CUTE – Bringing a fuel cell bus fleet on the road in European cities

Reinhold Wurster

Hydrogen Regulations, Codes and Standards
for Road Vehicles and their Refueling Infrastructure
in Europe

L-B-Systemtechnik
Ottobrunn
Presentation overview

1. Safety Implications of Hydrogen Use in Road Transport
2. Why Harmonized Regulations and Standards?
3. EIHP’s Involvement in H₂ Regulations and Standards Work
4. Globally Harmonized Vehicle Approval
5. Recommendations
Safety Implications of Hydrogen Use in Road Transport

Challenges to be solved for a manufacturer of H₂ road vehicles

Source: BMW

18MAR2004
Safety Implications of Hydrogen Use in Road Transport

Challenges to be solved for safe operation H₂ vehicles on public roads

Source: BMW in www.eihp.org
Why Harmonized Regulations, Codes and Standards?

International Regulations, EU Directives, and Standards

- Legal Requirements and Regulations are ranked above standards
- UN Global Technical Regulation [1998 Agreement] 1st priority
  UNECE Regulation [1958 Agreement] 2nd priority
  EEC Directives 3rd priority
  National Directives and Regulations 4th priority
- Important directives regarding stationary hydrogen technologies and infrastructure systems are:
  - ATEX directives
  - PED (Pressurised Equipment Directive)
  - EMC (electromagnetic compatibility) directive
  - The Machinery Safety Directive
  - SEVESO II (large amounts of haz. mat.)
  - Transport of dangerous goods by road
  - UN IMO
- Standards (ISO, IEC, ...... CEN, ...... SAE) for both, stationary and mobile applications

Sources: Norsk Hydro - 2003, LBST - 2004
Some 44 directives have to be applied in order to receive an approval for a road vehicle in Europe. If a vehicle is successfully tested according to these 44 EC directives or equivalent ECE regulations it has to be approved. The result is a Whole Vehicle Type Approval.

If approval is sought for a hydrogen vehicle, emissions, fuel consumption and engine power cannot be tested according to the existing directives/ regulations. The reason is mainly the absence of a standardised reference fuel or the absence of a test procedure and the absence of corresponding EC directives respectively ECE regulations.

Some other directives can be fulfilled formally, but from the technical point of view they should be revised for hydrogen vehicles.

Some requirements regarding the safety of the hydrogen on-board storage systems are missing in the existing directives.
### Why Harmonized Regulations, Codes and Standards?

**Legal Situation for Approval of Road Vehicles in Europe**

#### List of directives/ regulations to be amended for road vehicles

<table>
<thead>
<tr>
<th>Subject</th>
<th>EEC-Directive/ECE-Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Emissions</td>
<td>70/220/EEC incl. latest amendment &amp; ECE R83</td>
</tr>
<tr>
<td>2. Fuel tanks/rear protective device</td>
<td>70/221/EEC incl. latest amendment &amp; ECE R34/58</td>
</tr>
<tr>
<td>3. Identification of controls</td>
<td>78/316/EEC incl. latest amendment</td>
</tr>
<tr>
<td>4. Fuel consumption</td>
<td>80/1268/EEC incl. latest amendment &amp; ECE R 101</td>
</tr>
<tr>
<td>5. Engine Power</td>
<td>80/1269/EEC incl. latest amendment &amp; ECE R84</td>
</tr>
<tr>
<td>6. Side impact</td>
<td>96/27/EC &amp; ECE R95</td>
</tr>
<tr>
<td>7. Frontal impact</td>
<td>96/79/EC &amp; ECE R94</td>
</tr>
<tr>
<td>8. Roadworthiness tests</td>
<td>96/96/EC &amp; PTI</td>
</tr>
<tr>
<td>9. CO₂ labeling</td>
<td>99/94/EC</td>
</tr>
<tr>
<td>11. Electric Vehicles</td>
<td>NEW EC Directive &amp; ECE R100</td>
</tr>
<tr>
<td>12. Defrost/Demist</td>
<td>78/317/EWG (already under progress)</td>
</tr>
</tbody>
</table>
The path of Council Directive No 98/14/EC, article 8(2)c, to approve hydrogen fuelled vehicles:

- Excessive amount of time required
- Uncertainty of the outcome of the process up until the very end
- Not suitable for electric drive vehicles (FCVs, HEVs)

A draft regulation for hydrogen vehicles should be developed
Why Harmonized Regulations, Codes and Standards?
Harmonized Frame for Europe - or the EEC Directive

[Current process according to exemption by Council Directive N° 98/14/EC, article 8(2)c]

[WVTA restricted to 36 months]

[Improvement of situation ruled by Directive N° 98/14/EC]

Application for approval (incl. exemption)

Technical Service for pressure vessels

Approval for high pressure parts and report

Technical Service Automotive Dept.

Expertise

National approval authority

Report

EU-Commission

Decision

EU-Commission

[CATP]

National approval authority

WVTA non-restricted
Why Harmonized Regulations, Codes and Standards?

Two Pathways to Present a Proposal for a Regulation in Europe
For the Whole Vehicle Type Approval of \( (H_2) \) Road Vehicles

**UN-ECE**
- **REGULATIONS**
  - Secretary General of the UN
  - Economic Commission for Europe
    - Inland Transport Committee
      - ITC
  - Working Party 29 (WP.29)
    - New Vehicles Construction
  - GRPE
    - working party on pollution and energy

**EC**
- **DIRECTIVES**
  - EU Council and EU Parliament
  - European Commission
  - Motor Vehicle Working Group
  - MVEG
    - Motor Vehicle Emission Group

**Binding for WVTA** (Valid for: EU)
EIHP’s Involvement in H₂ Regulations and Standards Work

European Integrated Hydrogen Project - Phases 1 & 2
[http://www.eihp.org]

Objectives: Initiate and provide inputs to support the development of legal requirements and standards on an EU and global level for the approval of hydrogen fueled road vehicles, hydrogen refueling infrastructure and the relevant interfaces.

Phase 1: 1998 – 2000
• Main focus on hydrogen fueled vehicles
• Vehicle - development of draft UNECE regulations
• Infrastructure - only very limited analysis
• Safety studies and limited computer simulations

Phase 2: 2001 - 2004
• Enhanced focus on hydrogen vehicle refueling infrastructure
• Vehicle - continued work to develop draft UNECE regulations and initiate work on a global level (GTR)
• Infrastructure - refueling stations and fueling interface - EU and North America
• Safety studies, computer simulations and first limited safety tests

EIHP, a partnership between the European Hydrogen Industry and the European Commission, provided inputs for regulatory activities on a European and global level to facilitate harmonised Procedures for the approval of hydrogen fuelled road vehicles. The project has been finalised by January 2004 and discussions are going on with regard to a possible continuation (intermediate step: HarmonHy proposal).
EIHP’s Involvement in H₂ Regulations and Standards Work
Harmonized Frame for Europe - the UNECE Regulation

PROPOSAL FOR A NEW DRAFT REGULATION

I. SPECIFIC COMPONENTS OF MOTOR VEHICLES USING LIQUID HYDROGEN;
II. VEHICLES WITH REGARD TO THE INSTALLATION OF SPECIFIC COMPONENTS FOR THE USE OF LIQUID HYDROGEN

PROPOSAL FOR A NEW DRAFT REGULATION

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
Globally Harmonized Vehicle Approval
International Regulations & Standards Links for H2 & FC Vehicles

Source: ELEDRIVE, 2003
Globally Harmonized Vehicle Approval
Global Platform for Harmonization of Regulations for Road Vehicles

UNECE WP29 - Global Platform for Harmonisation of Legal Requirements for Road Vehicles

- Request for a harmonized regulation
- UNECE Regulation (1958 Agreement)

