

# European Integrated Hydrogen Project - Phase 2 - Results

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Presentation by Reinhold Wurster,  
L-B-Systemtechnik GmbH

On behalf of the *European Integrated Hydrogen Project EIHP2* **EIHP**



# Hydrogen Fuelled Vehicles - Challenges to be Resolved



**TÜV**

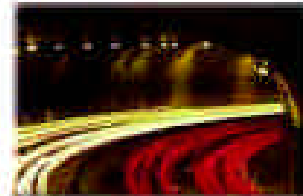
Vehicle  
licensing



Filling Station



Parking,  
Garaging



Tunnels



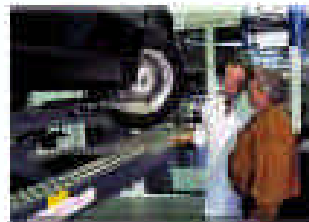
Data Transmission



Emergency  
Services



Accidents



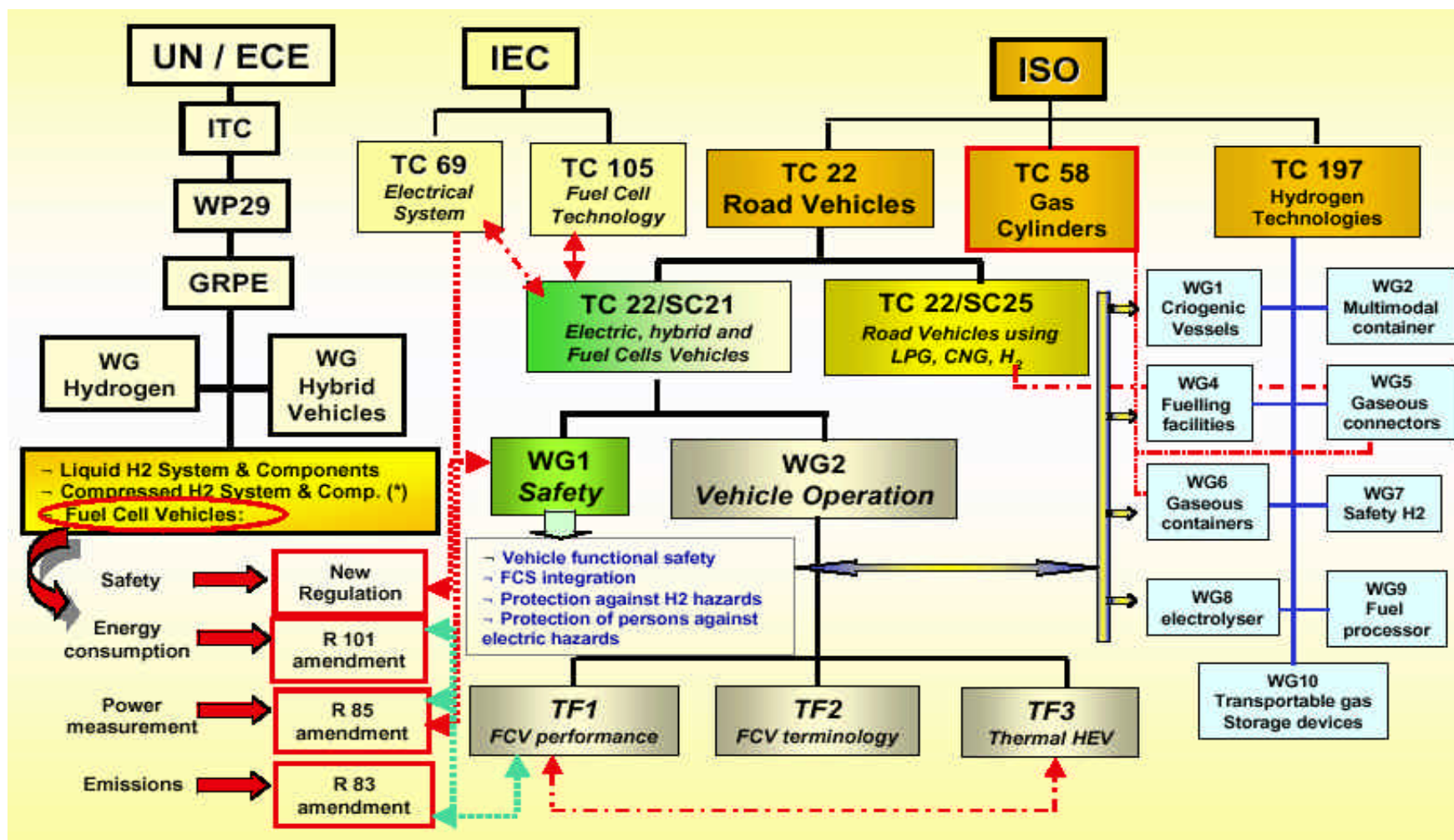
Repairs/maintenance



Service



# International Landscape of Vehicle Legal Requirements and Standards



# European Integrated Hydrogen Project - Objectives

**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 fuelled 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**



# Results Achieved in EIHP2

**WP1: Overall Co-ordination** - EIHP2 webpage at <http://www.eihp.org>

## **WP2: Refuelling Station**

- Input to risk assessment studies, risk reducing measures and recommendations of aspects to be addressed in future development of regulations and standard
- Gaseous hydrogen vehicle refuelling stations – guideline for designers and operators
- Risk based maintenance and inspection protocol for hydrogen refuelling stations

## **WP3: Refuelling Interface**

- It was concluded that for non-articulated single deck city buses an on-board storage pressure between 20 and 35MPa is the optimum
- Better understanding of the thermodynamic flow phenomena occurring during the filling at high pressures and software development for a better definition of the tank filling process and a better tank design procedure
