SGS 5 - 9

5th Meeting of the Hydrogen / Fuel Cell Vehicles
Subgroup on Safety (SGS)
Budapest - Hungary

19-21 January 2009

DRAFT Minutes

Place:	KTI Institute for Transport Sciences Nonprofit Ltd. Thán K. u. 3-5. H-1119 Budapest, Hungary
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Schedule:	Monday, 19 January	9:30 – 18:00
	Tuesday, 20 January	9:30 – 18:00
	Wednesday, 21 January	9:30 – 17:00

Monday, January 19

1. Welcome and Introductions

Mr. Narusawa welcomed the attendees, and thanked KTI for hosting the meeting. Mr. Koubek welcomed the head of KTI (Dr. Ruppert) who gave an overview of KTI (Institute for Transport Sciences: www.kti.hu).

The following contracting parties were represented: Canada (Transport Canada), China (CATRI), European Commission (DG and JRC), Hungary, Japan, Korea, and the United States (NHTSA/DOT, DOE, Los Alamos National Laboratory, SANDIA). The meeting was also attended by representatives from BAM (Germany), BASt, BMVBS, ISO TC197, JAMA and JASIC (Japan), KTI, OICA (GM, Honda, PSA, Toyota, Volvo), SAE, Swagelok, and TUV (Germany).

2. Logistical Arrangements

Meeting and lunch arrangements discussed

3. Approvals

Revised agenda was distributed in hard copy.

3.1 Minutes/decisions of the 4th Meeting: Some changes/clarification, which will be made by the co-chair and reposted on the SGS website. Specifically, per EC input we note the correct name of the organization where the seminar took place in

Tokyo: the EU-Japan Center for Industrial Cooperation. On page 3 in the minutes, we need to have "hydrogen" instead of reference to "hydrogen fuel cell vehicles" only.

4. Reports of UN Activities

4.1 44th Session of GRSP (December 2008)

Reported out by delegates from Germany and the US that SGS is making progress according to the Action Plan. Electric Safety Subgroup will meet right after this meeting, January 22-23 (will have a report from the Chair under agenda item 7).

4.2 146th Session of WP.29 (November 2008)

Mr. Albus (general manager) informed the WP.29 that this group is on schedule (draft GTR for HFCV is on schedule to be finalized by 2010).

Note: throughout the document:
Q = Question
A = Answer
C = Comment

5. Reports of other activities

All presenters urged to give copy to the secretariat (Mr. Nha Nguyen) and the co-chairs

5.1 National/Regional

Japan: no update

EC: Update on EU Regulation for type approval of hydrogen vehicles: split-level (parallel) approach: main requirements (co-decision: adopted on September 3, 2008 by the European Parliament, Council gave its final approval in December 2008) and technical details (comitology: still being developed, 1st meeting November 2008, 2nd meeting January 2009, draft is available on web: http://ec.europa.eu/enterprise/automotive/wgh_meetings/index.htm)

Q: How will the GTR be adopted, and how will the directive work with the GTR?
A: As reported in Japan at the 4th mtg, amendment by the European Parliament that the regulation will have to be amended when the GTR is available. Same approach as has been used for motorcycles
Q: Is the Comitology approval process the same?
A: Simpler than the co-decision approval process since there is much less involvement of the Parliament.

Korea: Study of CNG Bus Rollover Test: ~15,000 CNG buses in transit service. Most have storage cylinders on the roof. Data show an increased rate of rollover due to upward shift of the center of gravity. Valves on the side will sustain damage on a 40 degree rollover. There are no requirements for fuel system integrity in ECE R.866 or for rollover crash testing in FMVSS 303

Canada: will report on localized fire under agenda item 6.4

US: the USDOT research plan was presented at the 4th meeting in Tokyo. Testing has begun, and an update will be presented at the next meeting.

China: Crash test (frontal only) on fuel cell vehicle, used helium at 10MPa. Test on a tank designed for 35MPa – burst at 105MPa (water pressure). China developed three fuel cell vehicle standards in November 2008 (fuel cell vehicle safety requirements, test method of fuel cell engine (system), and terminology/definitions). Approval process will take time. China may be able to provide English version of the standards.

5.2 ISO/SAE

ISO: Standards were provided to the co-chair for distribution to the group (not to be posted on the site, but will be distributed by email – should not be shared outside of the group). Eleven files will be sent to members (due to the size, will be in several emails). Note: Memory stick was passed around at the meeting and attendees copied standards.
Q; What is the status of these standards?
A: All are published except the one on gaseous hydrogen fuel tanks – have the latest version, and only expect small editorial changes (not technical changes).
These standards are not for distribution outside the SGS.
Standards included:
13985 – Liquid hydrogen fuel tanks
14687 – Fuel quality for ICE engine
14687-1 – Hydrogen fuel product specification
14687-2 – Fuel quality for fuel cell vehicle
15869 – Fuel blends
17268 – Compressed H2 fueling connections
23273-1 – Safety specification part 1: vehicle functional safety
23273-2 – Safety specification part 2: protection against hydrogen hazards
23273-3 – Protection of persons against electric shock
23828 – Energy consumption measurement

SAE: Two documents were published recently (Jan 2009): (1) compressed hydrogen storage system (J2579 – it is a revised TIR – test methods were updated based by the Powertech tests. May refine the procedures a little more before making it a recommended practice, specifically regarding requalification) and (2) revision to the hydrogen and FC vehicle standard (J2578).
Q: Can we get an updated version of the TIR?
A: Will provide electronic version for use by the group, not for distribution.

