

Transmitted by the informal group "Hydrogen/Fuel Cell – Vehicles"

Draft Action Plan to develop Hydrogen / Fuel Cell GTR(s)

A Introduction

The World Forum for Harmonization of Vehicle Regulations (WP.29) initiated the development of regulations on hydrogen vehicles in 2001. More specifically, two draft regulations on liquid hydrogen and compressed gaseous hydrogen onboard storage systems (LH2, CGH2) were presented by Germany as potential ECE regulations under the 1958 Agreement during the 123rd session of WP.29 on 6-9 March 2001. They were subsequently presented to the GRPE during its 42nd session on 28-31 May 2001. At these meetings, the UN ECE members supported the initiative from Germany. A GRPE informal group on hydrogen and fuel cells vehicles was formed to prepare these ECE regulations.

The GRPE informal group on hydrogen and fuel cells vehicles, under the chairmanship of Germany, has met several times since 2002 to discuss the two proposals. The two drafts for new ECE regulations for hydrogen vehicles have been recently presented as formal documents to the GRPE (TRANS/WP.29/GRPE/2003/14 and TRANS/WP.29/GRPE/2003/14 Add.1 for liquid hydrogen vehicles, and TRANS/WP.29/GRPE/2004/3 and informal document GRPE-47-5 for compressed gaseous hydrogen vehicles). The scope of these regulations is limited to the components used for the storage and delivery of hydrogen to the fuel cell system or internal combustion engine and their installation onboard the vehicle.

The GRPE requested the informal group on hydrogen and fuel cell vehicles to prepare a proposal for a concrete action plan (road map) for the assessment of the hydrogen technologies for motor vehicles and development of GTR(s) for hydrogen vehicles.

B Development of the road map to GTR(s)

The GRPE informal group on hydrogen and fuel cells vehicles met on 6-7 October 2003 in Munich, Germany to discuss the preparation of the road map to GTR(s). At that meeting, a small drafting group was specifically created to prepare this roadmap.

This draft road map was prepared at the informal meeting on 12 January 2004 in Geneva.

1 Scope

The GTR(s) should extend to any vehicles powered either entirely by hydrogen, and vehicles using hydrogen as a complementary fuel (hybrid vehicles) and cover hydrogen aspects for:

- On-board storage system safety;
- Whole vehicle safety;
- Other aspects including energy and environmental considerations.

The detailed scope, test requirements and the number of GTR(s) required are to be finalized at a later date after the approach is confirmed by the GRPE.

2 Timing for the availability of GTR(s)

For vehicles to be on the road by 2010, the GTR development would have to be completed by 2007 to satisfy all involved contracting parties of the 1998 Agreement. The action plan will include three main tasks:

- Adoption of the proposal to develop a Hydrogen/Fuel Cell GTR(s)
- Development of the draft GTR(s)
- Decision process by contracting parties of the 1998 agreement and final adoption of the GTR(s)

The time schedule will be mainly influenced by information and answers concerning the open questions (see section 5).

3 Approaches — Available options for the development of the GTR(s)

Three principle options were considered for the development of GTR(s). These options are described below and shown graphically in Annex A.

3.1 Option 1 - One step approach

With this option, the development under the 1958 Agreement of the two ECE draft regulations on liquid hydrogen and compressed gaseous hydrogen components (ref. TRANS/WP.29/GRPE/2003/14 Add.1 and TRANS/WP.29/GRPE/2004/3) would be frozen and the GRPE would focus directly on GTR development.

3.2 Option 2: Two step approach

With this option, the two draft ECE regulations (LH2, CGH2) under the 1958 Agreement would be introduced as a first step. The GTR(s) would be developed in parallel.

3.3 Option 3: Three step approach

Step 1: Limit the work under the 1958 Agreement to the completion of the two ECE draft regulations for on-board liquid hydrogen and compressed gaseous hydrogen components. These two ECE regulations are to be of a limited life expectancy and replaced by GTR(s) at a second stage.