- Different LH<sub>2</sub> refuelling procedures have been examined considering requirements and different fuelling concepts while testing nozzles and considering different operating parameters



## Results Achieved in EIHP2 (2)

### WP4: Vehicle

- Initiating discussions at GRPE (working party on pollution and energy, subsidiary body of WP.29 the world forum for harmonisation of vehicle regulations, member of UNECE) regarding ECE/GTR. Work on the draft ECE regulations has progressed to the most advanced state possible by supporting the GRPE Informal Group on H<sub>2</sub>/FCVs.
- Both the LH<sub>2</sub> draft and the CGH<sub>2</sub> draft have now reached the status of official documents at GRPE and could be forwarded to WP.29 for political voting
- In terms of periodic inspection a draft amending the directive 96/96/EC has been created and prepared for forwarding to ACEA/OICA (European/world association of automobile manufacturers) in order to start the approval process
- Storage systems for liquid and compressed gaseous hydrogen have been manufactured and their safe and reliable functioning has been proved
- Automobiles using these H<sub>2</sub> storage systems have been developed or are currently progressing through the design phase
- Several meetings/ workshops were attended: a workshop with US authorities, several meetings with ISO TC 197, meetings with ISO and GRPE, a workshop with ELEDRIIVE, attendance to the launch of the European H<sub>2</sub> Technology Platform

