

DRAFT Meeting Minutes for the  
10<sup>th</sup> Meeting of the Subgroup on Safety (SGS)  
of Hydrogen-/Hydrogen Fuel Cell Vehicles

7-10 September, 2010  
San Francisco, California

Place: Hyatt at Fisherman's Wharf

Schedule: Tuesday, 7 September 10:00 – 17:30  
Wednesday, 8 September 09:00 – 19:15  
Thursday, 9 September 09:00 – 17:30 (dinner at 18:15)  
Friday, 10 September 09:00 – 12:30

Video equipment and wireless internet connection available

### 1. Welcome and Introductions

Jay Keller, Sandia National Laboratories, welcomed the members as local host. Co-chair Narusawa also welcomed the members, and thanked DOE and DOT for arranging the meeting in San Francisco. He also thanked again the Korean delegation for hosting the SGS-9 meeting last June. This is the last of our scheduled meetings for HFCV-GTR. Co-chair Koubek extended his welcome to the delegates to beautiful California. He also thanked Sandia for making the meeting arrangements. The members were reminded that 65 years ago the UN charter was signed in San Francisco, and the Chinese delegate signed first.

Attendees representing: BMW, CATARC, CSA International, EC, German Ministry of Transport, Building, and Urban Affairs, GM/OICA, KATRI, Korea Patent and Trademarks office, LANL, NTSEL, SAIC Motor, SNL, Transport Canada, Tsinghua University, USDOE, USDOT/NHTSA, and Volvo.

### 2. Logistical Arrangements

#### 2.1 Meeting arrangements

There is a reception Tuesday evening. Breakfasts and lunches are also provided. A group dinner will be held at a local restaurant on Thursday at 18:30 – meet in the lobby 18:15). Start times each day were moved up to 9am for the remaining days. Wednesday close may be extended to (as late as) 19:30. Lunch will be at 12:30 each day, except on Friday.

### 3. Approvals

#### 3.1 Minutes/decisions of the 9<sup>th</sup> Meeting

Comments were received from Korea and incorporated in to the Minutes posted. Permeation discussion on page 9 of the minutes requires some correction. The language is not consistent with ISO – it is equivalent to HySAFE/SAE proposals. Also, agreement was made on the rate numbers during the meeting (the action item was completed during the meeting). The revised document will be posted on the UNECE website.

#### 3.2 Action Items from the 9<sup>th</sup> Meeting

1. Electronic copy of China presentation to be provided to Secretary and posted on the SGS website. **Done**
2. Electronic copy of EU Regulation 406-2010 to be provided to Secretary and posted on the SGS website. **Done**

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3. Electronic copy of Korea presentation to be provided to Secretary and posted on the SGS website. **Done**
4. Electronic copy of FMVSS 305 and the presentation by DOE to be provided to Secretary and posted on the SGS website. **Done – emailed by DOT**
5. The Secretary will set up a conference call and send connection information to participants for a discussion of the LH2 proposal. Original proposal for July 8th; later changed to 14th. **Done**
6. Letter from Powertech will be posted on the SGS website. **Done SGS-10-12**
7. Germany, working with ISO, will propose language to be considered by the group that clarifies that the Powertech report is specific to certain types of tanks and that the data were collected on only a small number of tanks. **Done – received comment from BAM and discussed during SGS-10.**
8. Japan and HySAFE will work to harmonize the numbers. **Done SGS-9 meeting, result in SGS-10 – 13.**
9. HySAFE presentation to be posted on the SGS website. **Done – SGS-9-06 and SGS-9-11**
10. Edit the entire GTR document to ensure that SI units are used throughout. **In progress**
11. Presentation on localized fire test to be posted on the SGS website. **Done – SGS-10-08**
12. Chair requests that the cleaned-up draft of the GTR be distributed in July. **Done**
13. Co-sponsors will discuss with Project Manager Christoph Albus, WP.29, and AC.3 to determine the appropriate location of the type approval requirements so that all CPs can apply the GTR. **In progress (for the time being, use annex for type approval requirements and refer to these in Part B). If it is the decision of the whole group, Albus believes it will be accepted by WP.29.**
14. Japan will determine if the CSA test procedure on qualification test for hydrogen-flow closures (A.5.1.2.4) is substantially equivalent to the Japanese test procedure. **Done – JASIC agrees that it is substantially equivalent.**
15. Germany will get a legal opinion on whether the container labeling proposal is consistent with the regulation that the label is imbedded in the cylinder (concerned about free trade). **Done**
16. Co-Chair will get an opinion from WP.15 on their work for harmonized labels. **In progress. Outstanding for co-chair. EC representative did some work in this area, and reports on a conflict on the color of the label (green in EU regulation). Because these tanks are specifically exempted from the EU regulation (the tanks are for propulsion), this color conflict is not an issue.**  
**Q: is there additional information from WP.15 on design of the label?**  
**A: co-chair will follow up on this particular issue.**

