STANDARDIZATION AND REGULATION ON HYDROGEN SYSTEMS IN EUROPE AND IN THE WORLD PRESENT STATUS AND FUTURE DEVELOPMENTS

S. Chaudourne[1], C. Tombini[2], L. Perrette[3], M. Junker[4],

[1]CEA – Grenoble, DRT/DTEN/SCSE
Laboratoire Hydrogène et Pile à Combustible
38054 GRENOBLE cedex 9 (France)
Phone : +33 (0)4 38 78 30 18, Fax : +33 (0)4 38 78 51 98 E-mail : serge.chaudourne@cea.fr

[2]CEA – CESTA, DIA/SIA – BP 2, 33114 LE BARP (France)
Phone +33(0)5 57 04 43 34, Fax +33 (0)5 57 04 54 27

[3]INERIS – Parc Technologique ALATA
BP 2 – 60550 VERNEUIL-EN-HALATTE (France)
Phone : +33 (0)3 44 55 63 39, E-mail : lionel.perrette@ineris.fr

[4]ALPHEA – Zone d'Activités Ouest Marieneau,
Rue des Moulins, 57600 FORBACH (France)
Phone +33 (0)3 87 84 76 50 +33 (0)3 87 84 10 10, E-mail : michel.junker @alphea.com

Abstract

This paper gives an overview of the current legal and standard specifications to be taken into account while designing and using fuel cell systems. This overview embraces both stationary and mobile applications at European and international level. Current and under construction IEC and ISO standard are browsed. So are the one from the US, Canada and Europe.

The world-wide regulation project for vehicles is presented as well as the current legal situation for vehicle approval. Concerning stationary applications, this paper highlights the legal frame for both construction and use of these systems. A focus is made on France and Germany.

As a conclusion, the need for demonstration projects is indicated so as to gain experience. This newly acquired experience shall push towards relevant and tailor made regulations and standards that ensure homogeneous risk control.

1. Introduction : interest and drawbacks of hydrogen in energetic systems

Hydrogen has been used in chemical industry for a long time. However, using hydrogen as an energy carrier is a completely new application. This application is interested on the possibility to recover energy by hydrogen oxidation. This oxidation does not produce any pollutant or CO_2 emission.

The reaction is :

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$$

For one H_2 mole at the standard temperature $T_0 = 298\,\mathrm{K}$ and H_2O in gaseous state, the enthalpy, entropy and Gibbs energy of the reaction are :

$$\Delta_r H^0 = -241{,}8\,\mathrm{kJ \cdot mol^{-1}}$$

$$\Delta_r S^0 = -44{,}3\,\mathrm{J \cdot mol^{-1} \cdot K^{-1}}$$

$$\Delta_r G^0 = -228{,}6\,\mathrm{kJ \cdot mol^{-1}}$$

This means that with one mole of hydrogen (2 grams), it is possible to obtain 241,8 kJ of heat or in the ideal case of a reversible transformation 228,6 kJ of mechanical or electrical energy without any pollutant emission.

In fact real transformations are far from the ideal case and the mechanical or electrical energy is much lower then 228,6 kJ/molH_2. If we define the energetic efficiency η of an engine as the real electrical or mechanical energy provided reported to the maximum physically possible $\Delta_r G^0$, we can calculate the real hydrogen consumption necessary for a given energetic need. The table 1 gives for different efficiencies the hydrogen mass and volume (gaseous at 293 K, under 1 atmosphere, 25 MPa, 35 MPa and 70 Mpa) to obtain 1 kWh (3,6 MJ) of usable energy (mechanical or electrical).