Q: How are these different from the ISO standards?
A: Tank for ISO versus system for SAE. Hydraulic testing is similar, since it is only the tank that is tested (some differences in the actual test). US voted against the ISO document because of the difference in the testing.

JRC: Table of the synopsis of all the testing procedures that are contained in the regulations has been updated. It is a living document, since some of the regulations are still draft. Will be distributed, but should not be posted. It is a work-in-progress, and any corrections should be sent (more details under agenda item 6.4).

6. Discussion of Key Items for HFCV GTR

US (Mr. Nguyen) has the lead for GTR drafting with OICA and others who can contribute. The draft follows the format of the GTR. Combine purpose and scope together as suggested by Mr. Albus.

6.1 Definitions

6.1.1 Discuss the comparison of definitions

In Tokyo, we discussed the issue of definitions, and the importance of establishing a set of definitions so that we can agree on the use of certain terms in the text of the regulation. ISO, EC, and Japan were supposed to work informally on creating a list of terms and comparison of existing definitions, as common understanding will be critical to the efficient drafting of the regulation. No document has been generated yet – co-chairs urging progress be made by the next meeting.

Q: Definitions all in one place or at the head of each section?
A: Format of GTR has Section 3 for definitions. Heading for each section is only a description/introduction to what the section is about, not the definition.

6.2 Vehicle Fuel System Integrity – question raised what do we mean by VFSI – should it be changed to Vehicle Fuel System Safety instead?
Fuel System and Storage System need to be added to the list of terms that need to be in the definition section.

In Use (this section is about NORMAL operation)

6.2.1 PRD discharge direction

- Do we have a general agreement?
- Test procedure

Q: Is the text in this section (5.2.1.1) limited to thermal PRDs or any kind of PRD?
A: TPRD specified, want to protect from high-pressure releases.

6.2.2 Leakage limit for enclosed areas within the vehicle

- Discussion of OICA's paper on test procedures (4% by volume) – this was distributed about 1 year ago. Test Procedure in GTR draft will stay as a draft.
- Current industry requirements/practices (SAE recommends 1% by volume, which is 25% of the LFL)
- Verification of the main shut-off valve and detection system's operability

OICA had an action item from the 4th meeting to provide the paper on test procedures. Documents was provided to the chair but not posted. Proposed definition of enclosed or semi-enclosed space: volume surrounded by vehicle components or structure in such a manner that hydrogen may accumulate within the volume. Examples: Enclosed and semi-enclosed spaces (do not want to distinguish between these two types of spaces): Passenger and luggage compartments,

under the hood (engine compartment), under the vehicle (a cavity). Prevent accumulation in places with potential ignition sources.

SAE does not specify enclosed or semi-enclosed. It does make a distinction between equipment that is suitable for flammable locations and that which is not. Proposed language: Flammable fluids shall not be discharged into locations that are not suitable for operation in flammable environments (or something similar).

Proposed text was developed – see draft GTR Section 5.2.1.2.2 and the text highlighted in green.

6.2.3 Leakage limit for exhaust outlet

- Have we determined that there are no major concerns? If so, what are they?
- Japan's test procedure?
- Detection system?

Point-of-discharge definition provided by OICA: geometric center of the area where fuel cell purge gas is discharged from the vehicle.
C: Section 5.2.2.3 should not be only for the fuel cell vehicle. Could be for other purges or discharges as well. HICE could run fuel-rich, and therefore it should not be excluded.
C: Normal operation for a fuel cell will be the release of hydrogen into the exhaust system – this is specific to the operation of a fuel cell. We are not talking about failure modes in this section.
C: What stops the manufacturer from running fuel rich in an HICE?
C: Why would they want to run rich?
C: Propose the change be made to include any hydrogen vehicle. The exhaust system has to include the boil-off exhaust from a liquid hydrogen system, among other potential exhausts.

Q: The language related to the time-average concentration in the discharge is confusing. Is it averaged over the exhaust area (at the centerline) or over time?
A: Time-average aspect needs to be more clearly written.
Q: Why 4% (which is mostly not ignitable)?
A: 4% is the only literature value that is widely accepted.

C: The group would benefit from seeing the Japanese test data on the measurement of hydrogen in the vehicle exhaust during normal operation.

SAE test is 10 minutes: startup is about 5 seconds, run at idle for ~10 minutes, and then shut down.

Q: Are we focusing on the warm start up?
A: OICA argues that the test procedures are such that the results are comparable and repeatable. Therefore, the fuel cell has to be warmed up.
C: But from a safety perspective, we should explore the worst case scenario, which might be cold startup.
C: We need the OEMs to tell us what constitutes the worst case.

Japan test procedure – the peak in hydrogen concentration depends on the control (purge) procedure used by the manufacturer, so the peak is not always at the same point in the test procedure.