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17. A small group should focus on the definitions section to ensure the language is consistent and correct. **Good set was developed, but additional work is needed. Open**
18. Canada will provide a rationale for the inclusion of 11,000 cycles. **Done. Rationale in the text has a number of different cycle requirements (in Part A).**
19. EC will provide an example definition of type approval. **Open/in progress.**
20. Each CP to provide comments on the proposed language for the use of Annex A. **Open (no comments received). Will be discussed.**
21. EC will propose text for section B.5.3.1.1 on fueling interface. **In progress – want to use existing language in Part A. ISO also has a proposal.**
22. NHTSA will provide the report on the vehicle trunk explosion. **Open. The report has not been published yet. As soon as it is published, a link to the website will be provided.**
23. OICA will submit a test report to validate the alternative test procedure in B.6.1.2. **Open - no OICA members were able to provide the report. Propose to keep it in place, since otherwise there is a requirement for sensors and thus is design restrictive.**
24. China will provide material data for consideration by material scientists for inclusion in the list of compatible materials. **Do not want to include specific materials in the GTR at this time.**

**Action items from the LHSS teleconference on 7/14/10 All have been completed and will be discussed during the LH section of the GTR: SGS-10-09.**

25. Correct text in part A3.3.2 as needed. – BMW
26. Provide rationale and justification in section A5.2. - BMW; GWS and Nha
27. Create a summary table of requirements from ISO standard, EU regulation and BMW proposal - BMW and ISO
28. Provide a separate section for LHSS fuel delivery system (from fuel container assembly to the engine) in section A3.4 – BMW and GWS
29. Reword and/or combine the 5 bullets on MAWP of section B5.2, page 43. Decision needed on whether move these requirements to Annex 7.2 or keep in part B – BMW and GWS
30. B5.2.2 Material compatibility: review the material qualification requirements for CGH, specifically section B6.2.1, to see whether the approved material can be used for LHSS or develop a separate material section for LHSS. This should also be in Annex 7.2 - BMW and GWS
31. Passing criteria in section B5.2.3.2 is not clear. Keep the test requirements and pass/fail criteria in the section and move the test set-up and procedures to section 6; this should be done with other requirements - BMW and GWS
32. Section B5.2.3.3 Leak test: need to verify that the allowable permeation rate is consistent with CGH - BMW and GWS
33. Review to verify that LHSS shall meet the same in-use and post crash requirements in section B5.3. and related test procedures - BMW and GWS

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#### 4. Reports of UN Activities

##### 4.1 151<sup>th</sup> Session of WP.29 in June 2010

Project Manager Albus reported that HFCV-SGS is making good progress. He announced that we would be submitting a draft GTR in December 2010. SGE is also preparing a technical report for submission.

Q: will the draft GTR include ELSA (electric safety) information?

A: yes – this will be one of the three sections (container, vehicle safety, electric safety)

##### 4.2 ELSA Meeting

As FMVSS 305 has been published, the meeting last week will be reported in this agenda under item 6 (reordered from draft agenda).

#### 5. Reports of other activities

##### 5.1 National/Regional

Canada: No update.

China: Two standards for fuel cell vehicles are under development.

EC: Plans include understanding the number of cycles, and research efforts in support of this effort. The EC has just received a request to approve a fuel cell motorcycle – it would be good to have input from any other members who may have similar experiences. There will be a vote at the end of the year. The representative is interested in hearing opinions and thoughts.

Germany: No update.

Japan: No update.

Q: what is the status of the new regulation on containers?

A: comment period is closed; should be issued by the end of this year. Pressure is increased to 70 MPa in the new regulation.

Korea: No update.

US: DOE presentation – the program has expanded to include portable and stationary fuel cells. Vehicle demonstration projects are coming to an end in 2010. Demonstrations of forklifts (lift trucks) are a growing area for the program. International collaborations through IPHE and other groups are important to the DOE program. Upcoming meetings were discussed and participation was encouraged.

**ACTION:** US DOE will provide update presentation so that it can be posted

Q: are members of the group going to be at the China meetings next week (IPHE and related meetings)?

A: USDOT and USDOE members will be present. China members will also participate. An EC representative will be present.

A: OEMs have committed to attend the follow-on meeting to the US workshop on compressed gas storage (CNG and H<sub>2</sub>) from around the world. There will also be a good representation of tank manufacturers. The meeting is very much industry focused.