Efficiency %	H2 (moles) mol	H2 (mass) kg	H2 (Volume) Ndm3	H2 (Volume) dm3 (25MPa)	H2 (Volume) dm3 (35MPa)	H2 (Volume) dm3 (70MPa)
100	15,748	0,032	352,976	1,622	1,229	0,730
90	17,498	0,035	392,196	1,802	1,366	0,812
80	19,685	0,040	441,220	2,028	1,536	0,913
70	22,497	0,045	504,252	2,317	1,756	1,043
60	26,247	0,053	588,294	2,703	2,049	1,217
50	31,496	0,063	705,953	3,244	2,458	1,461
40	39,370	0,079	882,441	4,055	3,073	1,826
30	52,493	0,106	1176,588	5,407	4,097	2,435
20	78,740	0,159	1764,882	8,110	6,146	3,652

Table 1 : Hydrogen mass and volume to obtain 1 kWh with efficiency from 20 to 100%

Table 2 gives a comparison of mass and volume energy density for Hydrogen and conventional fuels. It can be seen that hydrogen is very competitive for mass energy density but not for volume energy density.

Energy carrier	Form of storage	Energy density by mass kWh/kg	Energy density by volume kWh/dm^3
Hydrogen	Gas (30 Mpa)	33.3	0.75
	Liquid (20 K)	33.3	2.36
	Metal hydride	0.58	3.18
Natural gas	Gas (30Mpa)	13.9	3.38
	Liquid	13.9	5.8
Propane	Liquid	12.9	7.5
Methanol	Liquid	5.6	4.42
Gasoline	Liquid	12.7	8.76
Diesel	Liquid	11.6	9.7

Table 2 : Comparison of mass and volume energy density for various fuels

As a conclusion, the use of hydrogen to replace conventional fuel has the very important advantage to produce mechanical or electrical energy without any local pollution. The main drawbacks are its low volume energy density and the safety problems due to its flammability and explosivity. Additionally, the high pressure storage which is a method to increase the volume energy density can generate additional safety problems.

As a consequence, hydrogen use can be technically difficult and safety requirements have to be seriously considered. So the need for accurate technical standards to ensure a good conception of products and the need for regulations to guarantee user safety are key points in the hydrogen energy development.

Compliance with regulations is compulsory. Whereas standards are followed on a voluntary basis. Regulations usually set objectives whereas standards propose means to reach these objectives. Standard enforcement is sometimes a mean to comply with related regulations (harmonised standards). It also indicates that state of the art has been taken into account while designing a system.

2. Standardization and regulation for hydrogen vehicles

2.1 General survey

It is given for granted that standardisation and regulation related to vehicles must harmonised on a *global* basis. It shall not be different from one country to another, in order to enable products to move freely across every national markets.

Hydrogen use for vehicles generates several difficult security problems coming from :

- The necessity to store in the vehicles a fair quantity of hydrogen (several kilogrammes) to have a range of the same order as classical vehicles

- The vehicle motion which makes it come across with many different environments such as circulation in towns, tunnels crossing, underground car parks, etc. Each of these various environment feature its own type of risks.
- The high speed motion which induces a potentially highly energetic collision hazard.
- The building of urban hydrogen service-stations for car refuelling. These service-stations have to store large quantity of hydrogen. They also have to be able to transfer liquid hydrogen or compressed hydrogen to vehicles at high rate.

Standards erection favours homogeneous safety levels. It suggests good practices.

In most countries certification is required to put a new car into service. These regulations set safety objectives to be satisfied.

In a regulatory framework, the manufacturer has *to prove* that he has used all adapted technical means to prevent accidents or to limit their consequences. On the other hand, the manufacturer has only to show that its product is in agreement with a given standard.

2.2 Standardisation overview

The international technical committee in charge of hydrogen is ISO/TC197 "Hydrogen Technologies". Some ISO/TC197 work is shared with other technical committees dedicated to connected subjects. The main liaisons are with ISO/TC22 (Road Vehicles) and IEC/TC105 (Fuel Cell Technologies) committees. There are also connections with ISO/TC58 (Gas cylinders), ISO/TC220 (Cryogenic Vessels) and some other committees.

An important part of ISO/TC197 work is dedicated to vehicles, namely the WG1 (Liquid hydrogen fuel tanks for land vehicles), the WG5 (Gaseous hydrogen service station and connectors) and the WG6 (Gaseous hydrogen fuel tanks for land vehicles). The most active country within TC197 are Canada, USA and for Europe Germany, Sweden and France. Summery of ISO/TC197 work is given on table 3.