UNECE, WP29

Harmonized regulation in a global register

MEMBERS OF THE 1958 AGREEMENT:
[(E/ECE/324-E/ECE/TRANS/505/Rev.2)]
GERMANY, FRANCE, ITALY, NETHERLANDS, SWEDEN, BELGIUM, HUNGARY, CZECH REPUBLIC, SPAIN, YUGOSLAVIA, UNITED KINGDOM, AUSTRIA, LUXEMBOURG, SWITZERLAND, NORWAY, FINLAND, DENMARK, ROMANIA, POLAND, PORTUGAL, RUSSIAN FEDERATION, GREECE, IRELAND, CROATIA, SLOVENIA, SLOVAKIA, BELARUS, ESTONIA, BOSNIA AND HERZEGOVINA, LATVIA, BULGARIA, TURKEY, THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA, EUROPEAN COMMUNITY, JAPAN, AUSTRALIA, UKRAINE, REPUBLIC OF SOUTH AFRICA

MEMBERS OF THE 1998 AGREEMENT:
[(E/ECE/TRANS/132 AND Corr.1)]
CANADA, UNITED STATES OF AMERICA, JAPAN, FRANCE, UNITED KINGDOM, EUROPEAN COMMUNITY, GERMANY, RUSSIAN FEDERATION, PEOPLE'S REPUBLIC OF CHINA, REPUBLIC OF KOREA, ITALY, REPUBLIC OF SOUTH AFRICA, SPAIN
EIHP was a partnership between the European Hydrogen Industry and the European Commission. This consortium was created to provide inputs for regulatory activities on a European and global level to facilitate harmonized Procedures for the approval of hydrogen fuelled road vehicles.

EIHP2 Partnership

EIHP2 started cooperation with TC197 end of 2001 as no H₂ activities existed in TC22

ISO TC197

Hydrogen Technologies

Cooperation agreement between TC197 and TC22 was signed in June 2002

ISO TC22 SC21

Electric, Hybrid, FC Vehicles

ISO TC22 SC25

LPG, CNG, H₂ Road Vehicles

H₂ Industry Voice

mobile and stationary

ISO H₂ Voice
Published standards:
ISO 13984 Liquid hydrogen – Land vehicle fuelling system interface
ISO 14687 Hydrogen fuel – Product specification

Draft International Standards:
ISO/DIS 13985 Liquid hydrogen – Land vehicle fuel tanks
ISO/DIS 15869 Gaseous hydrogen and hydrogen blends – Land vehicle fuel tanks –
Part 1: General requirements
Part 2: Particular requirements for metal tanks
Part 3: Particular requirements for hoop wrapped composite tanks with metal liner
Part 4: Particular requirements for fully wrapped composite tanks with metal liner
Part 5: Particular requirements for fully wrapped composite tanks with non-metallic liner
ISO/DIS 17268 Gaseous hydrogen – Land vehicle filling connectors (based on SAE J2600)
ISO/ DIS 21009- 1 Liquid hydrogen storage
Globally Harmonized Standards

International working draft and committee drafts, etc. – ISO/TC197

**Working Drafts:**
- ISO/WD 22734 Hydrogen generators using water electrolysis process
- ISO WD 13986 Tank containers for multimodal transportation of liquid hydrogen

**Committee Drafts:**
- ISO/CD PAS 15594 Airport hydrogen fuelling facility
- ISO/ CD 22734 Electrolyzer
- ISO/CD 24490 Cryogenics pump

**Draft Publicly Available Specification:**
- ISO/PRF TR 15916 Basic considerations for safety of hydrogen systems

**Proposed New Work Items:**
- ISO/AWI 16110 Hydrogen generators using fuel processing technologies
- ISO/AWI 16111 Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride
- ISO/TC 197 NWIP N 253 Dispensing Unit
- ISO/NP 20012 Gaseous hydrogen and hydrogen blends — Fuelling stations (Draft Technical Specification)
The distribution and delivery of Hydrogen through pipelines, liquid bulk, and cylinders is well known in the industries as well as industrial filling installations. Major difference in Hydrogen Energy is environment (urban sites, public) and New Technologies required for improved performances (autonomy, fast filling).