Step 2: Simultaneously, initiate the development of GTR(s) that will cover all aspects of the hydrogen and fuel cell vehicles (onboard storage systems, fuel cells, safety in normal and crash conditions, fuel consumption, etc.).

Step 3: Combine the results of steps 1 and 2 to have GTR(s) that cover all aspects of the hydrogen and fuel cell vehicles.

4 Results of the informal group discussions

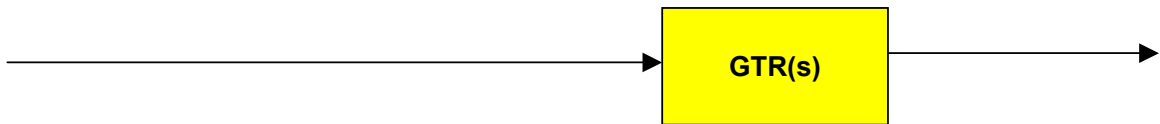
Although it was not possible to reach full agreement in the informal group on a recommended approach, there was support for Option 1 and 3. See comments in Annex B.

5 Open Questions

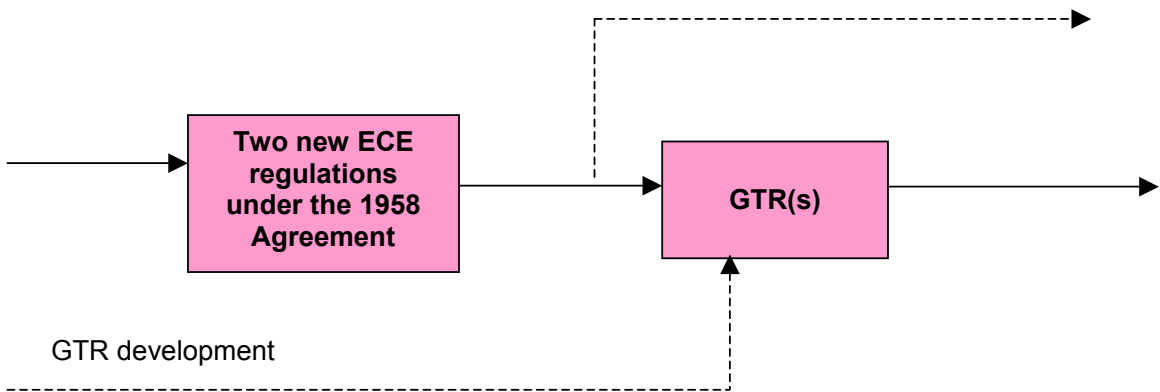
- Sponsor of the GTR(s)
- Scope and content of the GTR(s)
- Additional research and testing
- Time schedule of the GTR development
- Interim solutions for approval of Hydrogen / Fuel Cell vehicles

Approaches — Principle options for the development of the GTR(s)