Reference	Subject	Comment
ISO 13984	Fuelling connectors for liquid H_2	Published
ISO 14687	Hydrogen fuel - Specifications	Published
ISO/DIS 13985	Vehicle fuel tanks with liquid H_2	Harmonization with EIHP in progress at WP29/GRPE
ISO/WD13986	Multimodal transportation of liquid H_2	Cancelled (Jan. 2001)
ISO/DPAS15594	Airport fuelling facility	In progress
ISO/WD15866	Service stations	Cancelled (June 2002)
ISO/WD17268	Fuelling connectors for gaseous H_2	Restart on SAE J2600 basis – Joint with ISO/TC22
ISO/CD15869	Vehicle fuel tanks with high pressure gaseous H_2	Harmonization with EIHP in progress at WP29/GRPE

ISO/DTR15916	Basic considerations for the safety of H_2 systems	In progress
ISO/WD22734	H_2 generation using water electrolysis systems	New item accepted
	Transportable gas storage using metal hydride	New item proposed
	H_2 Generators using fuel processing technologies	New item proposed

Table 3: Work items of ISO/TC197

2.3 Current situation

Currently, vehicle approval refers to the many European directive. None of these European directive cover vehicles running on hydrogen.

Meanwhile, under the 70/156/CE directive it is possible for a manufacturer to run its prototype on the street. There are currently two possibilities :

- Either vehicle manufacturer can refer to its own national authorities to gain a *prototype approval*. This prototype approval is valid as long as the number of vehicles produced is kept below 500 units per year. This national approval does not give right to exportation unless the European exporting country agrees with this approval. In the case of prototype approval, the vehicle runs with a “W” type registration number. As long as the vehicle does not carry any passenger, responsibility falls on the manufacturer. In other cases, public authorities are kept responsible.
- For larger productions and for innovative technologies, any national authority belonging to the European Economic Community can submit a technical file to the European Commission. If the evaluation output is positive, the approved vehicle will be allowed to run freely within the 15 member states for a given period of time.

Both options are interesting. The first option is tailor-made for prototypes. However, this status can, in the long term, hinder hydrogen vehicles commercialisation.

The European project EIHP aims at tackling this legal issue.

2.4 Regulation projects in Europe : the EIHP work

The European Integrated Hydrogen Project phase II (EIHP2) is a consortium of 21 members (industrial partners and research centres) who work together to initiate and provide inputs for regulations on a European and Global Level concerning hydrogen fuelled road vehicles, hydrogen refuelling infrastructure and the relevant interfaces. It is a 3 years project (01 Feb. 2001 to 31 Jan. 2004). Its budget is about 5 M€ with a 50% European funding.

The project is divided into 4 technical work packages :

- WP2 Refuelling Station

- WP3 Refuelling Interface
- WP4 Vehicles (Liquid hydrogen tank, gaseous pressurised hydrogen tank, connectors)
- WP5 Safety

And two coordination work packages :

- WP1 Overall coordination
- WP6 Links with countries outside Europe

Concerning regulations, EIHP2 proposed two draft regulations for vehicles, one concerning liquid hydrogen [1] and the other one concerning compressed gaseous hydrogen [2]

2.5 Towards a Global Technical Regulation ?

The need to move progressively towards global regulations for hydrogen vehicles acceptable for all countries and in agreement with existing or in development standards is widely accepted. For this very reason, on March 6th, 2001 Germany submitted EIHP draft regulations for liquid and gaseous hydrogen vehicles to the UNECE WP29[1] in Geneva.

The request was welcomed and the work was given to the GRPE[2]. The GRPE launched an ad-hoc Working Group to examine the proposals (May 29 th, 2001). This WG delegated technical issues to 2 Groups of Experts (one for liquid H_2 and on for gaseous H_2). In parallel, an Harmonisation Group was created to find an agreement between EIHP draft regulations projects and ISO/TC197 standards projects (ISO/DIS 13985 for liquid H_2 and ISO/CD 15869 for gaseous H_2). All these groups of experts have to report to the ad-hoc WG to obtain a consensus which will then be transmitted for approval to GRPE and finally to WP29. This fair complicated process is summarized on Annex 1 and the agenda of the numerous meetings is presented on Annex 2.