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US: DOT update – post crash testing using hydrogen and helium. SNL will give a detailed presentation during the appropriate section of this meeting. DOT/NHTSA will be performing a whole vehicle crash test within the next two week. The report will be provided to this group when it is available.

Q: are the data qualitative or quantitative?

A: these were quantitative measurements.

Q: what was the vehicle type and weight? This information is needed so that it can be compared to previous crash tests.

A: this information will be provided in the report.

**ACTION:** USDOT/NHSTA to provide vehicle crash test results as soon as possible.

Electrical safety testing will also be performed and results will be incorporated into the GTR.

### 5.2 ISO/SAE/CSA

ISO: TC197 is creating a group to advise the chair on storage.

Q: what is happening with the gaseous hydrogen storage group?

A: the work will be restarted after the advisory group completes its work.

SAE: continuing efforts to update J-2578 and J-2579 (refinements for protocols for tank verification and cycling; materials in hydrogen service; and inclusion of the localized fire test). The standards should be ready for ballot by the end of the year.

CSA: component and fueling station standards for the US. Ten standards are published as interim documents for US use and will be put forward for approval as standards. Fueling station document is out for review, should be published as a TIR by the end of the year. CSA has been working with SAE to harmonize approaches.

## 6. Electric Safety

### 6.1 Update on ELSA activities

Meeting held last week in Washington DC. Good progress was made. Some clarification on the remaining issues is still needed; waiting for research results from NHTSA on barriers. There will be no further meeting of the ELSA group for the GTR contribution. There is a subgroup of interested experts to work on an amendment to the 1958 agreement – rechargeable batteries. In Use document is accepted for the most part (small clarification).

Post crash (protection of occupants) – first and second options are accepted by all; use of a barrier may be accepted based on the results of research; NHTSA does not accept the fourth option of post crash isolation (energy level and how to measure it).

The rationale for incorporation into Part A of the GTR is under development, but the technical content is essentially complete.

**ACTION:** Link will be provided to the draft ELSA document.

### 6.2 Discussion

Q: is this for fuel cell vehicles only, or all electric vehicles?

A: it applies to high voltage vehicles of any type.

Q: is this work also coordinated with other parties, such as SAE?

A: SAE is involved, and the requirements are universal (J-1766 does not talk about the particular power source, only the power level).

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Q: will all of the various regulations be harmonized in this GTR?

A: there are some issues with low energy level (DOT will not accept), and the physical protection is still under consideration (DOT ongoing research to be completed next year).

## 7. Finalizing the Drafting GTR

### 7.1 Revised Draft GTR

#### ***Outstanding issues for Part A and Part B***

Latest revision sent out on Sunday September 5, 2010 – SGS-10-01 rev 1

#### ***Discussion of LH2 container and system.***

BMW submitted a proposal, and a teleconference was held in July 2010 to discuss remaining issues.

All action items from the teleconference were addressed in a paper and posted (SGS-10-09)

Generic diagram developed.

**NOTE: changes were made to the draft GTR in the course of the discussion, specific to the test procedures. Please refer to the LH2 sections of the draft for the detailed changes to the text and for additional action items.**

The hydrogen container always has 2 phases – liquid and vapor. The hydrogen is always removed as a vapor, never as a liquid.

Heat exchange is also important in gaseous hydrogen storage systems. Thermal management is needed, but adding a heat exchanger to the generic drawing might be misconstrued as a design-specific requirement.

C: terminology – pressure relief device or pressure relief (regulating) valve or pressure safety valve. There seems to be no differentiation in the reclosing type versus non-reclosing types in this discussion. We need to make sure there is no confusion with the compressed hydrogen system. The terminology section does have definitions for PRD and PRV; may need to work on these definitions.

C: “safety concerns” – are there problems with using this phrase? Could change to “safety needs.” DOT will check with general counsel, but these phrases are often interchanged in DOT documents.

C: material capability and selection issues are similar for compressed and liquid systems (do not want to restrict future developments). This is still an open issue.

C: hydrogen discharge test. Normal (expected) boiloff could mean that hydrogen is released or discharged (depends on how this discharge is handled) - the maximum amount of hydrogen that could be released as hydrogen is still limited to the same level for both storage systems.

Q: minimum yield strength value used? Rp of 1.0 or 0.2?

A: will check

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**ACTION:** BMW will check on the minimum yield strength (Rp)

Still some work to be done to finalize the material compatibility section.

C: the temperature of the hydrogen vapor is very low, below the temperature of materials that are allowed in the compressed hydrogen system.

C: This is true – material selection is a very complicated issue.

Structure of this section needs to be consistent – some of the written material will need to be moved to the appropriate sections of the GTR.