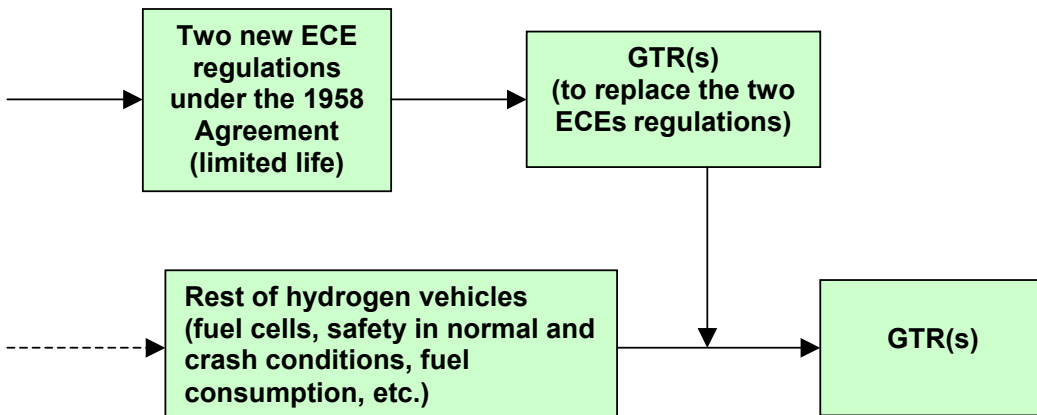
OPTION 1



OPTION 2



OPTION 3



Japanese Position on the Informal Document for Hydrogen Vehicles

1. Japan is of the opinion that the regulation of Hydrogen Fuel Vehicles should be created based on the concept of whole vehicle system safety performance evaluation, including crash safety such as passenger safety, fire prevention and others.
2. Therefore, individual component requirements should be limited only when such component requirements would be more reasonable than a system performance requirement.
3. Under the Japanese program regarding the Establishment of FCV regulation, Japanese Ministry of Land, Infrastructure and Transport is developing FCV regulations under the above concept in order to start Type Approval of FCV in April, 2005.
4. However, the current drafts of ECE regulations are not in line with the Japanese concept as it includes requirements of too many components. Japan concerns that too many component base regulations restrict the future technological development. Moreover, the Japanese proposal at the Hydrogen Informal Meeting to reduce the number of components to be regulated is not reflected in the proposed ECE regulations.
5. Therefore, Japan cannot support the proposed ECE regulations, as drafted, and cannot accept at all the “Two-Step Approach” (Option 2 and 3) in which these drafts would be the base of the future gtr for hydrogen fueled vehicles.
6. If it is necessary to establish regulations of a hydrogen fueled vehicle as soon as possible due to only the European situation, it should not be an ECE regulation but a national or regional regulation, because ECE regulations are not regional but international regulations based on the 1958 Agreement which not only European countries but also other countries including Japan accede to.
7. Therefore, Japan supports the “One-Step Approach” (Option 1) and that the proposed ECE regulations, as currently drafted, do not serve as the basis of the future gtr for hydrogen fueled vehicles.

Proposal for the Direct Development of Global Technical Regulation(s) for Hydrogen and Hydrogen Fuel Cell Vehicles

Transmitted by the Delegation of the United States of America

I. Introduction

During the 46th Session of the GRPE in May 2003, two drafts for new ECE regulations for hydrogen vehicles were presented as formal documents to the GRPE for adoption under the 1958 Agreement. The application of these draft regulations is limited to the components used for the storage and delivery of hydrogen to the fuel cell system or internal combustion engine and their on-board installation in vehicles. In the discussion of the proposed drafts, a view was expressed that the draft regulations, because of their focus on individual components, could constrain future technologies. The United States (US) supported this view, stressing the importance of developing a global technical regulation (GTR) that would be performance-based rather than too design-oriented, and encompass not only individual components, but also the whole vehicle. At the conclusion of the session, the GRPE directed the European Union, Japan and the United States in the Informal Group on Hydrogen and Fuel Cell Vehicles (IGH) to clarify by the time of the next GRPE session their technical and political approaches on the development of the GTR under the 1998 Global Agreement. The GRPE also requested that the IGH prepare a proposal for a concrete and action plan ('road map') for the assessment of the hydrogen technologies for motor vehicles and development of GTR for hydrogen vehicles.

II. Development of the road map to GTR

Prior to the Informal Meeting of the IGH on January 12, 2004, in Geneva, the group met on October 6-7, 2003, in Munich to discuss the preparation of the road map to the GTR. The US proposed a draft road map (please see the Attachment) a starting point for the discussion. The proposal highlighted the need for a timely development of GTR and the importance of having an adequate scientific basis for the development of GTR and specified the areas in which testing and additional research was needed in order to arrive at such a basis.

A number of parties were engaged in a discussion that focused on a policy approach the group should adopt: whether to develop GTR directly, or in two or more steps. During the discussion, primarily the industry representatives expressed their concerns over the timing of the GTR development and advocated the adoption of the two drafts as ECE regulations under the 1958 Agreement. A number of parties expressed a strong preference for a direct development of the GTR. The argument was made for the direct GTR development in terms of the benefits to the manufacturers and consumers alike. The direct, 'one-step' GTR development would also prevent scenarios experienced in other vehicle safety and environmental protection areas, where the parties have not been able to harmonize existing divergent standards and requirements.