Q: Is the test procedure in Section 6.3 similar to the Japanese procedure?
A: In principle, the procedures are similar (times might be different, and the sequence of events may be slightly different). Very fast sensor response was observed.
C: The time between shutdown and startup needs to be specified – there is a chance that the worst case scenario could be in a "cool" or perhaps cold startup (fuel cell off for a specified time).

6.2.4 Telltale

- General agreement reached that we will require warning – Need to set warning parameters such as within the field of view of the driver for visual and certain loudness for audible.

C: This is restrictive language ("telltale" is too specific) – perhaps "driver warning system" allows the manufacturer to decide how to provide the warning. Should have a definition. US commented that "telltale" is a well-understood concept.
C: Want to specify only the minimum. Other regulations contain requirements where telltales are required, i.e., brake lights.
C: Won't be able to assure compliance if vague language is used (headlamp cleaning system example).
C: "Visual and/or acoustic" warning is the language in the German regulation
C: Should not allow only acoustic/audible, since there are hearing-impaired drivers (and loud radios).
C: Telltales have to be described in US regulations (FMVSS 101 has a table for all the symbols).
C: Experts in the interface between driver and vehicle are needed to determine the parameters for such a display/warning.
C: We need to set the parameters for the warning

Post Crash

6.2.5 Leakage limit for post-crash

- Discussion of the SAE-Japan proposal for test procedures
- Need to decide fuel type – do we use hydrogen or helium as surrogate

Handout regarding Action item #10 from 4th meeting: explanation of the limit value used in the Japan regulation. Same as one used for CNG vehicles. Difference between Japan regulation and the FMVSS 301 is the use of lower heating value (Japan, and recommended by OICA, SAE) rather than the higher heating value (FMVSS). 120 NL/min will be used.
C: Canada also has crash testing regulation. Use the same values as the US FMVSS. Also have an installation standard for CNG vehicles (so that small CNG vehicle conversion companies would not have to crash-test these vehicles – based on a CSA standard that has been updated to include hydrogen). There is no hydrogen regulation in Canada at this date.

ACTION: Check the original work on the equation of state (fit of NIST data) for the ranges of temperature and pressure for which this curve-fitted equation is applicable (so that it is not used outside the appropriate range(s)).

6.3 Presentation of Proposals from Japan and Germany

Japan: Three documents distributed:

- Outline of proposed provisions on hydrogen safety of HFCV
- Concept of hydrogen safety underlying the Japanese standards
- Draft proposal for HFCV-GTR on hydrogen safety

Outline of proposed provisions on hydrogen safety of HFCV: Section 5: Performance Requirement will contain two sections: Section 5.1: Vehicle Fuel System Integrity has two parts: Whole vehicle safety requirement and Installation and functional requirement. Section 5.2: Storage System Approval of Device would be a second major section. Separate each of these sections into one related to the high-pressure system (to immediately upstream of the first pressure regulator) and another to the overall hydrogen system (see table).

Q: Many of these items are important and need to be part of the GTR. Does it need to be done in the context of installation and functional requirement, or is it already covered by the system requirement?
A: Installation specification is more safe/strict. Prohibition on piping in the passenger compartment prevents (most but not all?) leaks into the passenger compartment.
Q: How will manufacturers meet the hydrogen embrittlement requirement?
A: In Japan, only two materials are allowed.
C: This could lead to prescriptive materials selection. Guidance needs to be added (although there is little in existence).
C: Most of these items are currently recommended practices. The requirement of no leakage will likely result in the manufacturer following the recommended practice of not putting piping in the passenger compartment.
C: These requirements are not objective (they are subjective).
C: In the type approval process, provisions such as these are needed. Additional requirements cannot be added to a GTR by contracting parties – functional requirements are needed for type approval.
C: Recommended practices are not included in the US government standards. Requirements have to be supported/justified with safety-related data.

Germany: Installation and Functional Requirements (handout by TUV SUD Automotive et al.)
Three steps:

- compilation of all requirements (OICA, Japan, and ECE draft regulations)
- remove design-restrictive requirements (put as examples in the requirement)
- checked that each requirement can be validated: with easy inspection (visual – yes or no); or through tightness test (bubble test); or the OICA exhaust test

C: This was not discussed by OICA – it represents the work of the ‘German group’ (working group comprises Ministry person, TUV, and some German manufacturers). OICA has not

officially seen this proposal, so they are not "fully on board"; only the German OEMs have seen it. Not officially endorsed by the German government (it has not been submitted)
Q: Does section 1.1.5 cover only the storage system?
A: Section 1.1.5 "hydrogen system" refers to more than just the hydrogen storage system. Need a definition of the system boundaries.
Q: Section 1.1.1: how would type approval process work under this section?
A: This is the general section, and the subsequent sections cover what one must do to meet the general provisions.
C: The General section (1.1) has language that would belong to Part A of the GTR. The regulatory text has to be objective and concrete. The general section would not belong in Part B of the GTR.
C: Japan has many comments on this report.
C: Participants need to make comments on this proposal, including how to proceed.
C: In reviewing, the chair urges group members to keep in mind the idea that, if by including these sections, do we enhance safety, or conversely, by removing them, do we reduce it?
US pointed out that the language in general is very prescriptive, design-specific, and the individual requirements lacking technical support and robust justifications.
Japan cannot comment and will provide comments later. China commented that the requirements are too design specific without justifications. Korea agreed with China.

