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Global Registry

Created on 18 November 2004, pursuant to Article 6 of the Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles (ECE/TRANS/132 and Corr.1) done at Geneva on 25 June 1998

Addendum 13: Global technical regulation No. 13

Global technical regulation on hydrogen and fuel cell vehicles

Established in the Global Registry on 27 June 2013

Proposal and report pursuant to Article 6, paragraph 6.2.7. of the Agreement

- Authorization to develop amendments to global technical regulation No. 13 on hydrogen and fuel cell vehicles (ECE/TRANS/WP.29/AC.3/17)
- Report on the development of global technical regulation No. 13 on hydrogen and fuel cell vehicles (ECE/TRANS/WP.29/2013/42, adopted by AC.3 at its thirty-eighth session (ECE/TRANS/WP.29/1104, para. 98)

UNITED NATIONS

Authorization to develop amendments to gtr No. 13 (on (Hydrogen and fuel cell vehicles)

A. Objective of the proposal

1. The trilateral cosponsors goals are to develop and establish a global technical regulation (gtr) for Hydrogen-/ Fuel Cell Vehicles (HFCV) that: (1) Attains equivalent levels of safety as those for conventional gasoline powered vehicles and (2) Is performance-based and does not restrict future technologies. Given that hydrogen-powered vehicle technology is still emerging, AC.3 agreed that input from researchers is a vital component of this effort. Based on a comparison of existing regulations and standards of HFCV with conventional vehicles, it is important to investigate and consider: (1) The main differences in safety and environmental aspects and (2) What items need to be regulated based on justification.

B. Safety requirements

2. Most Contracting Parties have adopted vehicle crashworthiness standards that rely on dynamic crash test procedures, simulating real world crashes, to evaluate the ability of a vehicle to protect its occupants from (1) trauma and (2) fuel (gasoline and diesel) fed fires. These tests procedures include one for full frontal, offset frontal, side, rear and, to some extent, rollover crash modes. These standards and test procedures are not harmonized worldwide and/or not required in all jurisdictions. Tables 1 and 2 highlight the different safety and fuel integrity test requirements and their application for conventional gasoline and diesel, compressed natural gas, and hydrogen vehicles within the European Union (EU), Japan, and the United States of America (U.S.A.). While Japan and the U.S.A. specify at least some crash tests to evaluate the fuel system integrity of conventional and electric/hybrid vehicles, apparently only the U.S.A. does so for compressed natural gas (CNG) vehicles, and, currently, only Japan does so for hydrogen-powered vehicles. The EU regulatory approach is more based on testing of components and sub systems and requirements for the installation of fuel systems.

3. As noted above, only Japan has adopted a regulation to evaluate the performance of a hydrogen vehicle. The regulation has component, subsystems, and full system crash performance test requirements. The latter is evaluated using full frontal, side and rear crash tests. Evaluating the Japanese regulation as a potential starting point for the development of a gtr is a reasonable approach. However, the Japanese requirements for fuel system integrity of other vehicles as highlighted in the attached tables are not harmonized with those in the U.S.A. and EU (nor are the U.S.A. and EU requirements harmonized). Harmonizing crash performance requirements has proven to be a difficult task in the past. A harmonized solution may be achievable, but may take a long time to complete due to the need for research and evaluation.

4. Therefore, for the first phase of this effort, the trilateral group decided to avoid attempting to harmonize current national crash tests for the gtr and instead include language in the gtr specifying that the Contracting Parties apply their existing crash tests and check for compliance with an agreed set of requirements and limit values. The trilateral group will decide on a plan for phase 2 on how to harmonize crash test requirements for HFCV after the establishment of a comprehensive gtr in the first phase.