In recognition of the need for timely development of GTR, experts from the contracting parties and the industry were invited to participate in a closer cooperation. Specifically, the interested parties were encouraged to share, whenever possible, results of testing, and for example, bring experts from other contracting parties or industry to witness testing done by another party, as such closer cooperative efforts would accelerate the development of the GTR and foster more efficient use of resources of the parties.

Some experts in IGH also voiced their concern over the scope of the GTR, as outlined in the road map proposal, and questioned the rationale behind the additional research and testing that was identified in the proposal. A number of parties, while recognizing the amount of work that has been done by the IGH experts already, agreed and stressed the need to do more work in order to gain confidence in the safe performance and integrity of the individual components as well as of the whole vehicle. The US delegate assured the group that the work that has been done would all be seriously considered and adopted into a GTR draft, as appropriate, as not to ignore or duplicate the work that has been done to date. Because of the inability to reach a consensus in

the IGH on a recommended approach within the allotted time, the group has decided to put forward for GRPE's consideration two options. Option 1, which reflects the position of the United States and Japan, proposes a direct development of GTR and Option 2, which reflects the position of other parties in the IGH.

III. Option 1 - Direct Development of GTR

This approach is based on the draft proposal of the revised version of the road map from the United States recommending that the development under the 1958 Agreement of the two ECE draft regulations on liquid hydrogen and compressed gaseous hydrogen components (ref. TRANS/WP.29/GRPE/2003/14 Add.1 and TRANS/WP.29/GRPE/2004/3) stop, and that GRPE IGH focus on direct GTR development. Throughout the development process, the IGH would continuously examine the work presented in the two draft regulations with a view to adopt into the draft GTR whatever information is relevant and useful. The US proposed that the next critical step in the outlined process would be to identify what specific tasks would be done by what party. Specifically, the group is strongly urged to consider this a joint effort where the industry and government should share the workload in order to leverage and save resources, including the overall time needed for the development of the GTR.

IV. Special Issues

1. Scope

The GTR should extend to vehicles powered either entirely by hydrogen and vehicles using hydrogen as a complementary fuel (hybrid vehicles) and cover at minimum:

- On-board storage system safety;
- Whole vehicle safety;
- Other aspects including energy and environmental considerations (may be delayed for some time depending on the need to address specific concerns identified by the parties.)

2. Timing of GTR

For manufacturers to be able to initiate mass production of hydrogen vehicles around 2010, the GTR should be completed within the next 3-4 years. The detailed road map will include the following tasks:

- Agreement to develop a Hydrogen/Fuel Cell GTR
- Allocation to parties of specific tasks, including research and testing
- Drafting of the draft GTR
- Adoption of the GTR

Appendix

SECOND DRAFT¹

January 2004

PROPOSAL FOR A ROADMAP FOR THE DEVELOPMENT OF A GLOBAL TECHNICAL REGULATION FOR HYDROGEN VEHICLES

1. INTRODUCTION

During the 126th Session of WP.29 in March 2002, the Executive Committee of the 1998 Global Agreement adopted a Program of Work. Under the Program of Work, WP.29 has agreed to undertake work 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/Group of Experts on Pollution and Energy formed an Informal Group on Hydrogen/Fuel Cell Vehicles (GRPE/IGH) to discuss and evaluate these draft proposals.

The IGH, under the chairmanship of Germany, has met several times since 2002 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.