On May 19th, 2003, both an informal presentation concerning Gaseous Hydrogen Regulation and the formal presentation concerning Liquid Hydrogen Regulation have been given to GRPE. The objective is to obtain in some years an extensive regulation for hydrogen vehicles in the framework of ECE (1958 agreement, without USA, Canada and Japan) and in the framework of GTR[3] (1998 agreement including almost all countries).

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[1] United Nation, Economic Commission for Europe, Working Party 29

[2] Group on Pollution and Energy

[3] Global Technical Regulation

3. Standardisation and regulation for stationary fuel cell systems

The French SEREPAC [3] project reviewed standards and regulations that apply to fuel cell systems. Information given in this paragraph is mostly taken from this recent work.

3.1. General survey

Fuel cell systems integrate a wide range of components depending on their use. They can be fuelled not only with hydrogen but with different kind of fossil fuels. As a consequence, there is a large number of standards and regulations witch may apply to these systems depending on the country of manufacturing and installation. It makes it difficult for a manufacturer or an end-user to identify and fulfil every legal requirements needed to sell, export or use a fuel cell system.

To solve this problem, a lot of national and international initiatives are underway to develop "fuel cell specific" standards. For example, specific US standards have been erected and are under improvement. The first international standard will be published within one or two years.

National and international regulations are also under development. As the regulatory approaches are different from one country to another, these texts will be much more difficult to write. It will eventually take a few years more than the development of standards.

"Fuel cell specific" standards and regulations under development are among others concerned with the safety of the systems.

3.2. Standardisation overview

3.2.1. U.S. and Canadian standards

A lot of US and Canadian standards have been developed, are under improvement or are under development by different organisations. All fuel cell applications are covered: stationary as well as non stationary (e.g. portable and vehicular).

A document published by the National Evaluation Service gives a good overview of all these standards [4]. Table 3 summarises the most important US and Canadian standards.

The ANSI Z21.83 standard on "Fuel Cell Power Plants" is actually under improvement and will cover all types of stationary fuel cell applications (portable and residential), excluding vehicular.

The U.S. DOE is strongly supporting the work on fuel cell standards. Information on this subject is disseminated to end users and local approval authorities through specialised publications (ex.: "Fuel Cell Summit Newsletter"), annual seminars ("Fuel Cell Summit"), specialised guides on the applications of these standards and the internet (www.pnl.gov/fuelcells/).

Standard	Title - Subject
ANSI Z21.83	— "Fuel Cell Power Plants" — applies to packaged, self contained or factory matched packages of integrated systems of fuel cell power plants for use with natural or LP gas and having a maximum output of 1000 kW operating at no less than -29°C
CSA CAS n°33	— "CSA Component Acceptance Service n°33 for PEM Fuel Cell modules" — this documents contains requirements for providing CSA international component acceptance service for proton exchange membrane (PEM) fuel cell stacks (modules) using hydrogen as the fuel source
CSA U.S. requirement n°1.01	— "Residential Fuel Cell Power Generators" — this document applies to packaged, self contained residential fuel cell power generators for outdoor applications – the residential generator is defined as a unit serving a single family or two family dwelling not exceeding 50 kW in total AC power output
CSA U.S. requirement n°3.01	— "Portable Fuel Cell Appliances" — this document applies to AC and DC type portable fuel cell power generators, with a rated output voltage not exceeding 600 V, for commercial indoor and outdoor use in non-hazardous locations
CSA U.S. requirement n°5.99	— "Hydrogen Generators"
NFPA 853	— "Standard for the Installation of Stationary Fuel Cell Power Plants" — the scope of this standard is the design, construction and installation of stationary (non-portable) fuel cell power plants with a gross electrical generation that exceeds 50 kW
NFPA 70	— "National Electric Code" — article 692 of the code covers fuel cells
UL 1741	— "Standard for inverters, converters and controllers for use in independent Power Systems"
UL 2264	— "Gaseous Hydrogen Generating Appliances"
UL 2265	— "Replacement Fuel Cell Power Units for Appliances"
ASME PTC 50	— "Performance Test Code for Fuel Cell power System Performance" — PTC 50 covers PAFC, PEMFC, MCFC and SOFC Fuel Cells
IEEE P1547	— "Standard for interconnecting Distributed Resources with Electric Power Systems
SAE Standards	— J2578: "Recommended Practices for General Fuel Cell Safety" — J2579: "Recommended Practices for hazardous Fluid Systems in Fuel Cell Vehicles — J2574: "Fuel Cell Vehicle Terminology" — J2615: "Performance Test Procedures of Fuel Cell systems for Automotive" — J2616: "Performance Test Procedures for fuel Processor Subsystems of Automotive fuel Cell Systems — J2617: "Performance Test Procedures of PEM Fuel Cell Stack Subsystems for Automotive Applications — J2594: "Fuel Cell Recyclability Guidelines" — J2572: "Recommended Practice for Measuring the Exhaust Emissions, Energy Consumption and Range of Fuel Cell Powered Electric vehicles Using Compressed Gaseous Hydrogen"