Leak Test section should use the same language for maximum allowable hydrogen discharge as in the compressed gas section. Sentence was pasted from the compressed gas section. Need a test procedure.

**ACTION:** BMW and GS will develop a proposal for a test method for the LH2 Leak Test.

**ACTION:** Interested parties will develop clarifying language for Vacuum Loss Test related to the text around the first and second pressure relief valves.

Concerns expressed that this is a lot of new information on LH2 and final agreement will be difficult in the short time before we are to finalize this GTR. Co-Chair assures that no shortcuts will be taken.

C: Japan is very concerned about the possibility that liquid oxygen may form.

C: Including a statement that the forming of liquid oxygen (liquefied air) is prohibited will make this GTR consistent with the EU regulation (Regulation (EU) 406/2010 paragraph 9.3: page 38 of the official publication).

Q: how do we make this a performance requirement? Just because it happens does not necessarily mean it is a safety issue.

C: the EU regulation says liquid air AND combustible materials cannot be in contact.

C: would have to be in the annex, since it is pretty specific for the type approval mode, if we use the EU regulation language.

Proposal made to use the language in the EU regulation.

C: this language is too ambiguous to be accepted by the US. It can be moved to the annex as a type approval requirement (after small change to the language).

C: ISO 21014 has language related to a requirement for insulation and this should be considered in an effort to harmonize.

C: an earlier effort to address this issue resulted in the development of language that does not include a reference to insulation.

Q: Has BMW looked at the post-crash requirements? We developed a test procedure for the CH2 system, but how do we identify the leakage of an LH2 system?

A: the leakage level should be the same.

Q: is the procedure the same as for the CH2?

A: no. we will need a new procedure.

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**ACTION:** BMW and GS will develop a proposal for an LH2 crash test procedure once the CH2 crash test procedure is available (LH2 will likely be a modification of the CH2 test).

Q: isn't there already a crash test for CH2 vehicles?

A: Korea has done the test, and the US will be doing it next week in Texas.

C: The GTR has the procedure for measuring the leakage.

C: It is possible to do the equivalence for LH2 (leak). The issue is the secondary requirement to measure gaseous leakage into the passenger compartment and we are not sure how to do this (likely to use liquid nitrogen as the surrogate fluid, whereas gaseous helium is used as the surrogate gas in the CH2 test).

Discussion of the comparative table (ISO, EU, this proposal):

C: For the LH2 section, there needs to be performance tests and type approval tests so that LH2 is equivalent to the CH2 sections.

C: we agreed that only the critical components need to be tested, and only those tests need to be incorporated.

C: should look to see what is missing and add only those tests.

Q: this is new technology for NHTSA – are there any reports that can be provided that will help NHTSA decide on this language?

A: there is some internal data and it is company confidential – will check on the potential to release some of those data and report back on the result.

C: sharing of data and reports is critical to the development of the GTR.

**ACTION:** BMW will check on the potential for release of some of their LH2 data.

### ***End of Tuesday Meeting***

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### ***Wednesday Meeting***

The Co-Chair reminded the members that it is critical that all concerns be raised as soon as possible in order for the GTR draft to be completed on time.

A review of the discussion yesterday:

The requirements for LH2 need to be rewritten and the test procedures need to be moved/added to section 6. Clarification is also needed for some of the test procedures. The localized fire test may or may not be appropriate for the LH2 containers, but we will need a strong justification to have the test only for the CH2 containers.

C: the localized fire test is not applicable for the LH2, since the pressure will increase in the LH2 test when it is in a bonfire, as opposed to the CH2 tank, where the relief valve is temperature-actuated.

C: true, but it may be necessary to test to see if the location of the fire on an LH2 tank always causes the pressure relief device to actuate.

C: the comparison table presented yesterday shows a large number of differences. In addition, the LH2 section of the GTR does not parallel the CH2 section. There is much more information in the CH2 section. The draft GTR does not provide the same level of safety as the EU



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regulation or ISO documents. It would be relatively easy to extract the language from either or both of these documents to enhance the draft GTR.

C: the material test requirements are difficult (for both LH2 and CH2, actually).

US: the current text on requirements is sufficient for the US. There may be additional requirements for type approval, and the contracting parties using type approval should determine which components need additional requirements.

EC: consultation is needed – it is a good way forward to add requirements to the annex for type approval and replacement parts (free movement of goods). It is more complex than can be addressed in this meeting.

C: the performance-based tests that are in the GTR now are a very good set. Any additional component tests should be carefully considered to avoid redundancy (of required tests).

C: Components must often be certified before they can be approved in a system, so there is precedence for have critical components tested, and additionally tested in the system.