C. Gtr development process

5. In June 2005, AC.3 agreed to a proposal from Germany, Japan and United States of America regarding how best to manage the development process for a gtr on hydrogen-powered vehicles. Under the agreed process, once AC.3 develops and approves an action plan for the development of a gtr, two subgroups will be formed to address the safety and the environment aspects of the gtr. The subgroup safety (HFCV-SGS) will report to the Working Party on Passive Safety (GRSP). The chair for the group will be discussed and designated by summer of 2007. The environmental subgroup (HFCV-SGE) is chaired by European Commission and reports to the Working Party on Pollution and Energy (GRPE). In order to ensure communication between the subgroups and continuous engagement with the World Forum for Harmonization of Vehicle regulations (WP.29) and AC.3, the project manager (Germany) will coordinate and manage the various aspects of the work ensuring that the agreed action plan is implemented properly and that milestones and timelines are set and met throughout the development of the gtr. The gtr will cover fuel cell (FC) and internal combustion engine (ICE), compressed gaseous hydrogen (CGH2) and liquid hydrogen (LH2) in the phase 1 gtr. Vehicle categories (applicability, scope) will be determined.

6. In order to develop the gtr in the context of an evolving hydrogen technology, the trilateral group proposes to develop the gtr in two phases:

(a) Phase 1 (gtr for hydrogen-powered vehicles):

Establish a gtr by 2010 for hydrogen-powered vehicles based on a component level, subsystems, and whole vehicle crash test approach. For the crash testing, the gtr would specify that each contracting party will use its existing national crash tests but develop and agree on maximum allowable level of hydrogen leakage. The new Japanese regulation, and any available research and test data will be used as a basis for the development of this first phase of the gtr.

(b) Phase 2 (Assess future technologies and harmonize crash tests):

Amend the gtr to maintain its relevance with new findings based on new research and the state of the technology beyond 2010. Discuss how to harmonize crash test requirements for HFCV regarding whole vehicle crash testing for fuel system integrity.

Phase 1: The gtr will consist of the following key areas:

(a) Component and subsystem level requirements (non-crash test based):

Evaluate the non-crash requirements by reviewing analyses and evaluations conducted to justify the requirements. Add and subtract requirements or amend test procedures as necessary based on existing evaluations or on quick evaluations that could be conducted by Contracting Parties and participants. Avoid design specific requirements to the extent possible and do not include provisions that are not justified. The main areas of focus are as follows:

(i) Performance requirements for fuel containers, pressure relieve devices, fuel cells, fuel lines, etc.

(ii) Electrical isolation; safety and protection against electric shock (in-use).

(iii) Performance and other requirements for sub-systems integration in the vehicle.

(b) Whole vehicle requirements (crash test based):

Examine the risks posed by the different types of fuel systems in different crash modes, using as a starting point the attached tables. Review and evaluate analyses and crash tests conducted to examine the risks and identify countermeasures for hydrogen-powered vehicles. The main areas of focus are as follows:

(i) Existing crash tests (front, side and rear) already applied in all jurisdictions.

(ii) Electrical isolation; safety and protection against electric shock (post-crash).

(iii) Maximum allowable hydrogen leakage.

Phase 2:

(a) Develop and implement a plan to update the gtr to account for changes in the state of the technology beyond 2010

(b) Discuss how to harmonize crash test requirements for HFCV. Develop an amendment to incorporate improvements into the hydrogen gtr.

Timeline for phase 1:

(a) WP.29/AC.3 - March 2007:

(i) Submit draft gtr Action Plan to AC.3 for agreement.

(ii) Discuss chairmanship for the safety subgroup (HFCV-SGS).

(b) GRSP - May 2007:

(i) Project manager (Germany) to update GRSP and discuss the formation and next activities of the HFCV-SGS.

(c) WP.29/AC.3 - June 2007:

(i) Provide the first of regular progress reports

(d) Summer 2007 (TBD): Hold first HFCV-SGS meeting to begin work on phase 1 of the gtr.

(e) In parallel the environmental informal group (HFCV-SGE) will investigate the possibility of harmonization of environmentally related requirements.