Table 3: most important U.S. and Canadian Standards

3.2.2. IEC standards

The international technical committee in charge of “fuel cells” is the IEC / TC 105 “Fuel Cell Technologies”. Some of the work is shared with other technical committees dedicated to connected subjects: ISO / TC 197, ISO / TC 22, IEC / TC 31, SAE…

As this committee is quite young, no international standard on fuel cell has been published. Table 4 gives a summary of the work of the different working groups in the IEC / TC 105.

New work items are under discussion.

Working group	Subject
1	Fuel Cell Technologies - Part 1: Terminology
2	Fuel Cell Technologies – Part 2: Fuel Cell Modules
3	Fuel Cell Technologies – Part 3.1: Stationary Fuel Cell Power Plants - safety
4	Fuel Cell Technologies – part 3.2: Stationary Fuel Cell Power Plants – Test methods for the performance
5	Fuel Cell Technologies – Stationary Fuel Cell Power Plants - Installation
6	Fuel Cell Technologies – Fuel Cell System for Propulsion and Auxiliary Power Units
7	Fuel Cell Technologies – Portable Fuel Cell Appliances – Safety and Performance Requirements

Table 4: work items of IEC / TC 105

The U.S., Canadian or Japanese Fuel Cell Standards are mostly the basis for the work of the different WG’s of IEC / TC 105.

3.2.3. CEN / CENELEC standards

A CEN / TC with the name “Fuel Cell Gas Appliances up to 70 kW” has been created in 2003.

The aim of this TC is to propose European standards for gas appliances that produce energy on the basis of using fuel cell technologies.

Fuel Cell manufacturers and developers, energy companies and representatives of national standards organisations are collaborating within this TC.

The work has been divided in three topics: basics and definitions, PEMFC and SOFC.

3.3. Regulation in Europe: some examples

One has to consider both the manufacturing of a stationary fuel cell system as well as its installation in a given country.

Up to now, there is no specific European regulation for stationary fuel cell systems manufacturing. Even though not specific, some European directives are to be followed to gain CE marking. CE marking concerns all type and power range of fuel cell systems.

As far as installation and use is concerned, it barely depends on the fuel cell system power and specifications (hydrogen storage,…). Domestic fuel cell would only require CE marking to be installed and used whatever the European country. On the other hand, large power units have to comply with national rules. There are different approaches from one country to anothe. As such, they would need an approval from local authorities prior to be installed and used. As an example, we will give a quick overview for France and Germany.

3.3.1. EU regulation

Table 5 gives an overview of all the EU Directives that generally apply to fuel cell systems.