Tuesday, January 20:
The discussion of the TUV proposal will continue. Every participant especially all contracting parties are urged by the co-chair to give their comments prior to the next meeting but stressed that the comments must be official for the group to discuss.

C: The EC supports the process that has been proposed but the delegate stated that he had not have enough time to go over the document in detail. Other delegations voiced same positions/reservations. Need time for the appropriate experts to review and comment.

Review of the TUV proposal:

As background, TUV and Germany clarified that the proposal was primarily developed by TUV with some German manufacturers' input and German Government guidance.

Overall justification: Obligatory to use the ECE draft (or equivalent) in Germany for (single) approval of hydrogen vehicles, guidance is needed for small manufacturers; safety
C: At the European level, in the process of adopting the draft UNECE document (few changes are being discussed). EC type approval for hydrogen vehicles is currently not possible, but as soon as the draft is approved in one state, it is valid in the remaining.
C: Compromise between the ECE drafts for LH2 and GH2, OICA proposal (SGS-3-05) and the Japan regulation (attachment 100).
Q: How much of each proposal is contained in this draft/proposal?
A: OICA proposal is covered completely, Japanese and ECE drafts are included, nearly completely (have many of the same requirements). Balance is more on the ECE draft.
C: Target of the EIHP project was to develop a harmonized draft of a hydrogen regulation for type approval.

Overview – Table of Contents:
1. Technical requirements (Performance requirements)
1.1 General
1.2 Installation on board
1.3 Shut off, regulating and non return devices
1.4 Overpressure protection (of the low-pressure parts, downstream of the container)
1.5 Leakages and releases
1.6 Fuel lines and fittings
1.7 Safety instrumented system and electrical installations (covered by ELSA)
1.8 Removable storage systems (French industry proposal)
1.9 Refilling systems
1.10 Liquid storage systems
1.11 Information for operation, maintenance and inspection
2. Tests
2.1 Visible inspection
2.2 Air tightness test
2.3 Fuel cell vehicle exhaust test
2.4 Post crash test
2.4.1 Compressed gaseous hydrogen
2.4.2 Liquid hydrogen
2.5 Single failure conditions test

Detailed remarks (captured in the revised table of the proposal) – discussion captured here.

1.1 General: What is the purpose? Can the information be found elsewhere in the document? This is general guidance, a recommendation but not a general requirement. Belongs in Part A, as a preamble to Part B, where justification, rationale and additional background and information as well as critical meeting discussions, should be reflected. Requirements must be performance-based, objective so that they can be checked for and enforced, and justified based on research and test data.
1.1.1: Same - text belongs in Part A
1.1.2: This too is more of a recommended practice, should not be in a regulation/requirement (suggest deletion). It is difficult to justify as a requirement since we have only a “sense” that shorter piping is safer than longer piping, etc. “Fewer connections” means fewer potential leak points. Design-specific, maybe but confusing, even as guidance.
1.1.3: Part A
1.1.4: Similar temperatures as those found in SAE and ISO documents. General guidance, again. Are these temperature ranges required to be in the document? For type approval, this is needed for testing. Have to fix the operating temperatures and pressures, and tests are performed in that range. Also, is it out of scope for GTR? Concern is that without these ranges, contracting parties will set up different tests for approval. Should be part of the component and system requirements. Deleted from this section (ranges will be in the testing section).
1.1.5: shortened from the ECE draft (listed all the valves, too design specific). List now has general functions of these components.
C: We need definitions.

All functions will be addressed in Part A. If it is not listed, is it not required?
"Shall" is a legal requirement – use "should" in Part A. Regulation is then addressed in Part B.
All of these functions are required (issue with shall vs should). Need justification in Part B (where it is explained why it is required). Use language such as "Part B addresses the following items"
Also need to cover in Part A: pressure protection during the fill comes from the fueling station.

1.2 Installation on board
1.2.1: confirmable by visual inspection. Can be cast as a system-level requirement.
Q: Is this a necessary requirement?
A: Yes. Many inspections have found violations (example of filling receptacle projecting beyond bumper) This requirement is not objective enough for certification or inspection (what is the outline of the vehicle, and what is meant by projection beyond)? Need definition of vehicle outline and protective structures (i.e. bumper). Exhaust pipe is exempted (not part of the hydrogen system).
Possibly acceptable for Part B provided it is reworded (specification of the vehicle outline).
Recommendation to move to Part A, per Korea.
We need data that support (justify) inclusion as a requirement in the GTR. Must be able to justify every single regulation (this is not specific to this issue, but is just a reminder that we must be able to do this throughout.
Also need definitions for hydrogen system, protective structure, etc.
Is this a requirement of gasoline vehicles? Yes, in the US (although not a fuel safety-related requirement).
1.2.2: Can be confirmed with visual inspection.
Q: what does "near" mean?
A: There was a distance specified originally, which was deleted because it was design-restrictive.
China and US contend that it is design-restrictive. "Adequately" is also open to interpretation.
Is this a recommended practice? China and Korea recommend that this language be included in Part A of the GTR but not part of the regulations.
US agreed and commented that we need 'definitions' and testing requirements that are objective
ECE agreed.
"Material must be able to meet the conditions of the environment in which it is found."
TUV prefers to have it Part B as a requirement (otherwise already covered by 1.1.1 in Part A)
Recommended practices do not have legal standing in EU regulations. That which is required must be in Part B.
For self-certification, the manufacturer has to interpret this requirement and know exactly what test their vehicle would be subject to in order to certify its compliance? It must fulfill all criteria : be repeatable, feasible, objective, etc. This needs to be reworded, and most likely, put in Part A, unless it can be rewritten, i.e., in objective terms, etc., which might be difficult, but is it really necessary for Part B.