Vehicle Fuel Integrity (Table 1)

		Conventional Gasoline and Electrical / Hybrid			*CNG/LPG*			*Hydrogen- / Fuel Cell- Vehicle*		
		Japan	*EU*	*U.S.A.*	*Japan*	*EU*	*U.S.A.*	*Japan*	*EU***	*U.S.A.*
Fuel Integrity Crash test	Full frontal	50	N	48	N	N	48	50	N	N
	Offset frontal	N	N	N	N	N		N	N	N
	Side	50	N	53	N	N	48	50	N	N
	Rear	50	N	80	N	N	48	50	N	N
	Rollover	N	N	Static rollover	N	N	N	N	N	N
Integrate system safety and system requirements	Fuel tank and underride protection		Y	N		Y	Y (Tank)		Y	N
	Fuel lines		Y	N		Y		Y	Y	N
	Detection of leakage	N	N	N	N****	N	N	Y	N	N
	Purge gas							Y	N	N
	Blow off	N/A	N/A	N/A	N	N	N	N	Y	N
	Container Assembly	N/A	N/A	N/A	N	Y	Y	Y	Y	N
	Fault Strategy / Safety management system	N	N	N	N	N	N	N	Y	N
	Prevention of misfueling	N/A	N/A	N/A		Y			Y	
	Installation and mounting requirements		Y		Y	Y		Y	Y	
Component requirements	Container	N/A	N/A	N/A	Y	Y	Y	Y	Y	N
	Container Attachments	N/A	N/A	N/A	Y	Y	N	Y	Y	N
	Other components of the fuel system	N/A	N/A	N/A	Y	Y	N	Y	Y	N
	Fuel Cell	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N

Vehicle Fuel Integrity (Table 1)										
		Conventional Gasoline and Electrical / Hybrid			*CNG/LPG*			*Hydrogen- / Fuel Cell- Vehicle*		
		Japan	*EU*	*U.S.A.*	*Japan*	*EU*	*U.S.A.*	*Japan*	*EU***	*U.S.A.*
Electrical Isolation and electric safety *	In-use	N	Y***	N	N/A	N/A	N/A	Y	N***	N
	During and post-crash	N	N	Y	N/A	N/A	N/A	N	N***	Y
	Total electric safety		N***					Y	N***	

Y Mandatory requirement
N No requirement
N/A Not applicable
* For electric, hybrid or fuel cell vehicles
** Draft European Regulation on hydrogen (already applicable in Germany)
*** Draft proposal to amend UNECE-Regulation No. 100 is under discussion
**** Odorant in CNG fuel
Values in the table means impact speed in km/h

	Vehicle Occupant Protection (Table 2)		
	Japan	*EU*	*U.S.A.*
Full frontal	50 km/h	Y	48 km/h
Offset frontal	N	56 km/h	N
Side deformable barrier	50 km/h	50 km/h	53 km/h
Side pole	N	N	53 km/h
Rear	N	N	N
Rollover	N	N	Y
Roof crush	N	N	Y

Report on the development of global technical regulation No. 13 on hydrogen and fuel cell vehicles

A. Introduction

1. During the 126th Session of WP.29 in March 2002, the Executive Committee of the 1998 Global Agreement (AC.3) adopted its programme of work. Under the programme of work, WP.29 has agreed to begin exchanging information on fuel cell/hydrogen vehicles. In 2002, two proposals for draft regulations for vehicles powered by liquid and compressed gaseous hydrogen, developed under the European Integrated Hydrogen Project (EIHP), were submitted to WP.29. The Working Party on Pollution and Energy formed an informal working group on Hydrogen/Fuel Cell Vehicles (GRPE/IGH) to discuss and evaluate these draft proposals.

2. The IGH, under the chairmanship of Germany, met several times between 2002 and 2007 to discuss the two proposals. The Contracting Parties represented on the IGH, in addition to Germany, are the European Union, France, Japan, the Netherlands, and the United States of America. The European Association of Automotive Suppliers (CLEPA), the International Standards Organization (ISO), and the International Organization of Motor Vehicle Manufacturers (OICA) as well as individual vehicle manufacturers also participate.