Q: what is the right way forward? Should we discuss it further here so that we know how to proceed? The system level approach could have an impact later on (for example, replacement part manufacturers).

The safety-critical components were identified for the CH2 system, and it would be a reasonable thing to do for the LH2 system. The list would likely be relatively short.

The EU regulation has a list, but it is related to those components subjected to 30 bar pressure. None of the components in the LH2 system will see this pressure.

**ACTION:** EC and BMW will develop proposal for type approval of LH2 components.

**ACTION:** All CPs and interested experts should provide comments on the revised LH2 sections.

***End of discussion on LH2 proposal.***

Review of the comments sent to the Secretary – see text of the GTR draft

**ACTION:** ELSA will provide input for Part A.

Discussion of the rationale section in A.5, specifically the second sentence related to the differences between self-certification and type approval.

US: do not see why this sentence should be included – contrary to the philosophy of self-certification. If it is changed into more of an advisory, it could be left in this section.

EC: the advisory route is a good one

Q: does Korea agree to this paragraph, given that the system used is a mix of component requirements and self-certification?

A: no immediate response.

C: making it a little broader could (more) effectively address the potential for changes to the way various CPs approve vehicles.

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Q: Why haven't the ISO comments, submitted in July, been included into the current draft?

A: comments that were discussed at the previous meetings were not included, as decisions were already made on how to deal with these comments. There was a long discussion on comments at the co-sponsors meeting. Each comment was evaluated (already decided, similar to another, to be discussed, obsolete, etc). We will discuss any comments that are brought up or submitted, unless the comment has already discussed, and a decision made, in a previous meeting.

The number of cycles was resolved at SGS-9 after a very lengthy discussion. The related comment from Germany was removed from the draft.

Co-chair: discussions of comments related to Part A are complete. We will now start the discussion of comments in Part B.

**NOTE: changes were made to the draft GTR in the course of the discussion. Please refer to Part B of the draft for the detailed changes to the text and for additional action items.**

Part B scope – Group discussed the content and placement of the sentence requiring CPs using the type approval system to adopt annexes B.7.1 and B.7.2.

ISO: there was a comment submitted that a statement that the currently known tank types are covered by this section, and that it needs to be clear that, when a new tank type is developed, it may be necessary to develop additional tests to ensure equivalent safety.

C: this would be more appropriate for Part A. It is not a regulation, so this advisory serves no purpose.

C: there is similar wording in B.7.1, so this needs to be considered further.

**ACTION:** Co-sponsors will draft language in Part A for an advisory that additional testing may be appropriate for introduction of completely new tank technologies.

Discussion of Performance Requirements section:

ISO questions the reference to the Powertech report and the comment paper from BAM and ISO. Powertech tested a limited number of tanks, and questions remain on the validity of the testing procedure to prove the safety of the tank.

The three questions that were to be answered by the Powertech tests were:

- can the test be performed safely? – it can be
- does the test accurately predict known failure modes? – yes
- if a tank fails this test but the tank was not flawed (i.e. passed by other testing), does this test result in false positives? – no

These are the proper validity criteria. Interestingly, the test sequence did find two previously unknown failure modes that would be expected to occur in future on-road service.

NHTSA will be performing a series of tests and the data will be shared once it is available (no later than summer 2011). It is hoped that additional CPs will also be able to share data.

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Timing is not sufficient to incorporate this into the GTR. This conflict was recognized early, but a decision was made to continue working on the draft in parallel with data collection and analyses on the tanks. Right now, all that is available is the Powertech report.

C: Concerns remain about the statistical issues relative to Type 4 tank variability and the approach of the GTR to test a small number of tanks for design qualification.

C: Powertech did include both Type 3 and 4 tanks. Historical tank qualification testing (standards and regulations) require testing of a small number of tanks for design qualification.

ISO: There are many unknowns. A task force could be set up to discuss and to come to some sort of agreement.

CP opinions:

Germany –Perhaps this issue can be brought up at the Shanghai conference.

US – accepts the Powertech report.

Japan – Japan is in the process of introducing a new regulation for CH.

Canada – hard to comment – do not think that enough testing has been done. Timing is a big concern; do we stop the GTR process and perform the tests to collect more data?

EC – Some EU tests are planned and could contribute to the final evaluation of this issue, but perhaps not in the near term (before the draft of the current GTR is due).

Level of confidence within the CPs in the testing requirements in the GTR and validation represented by the Powertech report:

US – confident in the GTR approach and the relevance of the results of the Powertech report.

Additional NHTSA testing will be conducted to broaden the experience, and a reference to the Powertech report should be included in Part A of the GTR as it reports very relevant information.