ACTION: suggestions for the language for section 1.2.2 of the TUV proposal should be provided by participants

1.2.3: Same problem as the previous issue.

1.2.4: Is this in conflict with 1.2.2? No, 1.2.2 requires that the storage container should be shielded against heat, but not against ignition sources (may not be the main issue). Also issue of high pressure and high temperature.
BMW should be consulted since they are the only OEM using HICE.
When does this become a problem? Leak at the container (high pressure tank leaks until it is empty).
Is there a similar requirement for gasoline vehicle? No, nobody has such requirement.
US: This is a very design-restrictive requirement. If removed, would the vehicle be less safe? There are other dangers in the engine compartment (battery acid, for example). It is not overly restrictive to keep this requirement. Is not arguing that this is not design-restrictive, only that it is not an unreasonable thing to require. Design guidance, in Part A.
Issue of motorcycles – what is the engine compartment?
No such requirement in Japan's national regulation, none.

1.3 Shut off, regulating and non-return devices
1.3.1: must define the container assembly. Must the shutoff device be upstream of the pressure regulator?
US: supports inclusion. Needs to be reworded to avoid confusion, once the container assembly is defined. Location of the shutoff valve. Drawing: in-tank regulator, followed by the shutoff valve (normally closed) for over-pressurize protection of the low(er) pressure section.
1.3.2: This is taken from the Japanese national regulation.
Q: What is the hazard that is to be avoided? As written it is only a requirement of the check valve, not its use or placement.
Q: Is it a requirement to have a check valve (design-specific)?
Q: Is this the filling line? If so, than we do not need 1.3.4 (see below).
C: Definition of filling line is needed. Its location may be an issue.
This requirement can be tested: as part of the hydrogen storage system (boundary defined), or you would need an additional test (requirement of the storage system: acceptable leakage and shall not burst)
C: Have seen problems with the shutoff valves at normal operation, because of the very cold temperatures that can be encountered. Manufacturers are looking to develop elastomers that survive at low(er) temperatures.
Moreover, it was not clear what the meaning of some specific requirements was so Japan will provide explanation later.

ACTION: Japan will research the inclusion of the container check valve requirement (TUV section 1.3.2) and report to the group.

1.3.3: Excess flow system must be defined.
Q: can a performance requirement be included here?
Q: do we need this, since we have a shut-off requirement?
Q: Is this leak detection or is it flow above some set point?
A: different modes of failure, so protected from these modes. Double system for extra protection.
Q: Once we define the hydrogen system, is this then covered?
These devices limit large releases much more quickly.

Under normal operation, no hydrogen is leaving the tank through the filling line; need a check valve in that line. This is mandatory. Add as another sub-bullet 1.3.4, unless it is already covered in the revised 1.3.2.

1.4 Overpressure protection:
Fundamental issue for this section: do we need to provide regulatory protection for the low-pressure system? If so, then most of these items are to be considered. If not, we can have a discussion in Part A (if deemed appropriate). Need justification, data (supporting this as a problem area), etc. on overpressure protection for the low pressure system.
1.4.1: Prevention is preferred (important European safety philosophy).
US: A regulation must set the performance requirement (must not leak), but should not add another requirement (that is design-specific). If this requirement was removed, would this make the vehicle less safe?
TUV: This concept is part of the "safety philosophy" to create a safety net to prevent a catastrophic outcome in case of a crash. The OEM response to this requirement is not specified – there are many ways to meet this requirement. Want to exclude/prevent the leak, rather than to have to respond to the leak. The risk might be a burst. Pressure regulator could fail, for example. This protects against that potential failure.
Q: What is the performance requirement that can cover both (?) requirements?
A: the pressure safety factor requirement is all (?) that is needed
Q: Is this part of the regulation or is it a recommended practice?
SAE: Can write a performance-based requirement (DOT: test at a whole-vehicle level?) to cover this requirement over the life of the vehicle.
DOT: Do not see how this would be tested – they buy a vehicle from a dealer (not from the OEM), and test the vehicle as a whole for compliance. It cannot be modified in any way to run the test(s).
TUV: pressure regulators are known to fail.
Q: How is this verified in type approval?
A: Visual inspection of the existence of a pressure safety device (of some sort), and verification of documentation - data sheet of the specifications of set pressure and maximum flow, or markings.
US: Needs additional discussion to resolve the differences between type-approval and self-certification at the whole vehicle level: how to test/ensure compliance. China agrees with US (Nha) regarding the ovr-pressure protection requirement.
1.4.2: This is part of the high pressure system.
Recommended practice? Put this in Part A?