B. Request to develop an action plan

3. At its forty-sixth Session in May 2003, GRPE considered two draft Regulations to be annexed to the 1958 Agreement: proposals – ECE/TRANS/WP.29/GRPE/2003/14 - for liquid hydrogen and Informal document GRPE-46-12 (ECE/TRANS/WP.29/GRPE/2004/3) – for compressed gaseous hydrogen. Following discussions, GRPE concluded that the draft Regulations were not ready for adoption and postponed action on the proposals. Some delegations specifically expressed their concern that the proposals were not comprehensive enough, as they addressed only individual components, not the safety of the whole vehicle. The need for evaluating the entire hydrogen fuel system, including conducting a fuel system crash test, which is not addressed by the current draft regulations, was also raised. In addition, a number of Parties found the draft regulations to be very design specific with the potential of constraining future technological innovations. The expert from the United States of America wanted to introduce the draft Regulations not under the 1958 Agreement, but under the 1998 Global Agreement.

4. GRPE recommended that, given the global nature of the automotive industry, the group take a more global approach when considering the regulations for hydrogen vehicles and asked the delegations of the European Union, Japan and the United States to clarify their technical and political positions on the development of regulations for hydrogen vehicles. GRPE also directed the IGH to work with Japan, the United States, the European Union and other interested delegations to develop an Action Plan for the assessment of the hydrogen technologies for motor vehicles outlining any necessary research development and testing that would be needed for the development of the gtr. In 2006, Germany, Japan and the United States reaffirmed their commitment to serve as co-sponsors to develop the gtr. Japan and the United States have served as co-chairs of the reorganized group into the Subgroup on Hydrogen Safety (HFCV-SGS) and began plans to develop an "Action Plan" for the gtr. The proposal for a new Action Plan and restructured working group was adopted by WP.29 in June 2007. It was proposed that a gtr for hydrogen-powered vehicles based on a component level, subsystems, and whole vehicle crash test approach would be established by 2010 in Phase 1 activity.

5. History of gtr development:

Gtr Development Tasks	*Dates*
Adoption of the Action Plan/ Establishment of the SGS	June 2007
1st HFCV-SGS meeting	September 2007
2nd HFCV-SGS meeting	January 2008
3rd HFCV-SGS meeting	May 2008
4th HFCV-SGS meeting	September 2008
5th HFCV-SGS meeting	January 2009
Drafting Task Force group meeting for fuel system	April 2009
6th HFCV-SGS meeting	May 2009
7th HFCV-SGS meeting	September 2009
8th HFCV-SGS meeting	January 2010
9th HFCV-SGS meeting	June 2010
10th HFCV-SGS meeting	September 2010
Task Force group meeting	November 2010
11th HFCV-SGS meeting	February 2011
12th HFCV-SGS meeting	June 2011
Working document to 50th GRSP session (ECE/TRANS/WP.29/GRSP/2011/33)	September 2011
Drafting Task Force group meeting	November 2011
50th GRSP	December 2011
Working document to 51st GRSP (ECE/TRANS/WP.29/GRSP/2012/12)	March 2012
51st GRSP	May 2012

Gtr Development Tasks	*Dates*
Working document to 52nd GRSP (ECE/TRANS/WP.29/GRSP/2012/23)	September 2012
52nd GRSP	December 2012
Final document adopted by WP.29/AC.3	March or June 2013

C. Evaluation of the safety problem

6. Safety of hydrogen vehicles has emerged in these years as an important motor vehicle safety issue. Ensuring that hydrogen fuel cell and internal combustion engine (ICE) vehicles provide consumers with a high level of safety requires extensive research efforts. Meanwhile, hydrogen vehicles have been deployed as part of demonstration fleets in several countries, including Germany, Japan and United States, yet very little data is available on safety performance of these vehicles.

7. Manufacturers have invested significant resources in producing and marketing these vehicles and it is important that data is shared including crash test data, with governments to serve as a basis in support of their regulatory actions. Without positive results of basic and comprehensive research and testing, which would demonstrate safety of hydrogen vehicles, governments would not be in a position to develop regulations, or to instil confidence in hydrogen vehicles in prospective consumers.

8. With respect to the application of potential global technical regulation for hydrogen vehicle, the main focus of the scope of the gtr could be vehicles powered entirely by hydrogen. Furthermore, the regulation covers individual components and address the safety performance and integrity of the entire hydrogen fuel system. These requirements have been written, to the extent possible, in terms of performance, as design-specific requirements may potentially constrain future hydrogen-related technological innovations and methodologies.