Directive n°	Directive name	Scope
73/23/EEC	Low Voltage Equipment (LVD)	Electrical equipment means any equipment designed for use with a voltage rating between 50 and 1000 V for alternating current and between 75 to 1500 V for direct currents.
87/404/EEC	Simple pressure Vessels	This Directive applies to simple pressure vessels manufactured in series. For the purposes of this Directive, 'simple pressure vessel' means any welded vessel subjected to an internal gauge pressure greater than 0,5 bar which is intended to contain air or nitrogen and which is not intended to be fired.
89/336/EEC 92/31/EEC	Electromagnetic Compatibility (EMC)	This directive applies to apparatus liable to cause electromagnetic disturbance or the performance of which is liable to be affected by such disturbance. It defines the protection requirements and inspection procedures.
98/37/EC	Machinery	It applies to all machinery and lays down the essential health and safety requirements. It also apply to safety components placed on the market separately. For the purposes of this Directive, machinery means an assembly of linked parts or components, at least one of which moves,… . It refers to the ATEX 94/9 CE directive dedicated to equipment and protective systems intended to be use in potentially explosive atmosphere
97/23/EC	Pressure Equipment (PED)	It applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure PS greater than 0,5 bar. For the purposes of this Directive, 'Pressure equipment` means vessels, piping, safety accessories and pressure accessories. Where applicable, pressure equipment includes elements attached to pressurised parts, such as flanges, nozzles, couplings, supports, lifting lugs, etc
90/396/EEC	Gas Appliances	It apples to appliances burning gaseous fuels used for cooking, heating, hot water production, refrigeration, lighting or washing and having, where applicable, a normal water temperature not exceeding 105 gC, It also applies to safety devices, controlling devices or regulating devices,… separately marketed for trade use and designed to be incorporated into an appliance burning gaseous

Table 5: EU Directives which may apply to fuel cell systems

All these Directives are “new approach directives”. They give some essential safety requirements that have to be fulfilled by the manufacturer or the importer of a system..

CE marking is required to market a product in every country of the European Union. Compliance with appropriate EU directives entitles for marking (auto-certification or notified body).

Therefore, fuel cell manufacturers (or importers) have to ensure that their systems are in conformity with Directives cited in table 5.

In Germany, a rule, namely VP 119, has been edited by manufacturers and end-users to facilitate residential fuel cell CE marking. On the basis of this rule fuel cell systems from Vaillant and Sulzer have been CE marked.

3.3.2. VP 119 industrial rule

It's the only German "fuel cell specific" regulation. It indicates technical requirements for the installation of fuel cell systems with a thermal output of less than 70 kW. It applies to PEMFC and SOFC systems.

In this regulation the fuel cell system is seen as a "gas heating appliance". It fits the requirements of the 90/396/EEC Directive and all applicable German standards.

This rule has been developed under the initiative of fuel cell manufacturers, energy companies and the DVGW ("german organization of the gas and water industry"). It responds to the need of one unique regulation for residential fuel cell systems in Germany.

This regulation will facilitate and shorten the time for the approval procedures of the numerous systems which will be installed in Germany in the next years.

3.3.2. *French regulation for installation of large power units*

There is no specific French regulation for stationary fuel cell installations.

Regulation which applies for "industrial fuel cell systems" (over 100 kW electrical output) is the "ICPE Regulation" ("Classified Installations for the Protection of the Environment"). It is hydrogen itself which is usually targeted (table 6) by this regulation. Indeed, it sets some specific rubrics concerning the production, the use and the storage of hydrogen.

Local authorities are referring to these rubrics and associated safety specifications to give their approval for the installation and use of fuel cell systems.

Rubric number	Title	Application level
1415	"hydrogen production"	No minimum limit
1416	"storage or use of hydrogen"	Over 100 kg

Table 6 : hydrogen specific rubrics of the french ICPE regulation

The fuel cell project from EdF (French electricity company) and GdF (French gas company) in the city of Chelles, near Paris, can be taken as an example of the enforcement of French regulation to a stationary fuel cell system (200 kWel fuel cell from UTC FC, PAFC technology fuelled with natural gas).

The most important learning from this project are as follow:

- application of the French regulation on pressure vessels;
- application of the French regulation on heating appliances;
- application of the French regulation on electrical systems;
- certification by the local authorities of a steam separator (pressure vessel regulation);

- non application of the 1415 rubric of the French “ICPE regulation” on the principle that hydrogen was not industrially produced and was immediately consumed after production;
- special “use approval” by the French Industry Ministry because the unit was not CE marked.