Note: Need to make sure that we are putting the right things into Part A, because it cannot be just a dumping ground of all these items. Generally, when moving to Part A is indicated, we will not just be cutting-and-pasting.

Q: Vague – can it be enforceable? Is it objective test? Visual inspection is one, perhaps.
C: These subsections contain many design details – we should not consider all the possible designs. We should be focusing on the performance requirements.
C: If the last phrase is removed, it can be objectively tested.
C: There is no comparable regulation for gasoline vehicle exhaust (to prevent blockage)

This is not part of the Japanese regulation. The OEMs took care of this problem, so it is not regulated.

ACTION: SAE to provide information on the France bus incident (paper published) – associated with section 1.4.2 of the TUV proposal

ACTION: OICA will have a discussion to find out what OEMs are doing to deal with this requirement (icing, dirt, etc) and the possible test – associated with section 1.4.2 of the TUV proposal

Chair cautions that the Action Plan contains a mandate for a performance-based GTR; this regulation should be written in such terms to the extent possible. It was put in specifically as to preserve flexibility for the manufacturer to design a vehicle as long as it complies with performance requirements.

ACTION: All participants should provide comments and justification on the (modified) TUV proposal and the Japan proposal (Draft Proposal for HFCV-gtr on Hydrogen Safety) to the co-sponsors (Germany, US, Japan) by February 13th – please focus on getting co-sponsors any potential show stoppers ASAP

ACTION: electronic versions of the modified TUV and Japan proposals will be emailed to participants by co-chair.

OICA: It will not be possible for OICA to get agreement from the manufacturers on comments before the end of March.
Note: China will be able to provide comments only by the end of February.

Proposal is to skip the remainder of these sections until the fundamental issue, indicated in the header of the section (1.4), is resolved. Any section that is on the high pressure side will be discussed.
1.4.3: Need information from BMW

ACTION: OICA to provide information on TUV proposal section 1.4.3 from BMW

1.4.4: Ok, with modification (also for LH2)
1.4.5: Requirement for a PRD. Also related to 1.4.9 – discharge direction (small change needed to 1.4.5 – removal of text after …into the container)
1.4.6: Fire test with vent pipe in place (not just the internal dimension, could also be related to the number of bends, fixing points, etc.). Covered by the storage system requirements (bonfire test)
1.4.7: Similar to 1.4.2 (need PRD protection as indicated in 1.4.7; not agreed on need for overpressure protection 1.4.2)
1.4.8: Container requirement – move to storage system requirement
1.4.9: Direction of PRD discharge. Do we not already require that all discharges are to be made outside the vehicle? See section 1.4.5 (container). Some of the bullet points may not be necessary,

since this is a significant release, probably as the result of a fire. Some issues related to First Responders training (generally approach from a 45 degree angle).

ACTION: NHTSA will provide clarification/guidance on the wording of TUV proposal section 1.4.9.

C: Type approval process needs requirements. Tests do exist, have been reviewed, and are used in practice. We do not have documentation on each requirement.
C: Need agreement (political?) on how to proceed, based on the different approach and requirements for type approval and self-certification.
C: For self-certification, justification is needed for requirements. A test must be developed to verify that the vehicle passes the test and meets the requirement.
Q: Will the TUV proposal table be updated?
A: It will be posted as a Word file so that it can be further updated.
C: Need a meeting of the co-sponsors to discuss and clarify the approach. May be some issues that can only be revised by WP.29. This should be the first step, rather than updating the document.
C: Our Action File (approved in 2007) requires that we avoid design-specific requirements as much as possible. Document 883 is the guidance for GTR structure. Guidance for WP.29 ("blue book"). Recommend that we read these documents.

Wednesday, January 21

C-chairs resumed the meeting with a brief recapitulation of the previous day's discussion. Clearly there are some major differences in approaches to the drafting of the GTR and the way TUV proposal handles some of the issues. In the absence of an agreement and for the sake of time management so that other issues on the agenda may be discussed, it will be best to suspend review of the proposal at this meeting. Participants are reminded to submit comments as soon as possible (see action items).

Proposal for a meeting of a Task Force **(proposed April 14-16, Frankfurt)** to prepare a consolidated "functional hydrogen system" proposal document, that will reflect all concerns raised during the discussion of the TUV and the Japanese proposals, and the comments as provided (by the end of February for most, and the end of March for OICA). Propose meeting in the middle to end of April in Europe (Paris (OICA), Munich (TUV), or Frankfurt). Proposal **(which is to be distributed by April 27)** will then be discussed at the next (6^{th}) SGS meeting in China.
Q: Who should participate, and how many members?
A: It is open, but the size of the meeting should be limited to ~2 persons per contracting party max.
Q: Will we be incorporating the results of the proposal into the current GTR draft, or will this Task Force be making a new document?
A: Incorporating into the draft GTR, which is our main document. At the Task Force meeting, we will be putting the material into the draft GTR.
C: Paper 883 (the draft GTR?) will be posted on the website for the 5^{th} meeting.