D. Review of existing international regulations

9. At present, Japan and the EC have national or international regulations or directives governing the manufacture of hydrogen vehicles in place, however, there have been several voluntary codes and standards developed by international standard setting organizations, including the Society of Automotive Engineers (SAE), International Standards Organization (ISO), etc. These standards generally address a specific component of hydrogen vehicles, such as on board storage tanks or pressure relief devices, but not the safety performance and integrity of the entire hydrogen fuel system or whole vehicles.

10. Existing Regulations, Directives, and International Standards:

(a) Vehicle fuel system integrity

(i) National regulations and directives

a. European Union – Regulation 79/2009 – Type-approval of hydrogen-powered motor vehicles

b. European Union – Regulation 406/2010 — implementing EC Regulation 79/2009

c. Japan — Safety Regulation Article 17 and Attachment 17 – Technical Standard for Fuel Leakage in Collision

d. Japan — Attachment 100 – Technical Standard For Fuel Systems Of Motor Vehicle Fueled By Compressed Hydrogen Gas

e. Canada — Motor Vehicle Safety Standard (CMVSS) 301.1 – Fuel System Integrity

f. Canada — Motor Vehicle Safety Standard (CMVSS) 301.2 – CNG Vehicles

g. Korea — Motor Vehicle Safety Standard, Article 91 – Fuel System Integrity

h. United States — Federal Motor Vehicle Safety Standard (FMVSS) No. 301 - Fuel System Integrity.

i. United States — FMVSS No. 303 – CNG Vehicles

j. China – GB/T 24548-2009 Fuel cell electric vehicles – terminology

k. China -- GB/T 24549-2009 Fuel cell electric vehicles - safety requirements

l. China -- GB/T 24554-2009 Fuel cell engine - performance - test methods

(ii) National and International standards.

a. ISO 17268 — Compressed hydrogen surface vehicle refuelling connection devices

b. ISO 23273-1 — Fuel cell road vehicles — Safety specifications — Part 1: Vehicle functional safety

c. ISO 23273-2 — Fuel cell road vehicles — Safety specifications — Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

d. ISO 14687-2 — Hydrogen Fuel — Product Specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles

e. SAE J2578 — General Fuel Cell Vehicle Safety

f. SAE J2600 – Compressed Hydrogen Surface Vehicle Fueling Connection Devices

g. SAE J2601 – Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles

h. SAE J2799 – Hydrogen Quality Guideline for Fuel Cell Vehicles

(b) Storage system

(i) National regulations and directives:

a. China — Regulation on Safety Supervision for Special Equipment

b. China — Regulation on Safety Supervision for Gas Cylinder

c. Japan — JARI S001(2004) Technical Standard for Containers of Compressed Hydrogen Vehicle Fuel Devices

d. Japan — JARI S002(2004) Technical Standard for Components of Compressed Hydrogen Vehicle Fuel Devices

e. Japan — KHK 0128(2010) Technical Standard for Compressed Hydrogen Vehicle Fuel Containers with Maximum Filling Pressure up to 70MPa

f. Korea — High Pressure Gas Safety Control Law

g. United States — FMVSS 304 - Compressed Natural Gas fuel Container Integrity

h. European Union — Regulation 406/2010 implementing EC Regulation 79/2009

i. China — QC/T 816-2209 Hydrogen supplying and refueling vehicles -specifications

(ii) National and International standards:

a. CSA B51 Part 2 — High-pressure cylinders for the on-board storage of natural gas and hydrogen as fuels for automotive vehicles

b. CSA NGV2-2000 – Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers

c. CSA TPRD-1-2009 – Pressure Relief Devices For Compressed Hydrogen Vehicle Fuel Containers

d. CSA HGV 3.1-2011 – Fuel System Component for Hydrogen Gas Power Vehicles (Draft)

e. ISO 13985:2006 — Liquid Hydrogen – Land Vehicle Fuel Tanks

f. ISO 15869:2009 — Gaseous Hydrogen and Hydrogen Blends – Land Vehicle Fuel Tanks (Technical Specification)

g. SAE J2579 — Fuel Systems in Fuel Cell and Other Hydrogen Vehicles

(c) Electric safety

(i) National regulations and directives:

a. Canada — CMVSS 305—Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection

b. ECE — Regulation 100 - Uniform Provisions Concerning the Approval of Battery Electric Vehicles with Regard to Specific Requirements for the Construction and Functional Safety

c. Japan — Attachment 101 – Technical Standard for Protection of Occupants against High Voltage in Fuel Cell Vehicles

d. Japan — Attachment 110 – Technical Standard for Protection of Occupants against High Voltage in Electric Vehicles and Hybrid Electric Vehicles

e. Japan — Attachment 111 – Technical Standard for Protection of Occupants against High Voltage after Collision in Electric Vehicles and Hybrid Electric Vehicles

f. Korea — Motor Vehicle Safety Standard, Article 18-2 – High Voltage System

g. Korea — Motor Vehicle Safety Standard, Article 91-4 – Electrolyte Spillage and Electric Shock Protection

h. United States — FMVSS 305 - Electric-Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection

(ii) National and International Industry standards:

a. ISO 23273-3 — Fuel cell road vehicles — Safety specifications — Part 3: Protection of persons against electric shock

b. SAE J1766 — Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing

c. SAE J2578 — General Fuel Cell Vehicle Safety

E. Specific safety issues to be addressed

11. Current existing regulations concerning the fuel system do not address the unique properties of hydrogen, hydrogen on-board storage, or fuel cells as a high voltage electrical component in vehicles. For example, hydrogen is colourless, odourless, with a wide range of flammability, and high propensity to leak.

1. Unique Safety Challenges Presented by Hydrogen and Hydrogen Vehicles

12. Even though the existing regulations address, for example, the storage of CNG, the on-board storage of hydrogen needs to be examined because of the high pressure that is projected. Also, hydrogen may be stored as a cryogenic liquid, requiring complex venting and cooling, as metal hydrides or as chemical hydrides, with both methods requiring specific safety and environmental considerations. Regulations also exist for electric vehicles, but these may not be properly address the unique properties of the fuel cell as a high voltage component since, among other reasons, fuel cell does not discharge like a conventional battery. The following issues have been identified to be examined and addressed by the gtr:

(a) Characteristics of hydrogen as a fuel differ from conventional vehicle fuels.

(b) Characteristics of hydrogen storage differ from storage of other fuels:

(i) High pressure (up to 70Mpa);

(ii) Cryogenic liquid (complexity of cooling and venting);

(iii) Metal and chemical hydrides (thermal management for charging and discharging H, high pH waste);

(iv) Ageing.

(c) Characteristics of fuel cells as high voltage electrical devices differ from conventional auto batteries:

(i) High voltage operation (up to 400V);

(ii) Electrical isolation.

2. Research and Testing

13. The objective of the research is to provide the technical basis for developing the gtr for hydrogen vehicles. At the component level, stakeholders conducted and evaluated bonfire, burst, and pressure recycling tests to determine adequacy of proposed requirements for hydrogen on-board containers. Along with these tests, additional testing has been conducted to evaluate safety performance of thermal and pressure activated pressure relief devices and thermal and electrical management systems for tanks, fuel cells, and batteries, purging of fuel cell lines, etc. Still, more testing should be done to better understand ignitability and flammability through controlled releases of hydrogen and electrical arc at various severed locations in tubing between on-board storage tanks and fuel cell stack. Extensive testing is also merited to examine if external debris or matter can cause ignition of venting hydrogen. Additional work should be also performed to evaluate onboard refuelling performance and to evaluate for potential leakage from vehicle or fuelling system interface.

14. On the full vehicle level, tests have been conducted to determine overall crashworthiness and integrity. During operation and while parked, hydrogen leakage and concentrations inside and outside the vehicle should be measured over time, as well as testing of the passive and active ventilation systems, with a specific emphasis on the performance of the recovery or conversion systems to remove hydrogen. Research and testing have been done to evaluate electrical isolation of the fuel cell, cooling system and auxiliary batteries to determine electrical isolation of the entire high voltage system in pre-crash and post-crash scenarios. Supplementary evaluation of post-crash, especially for emergency medical services, is recommended to determine any special post-crash handling requirements for occupants, rescue personnel, towing service or disposal.