Canada – more testing is needed

Germany – not confident that enough validation testing has been done

EC – agree that the reference to the report should be left in Part A. Additional testing is needed to validate the testing.

Japan – agree with US proposal

Korea – agree with US proposal

China – agree with US proposal

**ACTION:** OICA members will be surveyed about their willingness to share tank testing data.

Decision made to leave the reference to the Powertech report in Part A.

Review of Cycle Life section:

C: this was thoroughly discussed in SGS-9.

Presentation by Sandia National Lab (SNL) on hydrogen in the passenger compartment following a crash test:

**ACTION:** SNL presentation will be distributed to SGS-10 as soon as appropriate.

Discussion of Service Termination Tests:

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Note: the US-proposed localized fire test procedure was only sent to the group a few days ago, so participants should review the content and provide comments as needed, as soon as possible.

Q: how do you determine the farthest point from a TPRD, if there is more than one?

A: easy for one TPRD. For systems with two TPRDs, it will be at the midpoint between the TPRDs. Beyond that, it might get more complicated. The idea is to not put the TPRD in the fire.

**ACTION:** Participants are asked to provide comments on the new localized fire test procedure.

China: want to use natural gas rather than LPG, and also want to use air instead of hydrogen in the tank (same procedure for the CNG test).

EC: suggest changing LPG to "gas"

C: possible as long as the flame temperature is comparable and there is controllability of the flame orientation/direction.

Presentation on Developing Fire Tests (posted on the website as SGS-10-08)

### ***End of Wednesday Meeting***

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### ***Thursday Meeting***

The Co-Chair reminded the group that we will be meeting for a hosted dinner tonight. Please meet in the hotel lobby at 6:15pm.

Discussion continues on Service Terminating Performance:

Engulfing fire test (B.5.1.4.1) – clarification of rationale (comments from Germany in the text): the issue is that the TPRD may perform differently at low pressure (20% of NWP) compared to high pressure (NWP), so it is proposed that two tank tests be required.

Japan: only at NWP.

China: does not accept the proposal (do not believe it is necessary to do the test at 20% NWP). Also propose that air be used rather than hydrogen (also discussed above in the discussion about the localized fire test proposal).

Korea: can accept the test at 20% NWP, but Korea regulation does not include the 20% NWP test.

Canada: accepts the proposal, but more information on the cost of this additional test would be useful.

US: the purpose of this test is to ensure that the TPRD performs properly.

Germany: there should be an alternative – the component test (TPRD) could verify TPRD performance at 20% NWP, and then a system-level fire test would not be required. Propose that this be made optional.

C: these component tests are only required for type approval, so are not mandatory for self-certification

C: performing this on the system level is redundant (the TPRD is tested on the component level already)

The first proposal is from the US: the fire test proposed by the US includes a localized-followed-by-engulfing fire test.

CSS note: it's not a tank test, it's a system test.

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The second proposal is to perform two engulfing-only fire tests, one at NWP and one at 20% NWP.

Agreement of the CPs is that the second test (20% NWP) is not needed as long as the localized and engulfing fire test is performed, and the TPRD is qualified (see text for proposed language).

The Secretary reminded the group that there is a significant difference in the temperatures used in the two engulfing fire tests: the engulfing fire followed by the localized fire (note – this is a series test performed on a single system) is at 800°C; whereas the historical engulfing test – often/previously referred to as the bonfire test – is at 430°C.

China referenced a presentation on the use of air for the test, rather than hydrogen, in a bonfire test. Paper published in IJHE.

**ACTION:** China to provide presentation and the citation for the paper published in IJHE on the use of air in the bonfire test.

Canada: this will not be accepted in Canada due to a catastrophic explosion when air was mistakenly used to test a tank previously in CNG service (there was residual CNG in the tank). Only hydrogen or helium should be allowed to be used. A report was developed at the very beginning of this group's work on this and all other known gas cylinder accidents (not likely to be any additional information).

**ACTION:** Canada will review to see if the report on gas cylinder accidents is available.

Japan: JARI test results are very different (internal pressure rise is substantially different when air is used).

China: agree that the pressure-time histories for air and hydrogen are different, but the temperature-time histories are essentially the same for both gases, and the TPRD is activated by temperature.

Japan: in the bonfire test, pressure history is important.

C: The internal pressure can be important in TPRD performance, for example is clearing the vent line of TPRD material that fractures during activation; so the performance at realistic internal pressures must be verified. The important temperature for activating the TPRD is generally not the internal gas temperature; it is the external TPRD temperature.

Q: will China accept a tank that was tested with hydrogen?

A: China will accept hydrogen-tested tanks.