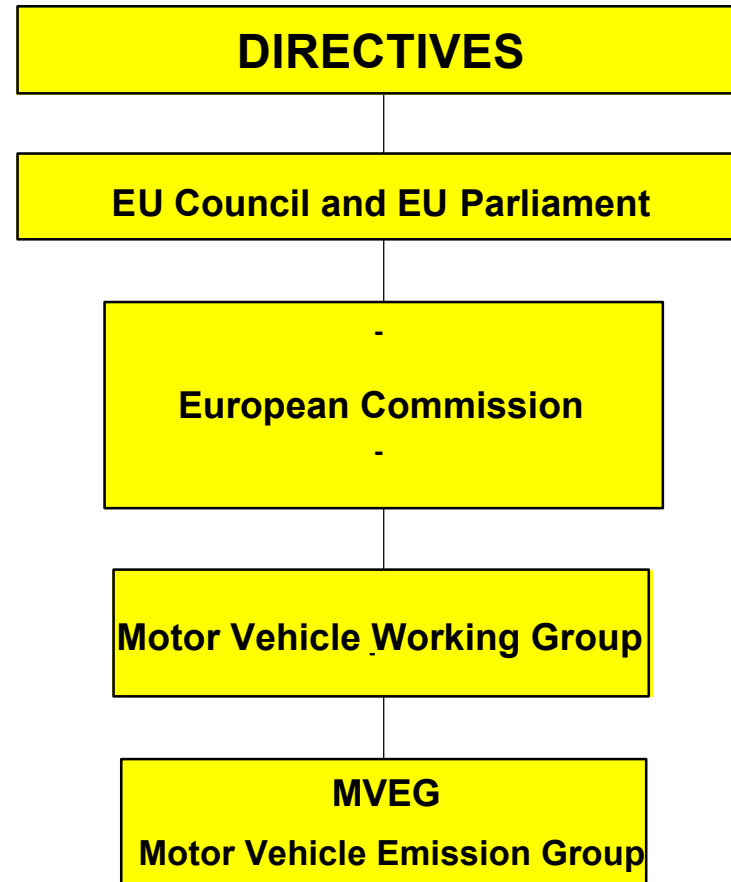


# Two Pathways to Present a Proposal for a Regulation

## UN-ECE



## EC

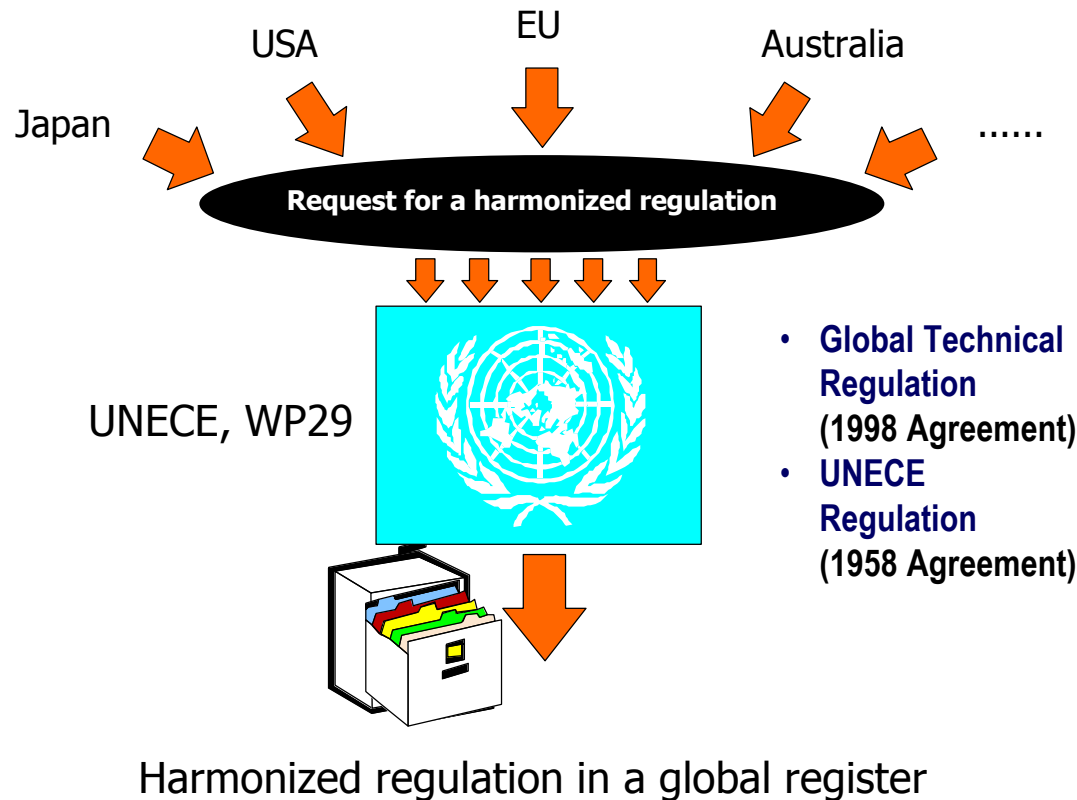


**Binding for WVTA** (Valid for: EU)



# Globally Harmonized Vehicle Approval - Existing