3.3.3. *German regulation*

Due to the large number of installed stationary fuel cell systems in Germany, it is easier to get an overview of regulations which may apply to fuel cell systems.

It can be summarised in four points.

- For similar systems, applied regulation can be different from one region to another, due to the federal system in Germany.
- The “Gerätesicherheitsgesetz” (safety of equipment) or the” Bundesimmionsschutzgesetz” (control of polluting emissions) are applied in all cases for fuel cell power plants (over 200 kW electrical output). The rubrics applied are those on “pressure vessels” or on “steam vessels”.
- In most cases, local authorities require some technical changes in the systems related to its safety. In some cases some additional safety analyses are also required.

4. Conclusion

Legal and standardisation frame for both stationary and mobile applications is evolving on an international and European level. Even though not always facilitated by the current context, demonstration projects are required to gain experience that is useful to appropriately shape specifications to come. Standardisation and common regulations shall provide world-wide homogeneous and relevant safety principles. It shall prevent accidents and associated bad press.

References

[1] EIHP, Proposal for a new draft regulation for the use of liquid hydrogen on motor vehicles, Revision 13, 25 Nov. 2002

[2] EIHP, Proposal for a new draft regulation for the use of compressed gaseous hydrogen on motor vehicles, Revision 11, 29 March 2003

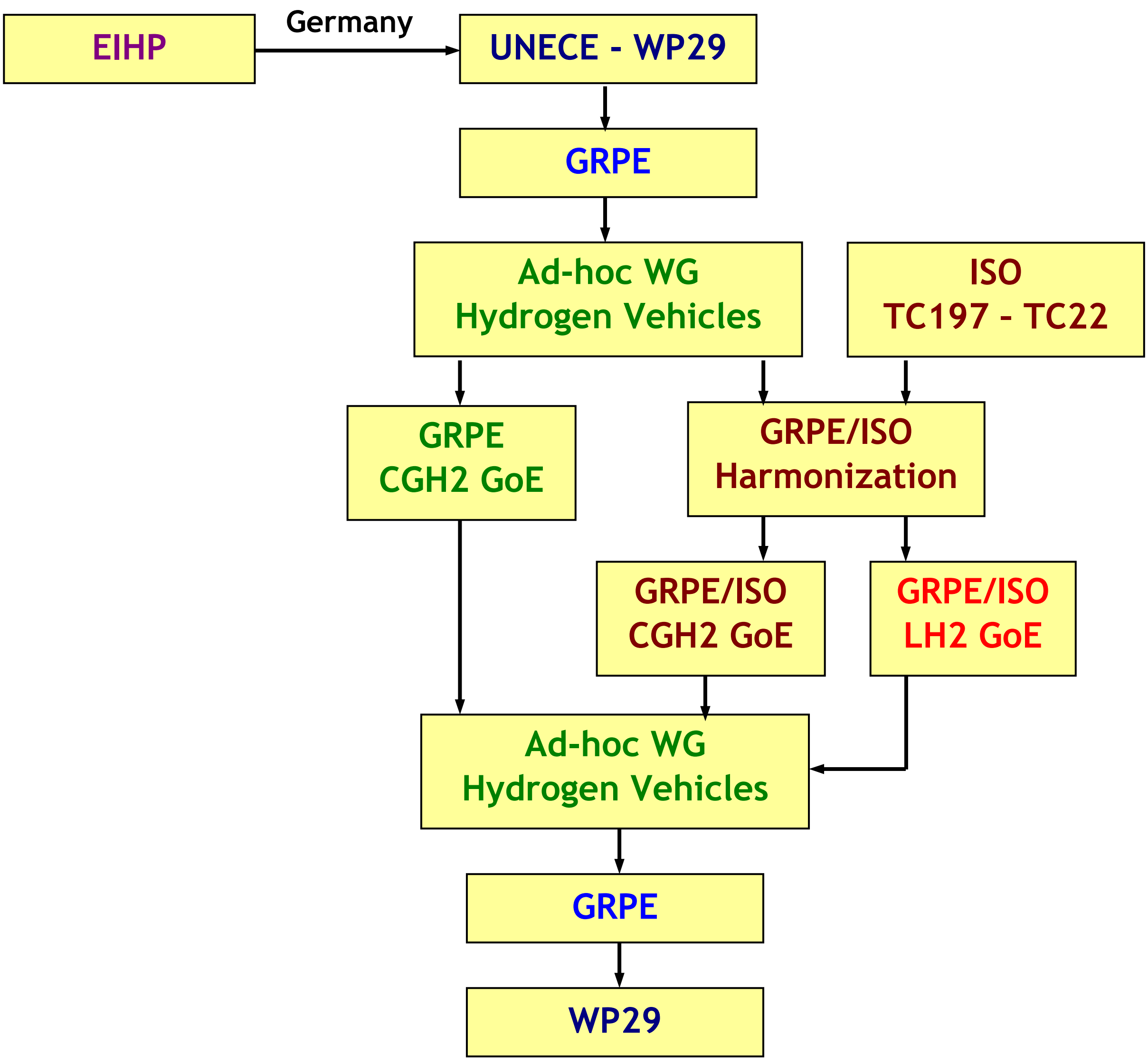
[3] M. JUNKER, B. BELLO, S. CHELHAOUI, L. PERETTE, D. GUICHARDOT; « Projet SEREPAC – CHAPITRE II : normes et réglementations sur les piles à combustible » - Rapport de projet (novembre 2002)

