burst pressure ratio is used to assess the residual strength after testing. This does not provide the required confidence level that the container is safe for all types of containers.	This subject should be further discussed in a task force meeting.
16	B.5.1.4 Verification test for service terminating conditions P. 42	The penetration test should be included as part of these tests.	The penetration test has historically been used for composite tanks both used for the transport of gases (ISO 11119) and onboard applications. This subject should be further discussed in a task force meeting.
17	B.5.1.4.1 Fire test P.42	The fire test procedure needs to be defined.	This subject should be further discussed in a task force meeting.
18	B.5.2 Liquefied Hydrogen Storage System P.42-46	We suggest that the requirements for the liquid hydrogen storage system be harmonized with the requirements of the international standard ISO 13985 *Liquid hydrogen — Land vehicle fuel tanks,* which has recently been reconfirmed by the ISO membership.	This exercise should be addressed in a task force meeting.
19	B. 5.3.1.1 Gas fuelling port P.46	Gas fuelling port: The gas fuelling port shall comply with ISO 17268.	The fuelling receptacle is an important component of the system from a compatibility and safety point of view.
20	B. 5.3.1.3.2, B.5.3.1.3.3 and B.5.3.1.3.4 Protection against flammable conditions P. 47	Up to 4 % hydrogen is allowed in passenger compartment. 4 % is the lower flammability limit (LFL) of hydrogen in air. Some margins should be allowed so that actions are triggered before the 4 % limit is reached.	In stationary applications, most of the standards require that an action be triggered when 1 % of hydrogen in air is reached.

21	B.5.3.1.5 Tell-tale warning to driver p. 48	The tell-tale should be prescribed. For safety reasons, the same warning should be provided when the conditions of B.5.3.1.3.4 are met.	Considering the importance of this warning, it is important that drivers are familiar with the sign. It should be consistent from one car to the other.
22	B.7.1 P. 58-59	There are a number of safety provisions that will only apply to countries that have a type approval system. They include material requirements, components requirements, batch tests, routine tests and overpressure protection of the low pressure system. This will possibly lead to a lower safety level in those countries that use the self-certification system. In the interest of safety and harmonization, these provisions should be made mandatory for all.	This subject should be further discussed in a task force meeting.
23	B.7.1.1 Material test requirements P. 58	Material properties are essential requirements for the safety of containers. In the interest of safety and harmonization, these provisions should be made mandatory for all, not only those countries that use a type approval system.	The overall based performance-based qualification does not address the suitability for use of the materials. Specific performance based material tests are needed. The proposed material requirements were provided by ISO in SGS-6-11 (see Clause 5.1.6). These material requirements are performance-based and are not design restrictive.
24	B.7.1.2 Qualification test for hydrogen-flow closures P.58	Critical components are not addressed properly. The testing done on the fuel system does not allow assessing the suitability of the TPRD, shut-off valves, etc. These components need to be subjected to additional testing that is yet to be determined.	The verification test for expected on-road performance described in B.5.1.3 and the fire test of B.5.1.4.1 are not sufficient to address the safety of critical components such as the TPRD, shut-off valve and check valve. Specific qualification test are needed to ensure the safety of these components. We suggest that the requirements included in the EC Directive be used as the basis for the HFCV GTR.
25	B.7.1.3 Verification tests for consistency of the qualification batch	This test in unclear.	This subject should be further discussed in a task force meeting.

26	B.7.1.4 Verification tests for Conformity of Production with Design Qualification P.59	The need for the container manufacturer to perform and keep record for the batch and routine production test should be recognized. In the interest of safety and harmonization, these provisions should be made mandatory for all, not only those countries that use a type approval system. The proposed batch and routine tests were provided by ISO in SGS-6-11 (see Clauses 5.1.8 and 5.1.9)	Batch and routine production test are essential to guarantee the safety of the containers that are produced in series. The manufacturing of container is a special process (i.e. the quality of the container cannot be fully assessed by non destructive testing at the end of the manufacturing process). It is therefore essential that the manufacturing process is kept under control and it is the purpose of the batch and routine test to demonstrate that the tanks that are produced on a daily basis have not deviated from the tanks that were initially qualified.
27	General	There are a number of requirements in the HFCV GTR that are not harmonized with the Japanese Regulations and the EC Regulation No 79/2009, which could lead to a reduction of the safety level compared to the existing regulation. At their meeting on 9-12 March 2010, AC.3 agreed in principle that the GTR should not lower the current stringency level of safety already addressed by existing national legislations and that experts of the SGS group should concentrate their efforts on technical matters.	This subject should be further discussed in a task force meeting.