2. REQUEST TO DEVELOP A ROADMAP

At its 46th Session in May 2003, the GRPE considered the two draft regulations as potential ECE regulations under the 1958 Agreement: proposals - TRANS/WP.29/GRPE/2003/14 - for liquid hydrogen and informal document - ID #6-Revision 12a, 1.09.03 - for compressed gaseous hydrogen. Following a discussion of the proposed regulations, the GRPE concluded that the draft regulations were not ready for adoption and postponed action on the proposals. The Japanese and US delegations specifically expressed their concern that the proposals were not comprehensive enough, as they addressed only individual components. The need for evaluation of 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 US questioned the rationale to introduce the draft regulations under the 1958 Agreement and not under the 1998 Global Agreement, as this approach could delay the development of a GTR in the long run.

The 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 with respect to the development of regulations for hydrogen vehicles. The GRPE also directed the IGH to work with Japan, the United States, the European Union and other interested delegations to develop a roadmap 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. The discussion of these issues will resume at the 47th Session of GRPE in January 2004.

¹ Draft 2 reflects comments US delegate received to the first draft in October 2003

TIMELINE FOR ROADMAP DEVELOPMENT

Roadmap Development Tasks	Dates
Meeting of Hydrogen Informal Group	6-7 October 2003
1st Draft of Roadmap	Mid-November 2003
2nd Draft	End of December 2003
Meeting of Hydrogen Informal Group	12-13 January 2004
Submittal of Draft Roadmap to GRPE	16 January 2004
Comments to the Draft Roadmap	Mid-February 2004
3 rd Draft	End of March 2004
Final Roadmap submitted to GRPE	May 2004

3. EVALUATION OF THE SAFETY PROBLEM

Safety of hydrogen vehicles has emerged in the last two 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, US, and Japan, yet very little data are available on safety performance of these vehicles.

Manufacturers have invested significant resources in producing and marketing these vehicles, and it is important they share their data, 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 will not be in a position to develop regulations, or to instil confidence in hydrogen vehicles in prospective consumers.

With respect to the application of potential global technical regulation for hydrogen vehicle, the GTR should extend to any vehicles powered either entirely by hydrogen, and vehicles using hydrogen as a complementary fuel (hybrid vehicles). Furthermore, the regulation should cover individual components and address the safety performance and integrity of the entire hydrogen fuel system. These requirements should be written, to the extent possible, in terms of performance, as design-specific requirements may potentially constrain future hydrogen-related technological innovations and methodologies.

4. REVIEW OF EXISTING INTERNATIONAL REGULATIONS

At present, there are no national or international regulations or directives governing the manufacture of hydrogen vehicles. However, there have been several voluntary codes and standards developed by international standards-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.

Partial list of Relevant International Voluntary Standards

- SAE J2578, Recommended Practice for General Fuel Cell Vehicle Safety
- SAE J2579, Recommended Practice for Fuel Systems in Fuel Cell and Other Hydrogen Fueled Vehicles
- ISO/CD 15869/1-5 –Gaseous Hydrogen and Hydrogen Blends – Land Vehicle Fuel Tanks

5. SPECIFIC SAFETY AND ENVIRONMENTAL ISSUES TO BE ADDRESSED

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 colorless, odourless, with a wide range of flammability, and high propensity to leak.

A. Unique Safety Challenges Presented by Hydrogen and Hydrogen Vehicles

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 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 10K psi)
 - ii. cryogenic liquid (complexity of cooling and venting)
 - iii. metal and chemical hydrides (thermal management for charging and discharging H, high pH waste)
 - iv. aging
- 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

B. Research and Testing

The objective of the research is to provide the technical basis for developing the GTR for hydrogen vehicles. At the component level, it will be necessary to conduct bonfire, burst, and pressure recycling tests to determine adequacy of proposed requirements for hydrogen on-board containers. Along with these tests, additional testing should be 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. Other testing should be done to understand better ignition 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. A series of tests should be also performed to evaluate onboard refuelling performance and for potential leakage from vehicle or fuelling system interface.

On the full vehicle level, tests should be run 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. Testing is also necessary to evaluate electrical isolation of the fuel cell, cooling system and auxiliary batteries. Conduct tests to determine electrical isolation of the entire high voltage system in pre-crash and post-crash scenarios. Likewise, evaluation of post-crash emergency medical services is recommended to determine any special post-crash handling requirements for occupants, rescue personnel, towing service or disposal.