3. Outline of gtr

15. Finally, dedicated discussion concluded that the gtr covers fuel cell (FC) and internal combustion engine (ICE), compressed gaseous hydrogen (CGH_2) and liquid hydrogen (LH_2) in Phase 1. The application of the GTR is for passenger vehicles and three main areas outlined in the Action Plan have been discussed and included in gtr text, these are fuel system integrity, electrical safety, and hydrogen storage system.

16. Discussion of HFCV-SGS and Task Force meetings:

(a) 1st meeting took place in September 2007 in Bonn.

At the initial meeting, the group developed and agreed on the Terms of Reference for the gtr development.

(b) 2nd meeting took place in January 2008 in Geneva

SGS began to discuss the overall features of the gtr and its scope. SGS also discussed the high pressure containers and container - storage assembly, hydrogen leakage and its detection.

(c) 3rd meeting took place in May 2008 in Washington, D.C.

SGS discussed in general the structure, scope and application of the gtr. Some delegates proposed including 2- and 3- wheeled vehicles, but requirements for those vehicles will be developed in Phase 2. Also discussed were vehicle fuel system integrity and the integrity of hydrogen containers, mainly for the compressed gaseous hydrogen. BMW presented a proposal on requirements for liquefied hydrogen vehicles.

(d) 4th meeting took place in September 2008 in Tokyo

Discussions and presentation on container bonfire test, FC bus and passenger vehicles, container development, and the overall storage system, vehicle fuel system integrity and electric safety.

(e) 5th meeting took place in January 2009 in Budapest

Discussions on definitions, vehicle fuel system integrity, pressure relief devices and their discharge direction, leakage limit for enclosed areas within the vehicle; leakage limits for the exhaust outlet. SGS held an extensive discussion on the need and requirements for telltale. Also discussed, were post-crash, electric safety,

(f) Drafting Task Force meeting took place in April 2009 in Frankfurt

The TF made a significant progress in identifying critical issues that need to be included in the gtr and proposed draft language, which was later adopted by SGS.

(g) 6th meeting took place in May 2009 in Beijing

SGS discussed hydrogen permeation, comparison of integrity of different hydrogen containers for gaseous compressed gas, and demonstration/testing protocols of container integrity.

(h) 7th meeting took place in September 2009 in Ottawa

SGS discussed the changes discussed and proposed by the Task Force. SGS also focused on resolving several key issues, namely, the number of cycles, initial burst pressure and of the storage system. Also discussed by the group were the differences between the hydraulic and pneumatic testing and leak permeation concerns.

(i) 8th meeting took place in January 2010 in Geneva

The two main topics of the discussions in Geneva were over pressurization of the downstream, which some delegation felt strongly about as deemed critical in order to ensure integrity of the system. SGS resolved this by developing a performance-based requirement; and the airtightness test for fuel lines. This issue, on which SGS was unable to reach a consensus, was resolved by agreeing in principle on a requirement describing an objective and reasonable test. Also resolved were the four types of containers that can be used for on-board storage of hydrogen.

(j) 9th meeting took place in June 2010 in Seoul

SGS discussed the issue of testing hydrogen containers' integrity; specifically, the number of cycles representative of the life span of containers given the difference in vehicles and their uses. SGS also discussed the issue of including in the gtr the requirements for individual components that are deemed safety-critical, such as PRDs, maximum fueling pressure, and testing that is needed to validate several of the requirements.

(k) 10th meeting took place in September 2010 in San Francisco

SGS discussed need for validation tests for material compatibility of containers and requirements for individual components. The group continued to discuss the liquid hydrogen requirements, specifically, the storage and refuelling. Most contracting parties felt that they were not ready for adoption of the liquid hydrogen portion of the gtr, but there is a general agreement that the issue will be addressed in further discussion and perhaps also in Phase2.

(l) Drafting Task Force meeting took place in November 2010 in Berlin

SGS discussed the BMW proposal for liquid hydrogen vehicles, electric safety, container composition, and TPRD performance.