ACTION: post current draft version of the GTR.

ACTION: Chairs urge participants to look at the nine existing GTRs for the structure and for the language of the requirements and the type of information that are included in the GTRs.

6.4 Storage System

- Transport Canada and NHTSA localized flame impingement test

Presentation: Compressed Gas Vehicle Fire Protection Deliverables (highlights of the five posted documents in the 5th meeting folder)
Test procedure for a localize fire test to ensure cylinder safety when the thermally-activated PRD is not directly in the fire.
NHTSA is continuing with the next phase of this work to verify/validate testing, and to come up with a recommended heating profile and potential mitigation of fire localization (i.e., protective coatings, shielding) – transmit heat to the TPRD to initiate the release, or insulate so that the tank never sees the effect of the fire.
PRD release/vent direction: upward or downward recommended by SAE. Horizontal is not recommended.
Q: is the direction (upward vent) a result of discussions with Fire Protection personnel or from some other source?
A: Need to determine if downward is also ok, but agree that horizontal is probably not recommended.

- ISO remarks

ISO delegate voiced her disappointment that greater emphasis is not put on the use of ISO standards in developing the GTR. Even though the standards are not published, they are basically finished or finished draft form. Is SGS favoring SAE-based standard? The co-chair from US responded that SGS is not taking sides with either organization. As a matter of practicality, we take into consideration all that have been completed including the regulations of Japan and EU and standards of SAE. The SGS will welcome the work of ISO after it has been completed.

Action item from the Tokyo meeting: Comparison of four documents for the containers: LH2 (covered by ISO 12985 and ECE draft regulation) and CH2 (ISO 15869, SAE J2579, ECE draft regulation and the Japanese regulation).
LH2 documents are very similar (only difference is the bonfire test)
CH2: cover tank types 1,2,3,4 (not all documents cover all four, or do not specify). It includes similar design requirements. Maximum filling pressure in the Japan regulation is currently only 35MPa, but is supposed to be modified for 75MPa. Burst pressure differences are significant. There are testing differences (tank versus system).

ACTION: ISO will provide a summary paper on the tank standards comparison.

- Volvo presentation on permeation

Estimation of an allowable permeation rate; level of safety – not to exceed 1 vol% hydrogen (25% LFL) – used by Building Codes in US and elsewhere. Looked at different scenarios (vehicles sizes, hydrogen storage, natural ventilation rates).
Q: is the permeation rate really linear with temperature?
A: review by SAE of the LLNL study indicated that it is not linear. Reference materials will be provided to update the graph.
Q: what about higher temperatures?
A: calculated values for other temperatures can be provided.

- OICA proposal on compressed hydrogen storage system requirements

Handout (revised version will be distributed electronically for comment): OICA proposal on compressed hydrogen storage system requirements: Action item from the Tokyo meeting.
Proposal has some open items (i.e., detailed test procedures need to be defined).
Numbering system in the document reflects the current numbering system of the draft GTR.
Details of test sequence are taken from SAE J2579 (which is to be provided – see earlier action item).
Would like to reduce the time it takes to complete all the tank tests, but need to be able to assert that the revised test sequence results in an equivalent level of safety.
Q: Any reports on the cycle testing?
A: USDOE funded some work at Powertech, and the report(s) should be available (at some point).

ACTION: comments are requested from the participants on the modified/alternative test sequence (Sections 5.2.2.3.4 and 5.2.2.4 (section numbers may be different in the revised version) of the OICA proposal on CH2 storage system).

The co-chair proposed to use this proposal as the starting point for discussion.
C: We should not use a document that has not been through extensive review and approval process such as that used on the four standards that are contained in the comparison table.
C: Earlier comparison was done (by Canada) to determine which of the (then) existing standards could be used if vehicles were to be certified. Do not plan/intend to update the earlier exercise.
C: ISO and SAE will be used as reference.
Q: OICA proposal will take precedence over existing standards?
A: Existing standards will serve as references to the regulation. OICA proposal for regulation will be used as the main text from which we will work. ISO and SAE (and other) standards will be referred to in the GTR regulation.
C: Existing standards are included by reference.
Q: So the comparison of the existing standards developed by ISO (see action item) does not matter?
A: It will be used to determine which standard will be used as the reference in the GTR. We are developing a regulation, which needs standards.
Q: Does the SGS need/want the ISO comparison table or not?
A: We are very interested in the comparison table.
C: ISO feels it is being ignored by this group, and does not understand why OICA proposal is taking precedence. In addition, the OICA proposal may have requirements that are less safe, or at least that have not been tested or verified.

C: Adoption of existing standards as part of the GTR.
C: If any participants believe that the OICA (or any other) proposal is less safe, evidence should be brought to the membership.

7. Electric Safety Working Group (ELSA)

7.1 Report on November 2008 Meeting of ELSA

Progress for electric safety in-use. Post crash was a problem (there are some standard procedures (GM newer proposal?) for testing, but not all contracting parties accept these procedures). Going to focus tomorrow's meeting on the in-use effort. Want to finish work in 2009. Report is posted: Document GRSP-44-13 (not sure of the number).