Today environmental policies are not very well harmonized between European Countries (e.g. Safety distances around LH$_2$ storages) whereas a lot has been achieved in transport policies through EEC Directives as well as UNECE global approach for vehicles.

Developing infrastructures for Hydrogen supply will require:

• Better harmonisation and standardisation in risk assessment analysis methodology - worst case accident scenarios
• Standardisation for implementation of new technologies and new components
• To improve feed back coming from Hydrogen projects
• Sharing and harmonisation of RC&S programs between Europe, USA and Japan

Source: Air Liquide
Approval of Hydrogen Refuelling Infrastructure

Approach for development of ISO Standards for Hydrogen

Sources: Norsk Hydro - 2003
Implementation of Stationary H₂&FC Equipment

Local implementation will always have to follow also local requirements

Normally the approval process takes several months and includes the following steps:

- Application for authorization
- Response from the authorities: A permission document with detailed description of all requirements
- Public hearing of the permission document
- Permission to build / establish the facilities
- Inspections of the established facilities, by Public Authorities / Notified Body
- Approval of the facilities and permission to operate

Authorities involved in the approval process are normally:

- Environment Authorities
- Fire and Explosion Authorities
- Municipal Building Authorities
- Civil Work Authorities

Important aspects regarding authority approval

- Relevant national regulations
- Risk analysis
  - knowledge about hydrogen safety related properties not yet fully explored
  - relevant operation and accident statistics missing or insufficient
- CE marking
  - dependent on risk analysis, testing and operation experience

Licences, permits, and certificates:

- Building licence
- Environmental licence
- Operational licence
- CE certificates (which includes detailed documentation of the equipment)
- Third party inspection document / certificate

Documents assisting local implementation in Europe:

EIHP2 Working Draft, Rev.3– Gaseous Hydrogen Vehicle Refuelling Stations
EIAG Document IGC 15/96/E (gaseous Hydrogen Installations)
Planned: HyApproval - Handbook for certification of public H₂ filling stations
**Recommendations**

Desirable Future Scenario For Regulations & Standards

- Legal requirements should be created only where necessary
- GTRs should refer to available ISO/IEC standards
Recommendations

Clear Vision of a Pathway to a GTR for H₂/FC Vehicles*

Onboard storage-related issues ⇒ Two ECE ⇒ GTR
Regulations under the 1958 Agreement (with limited lifetime)

Target date for a regulation 2006

Rest of H₂-Vehicle (FC, Safety in normal & crash conditions; Fuel Consumption; etc.) ⇒ ⇒ ⇒ ⇒ GTR
under the 1998 Agreement (referencing ISO, IEC)

Target date for a regulation 2010

* (still under discussion in the UNECE GRPE Informal Group on Hydrogen/Fuel Cell Vehicles)
Recommendations

H₂/FC Components/ Stationary Equipment - International standards

ISO and IEC standards are required for:

• H₂ production equipment ⇒ ISO/TC 197
• Service stations ⇒ ISO/TC 197
* Filling connectors ⇒ ISO/TC 197 and ISO/TC 22
• Fuel cells ⇒ IEC/TC 105
* Onboard H₂/FC equipment ⇒ ISO/TC 197, ISO/TC 22 and IEC/TC105
• Others

* For hydrogen, ISO/TC 197 will work with other TCs in joint working groups.
Conclusions and Recommendations

How to successfully harmonize R&S globally?

- do not re-invent the wheel
- join forces internationally in the largest automotive markets (Europe, USA, Japan, China)
- use existing regulatory and standardization bodies (UN, ISO, IEC) with active participation of all stakeholders
- avoid misunderstandings and misperceptions as early as possible
- avoid duplications and contradictory/ inconsistent approaches
- for implementation of stationary hydrogen equipment learn from requirements by local authorities all over the world (e.g. fire authorities, work safety authorities, environmental authorities)
Thank you for your attention!

For upcoming information please visit

www.EIHP.org

www.HyWays.de