(m) 11^{th} meeting took place in February 2011 in Brussels

Main issues discussed were the engulfing fire duration. The United States wanted to extend the time to 10 minutes, based on data presented earlier by Japan and SAE; the group however did not agree. Germany proposed to adopt a shorter time but discuss this issue in Phase 2. OICA proposed a component test for environment exposure. Drop and vibration tests were also discussed. SGS also discussed developing fuelling receptacle requirements. Another topic was the reduction of the allowable concentration from 4 per cent to 2 per cent. The United States argued that an additional margin of safety is needed to address the potential that random spot concentration of hydrogen could be higher than 4 per cent. Next topic was the liquid hydrogen container and post-crash requirements.

Many of the Contracting Parties are not prepared to adopt the LH_2 section, but will not object to the inclusion of this section in Phase 1. The container material compatibility was also discussed but in the absence of consensus, deferred to Phase 2. SGS discussed electrical safety issues, particularly such as electric shock protection.

(n) 12^{th} meeting took place in June 2011 in Paris

These main issues were: material compatibility, liquefied hydrogen system, electric safety and the engulfing, bonfire and localized fire tests. Another important issue is timing of the completion of the gtr. Based on the feedback from several contracting parties that are in the process of validating additional test procedures, the submission of the draft gtr as informal document to GRSP may be delayed until WP.29, June 2012. The co-sponsors, Germany, Japan and the United States, will continue their discussions with other Contracting Parties and participants to accelerate the work to complete it in a timely manner but an agreement has been made in SGS that we will not rush to the completion at the expense of submitting a robust gtr.

(o) Task Force meeting took place in November 2011 in Mainz

SGS concluded the Phase 1 with agreeing to present a draft gtr to the GRSP for discussion.

All documents related to HFCV-SGS informal meetings are available on following UN website: https://www2.unece.org/wiki/pages/viewpage.action?pageId=3178603

F. Benefits and costs

17. At this first stage, the gtr does not attempt to quantify costs and benefits. While the goal of the gtr is to enable increased market penetration of HFCVs, the resulting rates and degrees of penetration are not currently known or estimable. Therefore, a quantitative cost-benefit analysis was not possible.

18. Some costs are anticipated from greater market penetration of HFCVs. For example, building the infrastructure required to make HFCVs a viable alternative to conventional vehicles will entail significant investment costs for the private and public sectors, depending on the country. Especially in the early years of HFCV sales, individual purchasers of HFCVs are also likely to face greater costs than purchasers of conventional gasoline or diesel vehicles, the same goes for manufacturers of new HFCVs (However, costs incurred by HFCV purchasers and manufacturers would essentially be voluntary, as market choice would not be affected).

19. While some costs are expected, the Contracting Parties believe that the benefits of gtr are likely to greatly outweigh costs. Widespread use of HFCVs, with the establishment of the necessary infrastructure for fuelling, is anticipated to reduce the number of gasoline and diesel vehicles on the road, which should reduce worldwide consumption of fossil fuels. Perhaps most notably, the reduction in greenhouse gas and criteria pollutant emissions (such as NO_2, SO_2, and particulate matter) associated with the widespread use of HFCVs is anticipated to result in significant societal benefits over time by alleviating climate change and health impact costs. The gtr may also lead to decreases in fuelling costs for the operators of HFCVs, as hydrogen production is potentially unlimited and expected to become more cost-effective than petroleum production for conventional vehicles. Furthermore, decreased demand for petroleum is likely to lead to energy and national security benefits for those countries with widespread HFCV use, as reliance on foreign oil supplies decreases. Additionally, although not attributable to this gtr, the gtr may create benefits in terms of facilitating OEM compliance with applicable fuel economy and greenhouse gas emission standards by promoting a wider production and use of HFCVs.

20. The Contracting Parties have also been unable to estimate net employment impacts of the gtr. The new market for innovative design and technologies associated with HFCVs may create significant employment benefits for those countries with ties to HFCV production. On the other hand, employment losses associated with the lower production of conventional vehicles could offset those gains. The building and retrofitting of infrastructure needed to support hydrogen production and storage is likely to generate net additions to the job market in the foreseeable future.