C: Performing the fire tests with air may actually introduce a safety hazard. If the tank test is part of a non-destructive sequence, or the tester is using a tank that survived a non-destructive test and the earlier tests on the same tank will have been performed using hydrogen, it is possible that hydrogen would remain in the tank. It is difficult to completely remove the residual hydrogen from the tank prior to the introduction of air for the final destructive test. If there is any residual hydrogen in the tank, the introduction of air could result in an explosive mixture that would be very dangerous.

China: the tanks used in the fire tests are always virgin tanks (never had hydrogen introduced). Following safety procedures is critical.

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C: unless an error is made or a fault occurs – the Canadian tank that exploded was thought to have been purged twice but the pilot valve was not operating properly. There is a regulation that prohibits the use of air.

(Friday morning discussion)

JARI presentation of data on the effect of using air rather than hydrogen in the localized fire test. Simulation results for the pressure rise is significantly different for air and hydrogen, although the temperature rise is similar (consistent with Chinese report).

China; we also get similar results on the pressure curve, but the TPRD activates by temperature rise, not pressure.

JARI: the purpose of the localized fire test is to also evaluate the tank rupture (pressure). Using nitrogen (or another gas) would not get to the pressure that is expected when using hydrogen. Also, the use of LPG is important to get the required temperature of the impinging flame. The external temperature is important in activating the TPRD.

US: the pressure rise using nitrogen is not sufficient.

China: load carrying capacity is verified by burst test. The main objective of the localized fire test is to verify the performance of the TPRD.

C: the localized fire test verifies the competition between the speed at which the TPRD empties the tank, and the failure of the tank materials. A slow TPRD might be fine on some tanks, but not on others. The hydrogen-filled tank will see a higher pressure rise than a nitrogen-filled (or air-filled) tank, and the tank might actually burst if a slow TPRD cannot keep up with the pressure rise. The external temperature is important in activating the TPRD, which can release before the internal gas temperature has increased appreciably.

China: suggest tests be conducted on the system so that a proper conclusion can be reached, to prove that pressure rise is indeed as important as temperature rise.

China proposes to use compressed air instead of hydrogen (air and hydrogen exhibit the same temperature rise) in the localized fire test, and because air compressors are more available.

Japan proposes that hydrogen (or helium) be used because the pressure rise is as important as temperature rise, and compressed air does not exhibit the same pressure behavior as hydrogen (or helium).

**Issue remains open – Canadian regulation expressly prohibits the use of compressed air in tank testing.**

**ACTION:** CPs are asked to provide comments and supporting data on the potential to use compressed air (or nitrogen) instead of hydrogen (or helium), and on the fuel to be used in localized fire test.

Discussion of Labeling section:

This was thoroughly discussed at the SGS-9 meeting.

The inclusion of the date of manufacture may not be the right starting point for the 15 years of service (when does “service” start, and is there still stress on the tank before the vehicle is put into service?).

The US requires the inclusion of the Date of Removal from Service.

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Japan wants to include the number of cycles to which the tank has been tested.

C: This could be achieved by the additional labeling that any CP may require.

Germany suggests that we remove the Date of Removal from Service from the required information on the label.

C: the manufacturer cannot control the removal from service.

US: This cannot be eliminated – this is the most critical piece of information for the user and must be included.

Germany: the US is free to require the additional information.

C: the consumer will not have access to this label – the label is for tracking purposes only. Thus, the Date of Removal from Service is not needed.

US: this was extensively discussed during SGS-9 and the current list is the agreed list.

**ACTION:** CPs will develop appropriate language for consideration to be included in Part A to clarify what is meant by 15-year service life.

Discussion of additional comments on the Performance Durability (hydraulic sequential tests):

B.5.1.1.2: Rationale behind the selection of 22,000 as the maximum number of cycles – so far past the maximum expected cycles (equates to 4 million miles of stressful full-fill service).

C: to be consistent with existing documents, should be factor of 3 or 4. US: The current text is sufficient.

ISO: when the comparison was made in SGS-5 (Budapest), the number was 11,000 – there has been no justification for increasing it to 22,000.

Leave as is: Japan, EC, US, Korea, Germany, and China are in support.

Issue is closed.

Clarification was requested to explain the difference between the various burst pressures in the test sequence.

**ACTION:** OICA will draft text for inclusion in Part A that distinguishes between initial (beginning-of-life) burst pressure and end-of-life (residual) burst pressure.

ASIDE by Co-Chair: are we trying to write a GTR before we have enough test data with the proposed GTR procedure?

C: some will never be satisfied that enough tests have been done.

C: Important aspects: can the test be done, does it measure/test what we think it does, and is it repeatable?