- a. Fleet data collection and evaluation (manufacturers, governments, standard-setting organizations)
- b. Testing of individual components, including powertrain, fuel container, and delivery system
 - i. testing effectiveness of safety devices: pressure relief devices, cutoff, venting, etc.
 - ii. leak detection
 - iii. fire exposure and detection
 - iv. road hazards exposure
 - v. aging
- c. Testing of on-board refueling system performance
 - i. leakage
 - ii. spark/grounding
- d. Testing of full vehicle performance

- i. crash test
- ii. test for leakage during operation and parked
- iii. test for electrical isolation of fuel cell, cooling system and auxiliary batteries
- iv. post-crash assessment (handling, EMS)
- v. recycling
- vi. collection and evaluation of fleet data

C. Energy and Environmental Consideration

A series of studies and measurements are needed to determine appropriate fuel economy and environmental assessments, including:

- a. Identification of hazardous materials, recycling needs, etc.
- b. Hydrogen measurement tests
- c. Determination of conversion of hydrogen to liter/gallon equivalent
- d. Fuel economy and review of existing methodologies

D. Responsibility for Continued Comparative Evaluation of Existing and Draft International and National Standards and Regulations

E. Plan for Leveraging Resources/Task Distribution Among Contracting Parties and Standard-Setting Organizations

F. Timeline for the Development of the GTR

6. COST EFFECTIVENESS

The Group will consider the cost effectiveness of developing the GTR for hydrogen vehicles.

7. PARTIAL LIST OF WORKING AND REFERENCE DOCUMENTS USED BY THE IGH

Number of Documents**	Title of Document
TRANS/WP.29/GRPE/2003/14	Proposal for a New Draft Regulation – Uniform Provisions Concerning the Approval of: I Specific Components of Motor Vehicles Using Liquid Hydrogen; II Vehicle with regard to the Installation of Specific Components for the Use of Liquid Hydrogen
Informal Document-Revision 12a, 1.09.03TRANS/WP.29/GRSP/2002/ 15	Proposal for a New Draft Regulation – Uniform Provisions Concerning the Approval of: I Specific Components of Motor Vehicles Using Compressed Gaseous Hydrogen; II Vehicles with regard to the Installation of Specific Components for the Use of Compressed Gaseous Hydrogen
TRANS/WP.29/GRPE/46	Report of the GRPE on its Forty-Sixth Session (19-23 May 2003)
TRANS/WP.29/882	Guidelines Regarding Proposing and Developing of Global Technical Regulations (gtr)
TRANS/WP.29/883	Format of Global Technical Regulations (gtr)
SAE J2578 SAE J2579 ISO	Recommended Practice for General Fuel Cell Vehicle Safety Recommended Practice for Fuel Systems in Fuel Cell and Other Hydrogen Fueled Vehicles ISO/CD 15869/1-5 Gaseous Hydrogen and Hydrogen Blends – Land Vehicle Fuel Tanks

RECOMMENDATION FOR OPTION 3

The ultimate goal for everybody is GTR(s).

Even though two other options were considered for the development of GTR(s), **Option 3** is most feasible as it provides flexibility to meet the needs of all interested parties. Except for the USA and Japan, most informal group members including Canada, Germany, the Netherlands, Norway, the European Commission, the European automotive industry and ISO agreed with this approach.

While the other two options have some advantages, they present large risks. They will undoubtedly lead to the introduction of interim national/regional legislation in some countries. Once countries have their own regulations in place, harmonization at WP.29 level will be much more complex and difficult to achieve, leading to undesirable lead-time for the adoption of GTR(s).

Option 3 has a number of advantages. It makes use, for a limited life only, of the work already done on the two ECE draft regulations dealing with vehicle approvals concerning hydrogen storage systems. It also ensures that all resources are aimed towards one goal of developing a GTR while avoiding any duplication of work.