[4] National Evaluation Service, www.nateval.org , Status Summary (mai 2002)

Annex 1

Organisation chart for elaboration

of international hydrogen vehicles regulations



Note : GoE = Group of Expert

Annex 2

Table of meetings for elaboration of international hydrogen vehicles regulations since 2001

Date	Place	Organisation	Meet. #	Decision
6-9 March 2001	Geneva (CH)	WP29	123	Examination of EIHP proposal by GRPE
29-30 May 2001	Geneva (CH)	GRPE	42	Creation of an ad-hoc Working Group
29 Nov. 2001	Bonn (GE)	GRPE ad-hoc WG	1	First Step : ECE, Second step : GTR
17-18 Jan. 2002	Geneva (CH)	GRPE	43	Approval cooperation with ISO – Discussion ECE vs GTR
19 Feb. 2002	Munich (GE)	GRPE ad-hoc WG	2	Comparison with ISO-13985 (LH2) and ISO-15869 (CGH2)
4-5 June 2002	Nabern (GE)	GRPE ad-hoc WG	3	Report ISO-TC197/TC22 – Creation GRPE/ISO Group of Experts LH2/CGH2
29 July 2002	Munich (GE)	GRPE/ISO LH2	1	Resolution of main differences on LH2
30 July 2002	Munich (GE)	GRPE/ISO CGH2	1	Resolution of main differences on CGH2
26-27 Sept. 2002	Montreal (CA)	GRPE/ISO LH2	2	Harmonization on LH2 (EIHP Rev.11 and ISO/DIS13985)
24-25 Oct. 2002	Vancouver (CA)	GRPE/ISO CGH2	2	Harmonization on CGH2 (EIHP Rev.9 and ISO/DIS15869)
14-15 Nov. 2002	Cologne (GE)	GRPE ad-hoc WG	4	CGH2, LH2, FORD presentation
16-17 Jan. 2003	Geneva (CH)	GRPE	45	LH2 Rev.13 Informal presentation
22 Jan. 2003	Munich (GE)	GRPE/ISO CGH2	3	Harmonization on CGH2 (PRD, Burst pressure/Test pressure ratio)
23-24 Jan. 2003	Munich (GE)	GRPE CGH2	1	CGH2, JASIC Presentation
13-14 Feb. 2003	Rüsselsheim	GRPE ad-hoc WG	5	OPEL – GM presentation
5 March 2003	Munich (GE)	GRPE CGH2	2	
10-11 Apr. 2003	Göteborg (SW)	GRPE ad-hoc WG	6	
22-23 May 2003	Geneva (CH)	GRPE	46	CGH2 Rev.11 Informal presentation – LH2 Rev.13 Formal presentation
22-27 June 2003	Geneva (CH)	WP29	124	