C: CPs should recommend what additional tests would be needed to increase confidence.

Co-sponsors positions:

Japan: the Japanese regulation will be fully harmonized with the GTR when it is approved. The SGS-9 meeting also included a task force meeting where experts gathered – do not understand how another task force meeting will help.

Germany: the open issue should be declared at the end of the day by the Co-Chair, and we should not keep going over issues that were closed at previous meetings.

US: focus on the open issues.

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Proceeding to the next open item:

Labeling on the LH2 tank – not needed (compressed gas container labeling is much more safety critical).

Labeling on the LH2 receptacle/fueling port is needed. This perhaps can be added to the section that deals with the gas fueling port (B.5.3.1.1) – some modification will be needed but this would be the appropriate place to consolidate this information.

Changes were made to the gaseous hydrogen receptacle to cover both fuel types.

Discussion on moving the receptacle text (or parts of it) from Part A (A.5.3.1.8) to Part B or Annex.

US: this is totally subjective and is not consistent with self certification. This has been discussed many times; since it is a recommended practice, it belongs in Part A.

EC: it is necessary for type approval countries to require the recommended practices – this will be in the Annex.

CP poll – should the receptacle recommended practice section be moved or copied to the Annex as a requirement for type approval countries?

US: The issue is that these are too subjective and not measureable. The Annex is supposed to only include the “must have” items.

Germany: select the most important elements to Part B (wording should be changed to match the current EU regulation)

**ACTION:** The EC will provide modifications to the text on the receptacle requirements that has been moved to section B.7.3.2, as required.

Discussion on the Telltale section:

OICA: the requirements in section B.5.3.1.3.4 seems to imply that measurement of hydrogen concentration will be required. Some editing may be needed to remove this implication.

US: this is a critical safety requirement (>4% hydrogen in the passenger compartment).

C: do not want to remove the requirement. The concern is that the language will require a sensor in the passenger compartment.

US: this is a performance requirement – we do not tell the manufacturer how to do it.

Modifications to the text were incorporated and approved.

Discussion of the proposed section on monitoring of in-service performance (A.5.1.2.2)

After much editing, a poll of the CPs results in the removal of the paragraph.

***End of Thursday Meeting***

***Friday Meeting***

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Next was review of current action item list and assignment of due dates and discussion of future meetings.



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Continue with discussion of Post-Crash Requirements section:

Changes to the text were incorporated and approved – see next GTR draft.

**ACTION:** GWS will propose language in A.5.3.2.1 to more thoroughly explain why helium can be used as a surrogate for hydrogen in crash tests.

Additional cleanup of Part A (see revised text of draft).

OICA comment on the generic diagram and associated text for section B.5.1 – revised text inserted into the draft, and accepted.

Discussion of Post Crash Requirements section:

Clarification of the average leak rate is needed to avoid (mis)interpretation by inspectors.

**ACTION:** EC will propose text to be considered for revision of the fuel leakage limit and the accompanying test procedure (only if change is needed).

**ACTION:** US will provide a test procedure for ensuring that hydrogen or surrogate gas concentration does not exceed 4% hydrogen (or equivalent % if using a surrogate gas) in the passenger, luggage and cargo compartments.

Test procedure specifies the use of helium. It should allow for the use of hydrogen.

**ACTION:** OICA will review test procedures to ensure that it is allowed to use either helium or hydrogen in the leak tests.

**ACTION:** China will provide information on two types of steel to be included in section B.6.2.1.6.

**ACTION:** CSS will provide a proposal for a test procedure for embrittlement resistance to be used to qualify new materials that are not on the current list of compatible materials.

BMW challenges some of the materials on the current list. Some of the materials on the list are not appropriate for low-temperature systems. Comments will be provided once the next version comes out.

**ACTION:** Participants will provide comments on the list of hydrogen-compatible materials.

**ACTION:** Canada, Japan and GS will review and provide revised text for section B.6.2.3.3 and other sections such as B.6.2.1.3.

## **8. Miscellaneous Administrative Items**

### **8.1 Approval of Decisions and Action Items of the 10<sup>th</sup> Meeting**

Review of action items list. Due dates assigned.

### **8.2 Next Meeting**

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Teleconference (webinar) to incorporate comments will be held on November 5 (7am EDT, 12pm in Europe, 9pm in Japan) – 2 hours maximum.

Task Force Meeting (co-sponsors, CPs and interested parties) will be held on November 16-18 (after all action items are completed) in Berlin.

Possible SGS-11 on January 24-28 in Brussels (tentative) to address comments from GRSP on the draft GTR (that will be prepared and submitted after Task Force Meeting).

**8.3 Other Issues**

None.