7.2 Discussion, if needed

8. Miscellaneous Administrative Items

8.1 Review of Action Items from the 4th meeting:

SGS-4-03 rev 1

1. Compile a comparison of applicable definitions (Japan, EC, ISO, SAE, etc) US/SANDIA/ISO – *continuing*
2. Update a comparative table with container regulations and standards (ISO and Canada) – *ISO effort (discussed and will be distributed)*
3. Consider whether APU should be covered by GTR (all) – *ongoing*
4. Find data and reports on 4% LFL (OICA , SANDIA, and Japan) – *Report posted*
5. Develop definition of enclosed and semi-enclosed space, point of discharge, (OICA) – *completed (handout)*
6. Define `single failure` (OICA) – *completed (handout)*
7. Calculations – rationale of limit values (OICA) – *completed (handout)*
8. Provide experimental test results [to be clarified] (Japan) – *SAE paper and AVS paper (reference will be provided)*
9. Define better wording solution for `warning/telltale` (EC, US) – *Driver Warning System is proposed; ongoing*
10. Explanation of different limit value (Japan) – *completed (handout)*
11. Confirm on hydrogen concentration exhaust (BMW) – *ongoing*
12. Submit available test validation for post-crash requirements (Japan, OICA) – *ongoing*
13. Provide comments to Alfredo Perujo`s paper on fuel system integrity test (all) - *?*
14. Post JARI S001 on unece.org (Chair) – *completed*
15. Provide copy of current ISO draft standard to Chair to be shared with SGS (ISO) – *completed*
16. Provide definitions used in the draft standard to Chair (ISO) – *duplication?*
17. Update list of participants (Chair) – *completed*
18. Copies of presentations to Chair(s) and Nha – *completed*
19. Circulate revised draft of GTR, with corrected section numbers (US) – *completed*
20. Proposal for installation and functional requirement (Japan and TUV) – *completed*
21. Provide information on EU`s use of statistical approach (EC) – *ongoing?*
22. Provide aircraft regulation (Georg) – *ongoing*
23. Formal response to BMW presentation (US) – *ongoing*

8.2 Approval of the Decisions--Action Items -- of the 5rh Meeting

Consolidated list presented and circulated – it will be finalized and posted on the SGS website.

8.3 Next Meeting

Delegate from China cordially invites experts for the next, sixth meeting in Beijing. Visa form will be distributed. Invitation is needed and host needs to know if an email or fax is allowed. Proposed dates: May 26-28/29, 2009, but the group agreed that at least an additional half day be tentatively planned on, depending if the group has a more detailed proposal to discuss based on the work of the drafting task force.

8.4 Other Issues

Future meeting after China: Dates and place will be decided soon, but this time it would be North America's turn. Canada has expressed interested, co-sponsors will engage Canada in follow up communication via email.

Collected Action Items from draft minutes of SGS-5:

ACTION: Please give presentation file electronically to Mr. Nha so that it can be posted on the website.

ACTION: China to provide information on the crash test (tank type, etc) and English version of standards (if possible).

ACTION: SAE to explore possibility of distribution of standards, with the requirement that they not be distributed outside the SGS.

ACTION: OICA will check with BMW, specifically about the potential for (some other manufacturer) running an HICE vehicle in a fuel-rich mode. Also, what about liquid boiloff – should it also be considered an exhaust.

ACTION: Check the original work on the equation of state (fit of NIST data) for the ranges of temperature and pressure for which this curve-fitted equation is applicable (so that it is not used outside the appropriate range(s)).

ACTION: TUV will provide definition of vehicle outline and protective structures (section 1.2.1 of the TUV proposal).

ACTION: suggestions for the language for section 1.2.2 of the TUV proposal should be provided by participants

ACTION: Japan will research the inclusion of the container check valve requirement (TUV section 1.3.2) and report to the group.

ACTION: SAE to provide information on the France bus incident (paper published) – associated with section 1.4.2 of the TUV proposal

ACTION: OICA will have a discussion to find out what OEMs are doing to deal with this requirement (icing, dirt, etc) and the possible test – associated with section 1.4.2 of the TUV proposal

ACTION: participants should provide comments and justification on the (modified) TUV proposal and the Japan proposal (Draft Proposal for HFCV-gtr on Hydrogen Safety) to the co-sponsors (Germany, US, Japan) by February 13th – please focus on getting co-sponsors any potential show stoppers ASAP

ACTION: electronic versions of the modified TUV and Japan proposals will be emailed to participants by co-chair.

ACTION: OICA to provide information on TUV proposal section 1.4.3 from BMW

ACTION: NHTSA will provide clarification/guidance on the wording of TUV proposal section 1.4.9.

ACTION: post current draft version of the GTR.

ACTION: Participants should look at the nine existing GTRs for the structure and for the types of information that are included in the existing GTRs.

ACTION: ISO will provide a summary paper on the tank standards comparison.

ACTION: comments are requested from the participants on the modified/alternative test sequence (Sections 5.2.2.3.4 and 5.2.2.4 (section numbers may be different in the revised version) of the OICA proposal on CH2 storage system).