Agreements

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



### 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**:

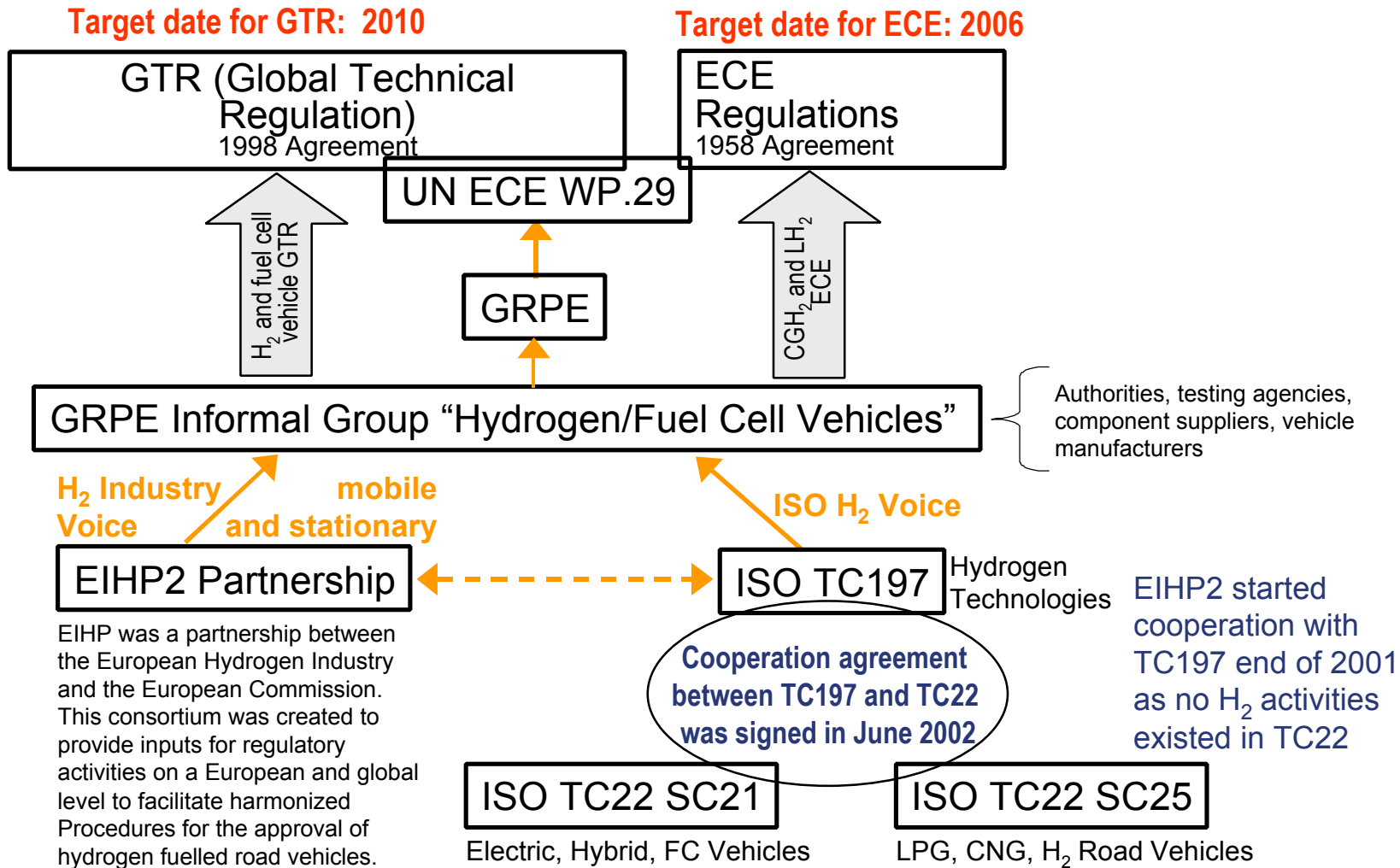
[(E/ECE/TRANS/132 AND Corr.1)]

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

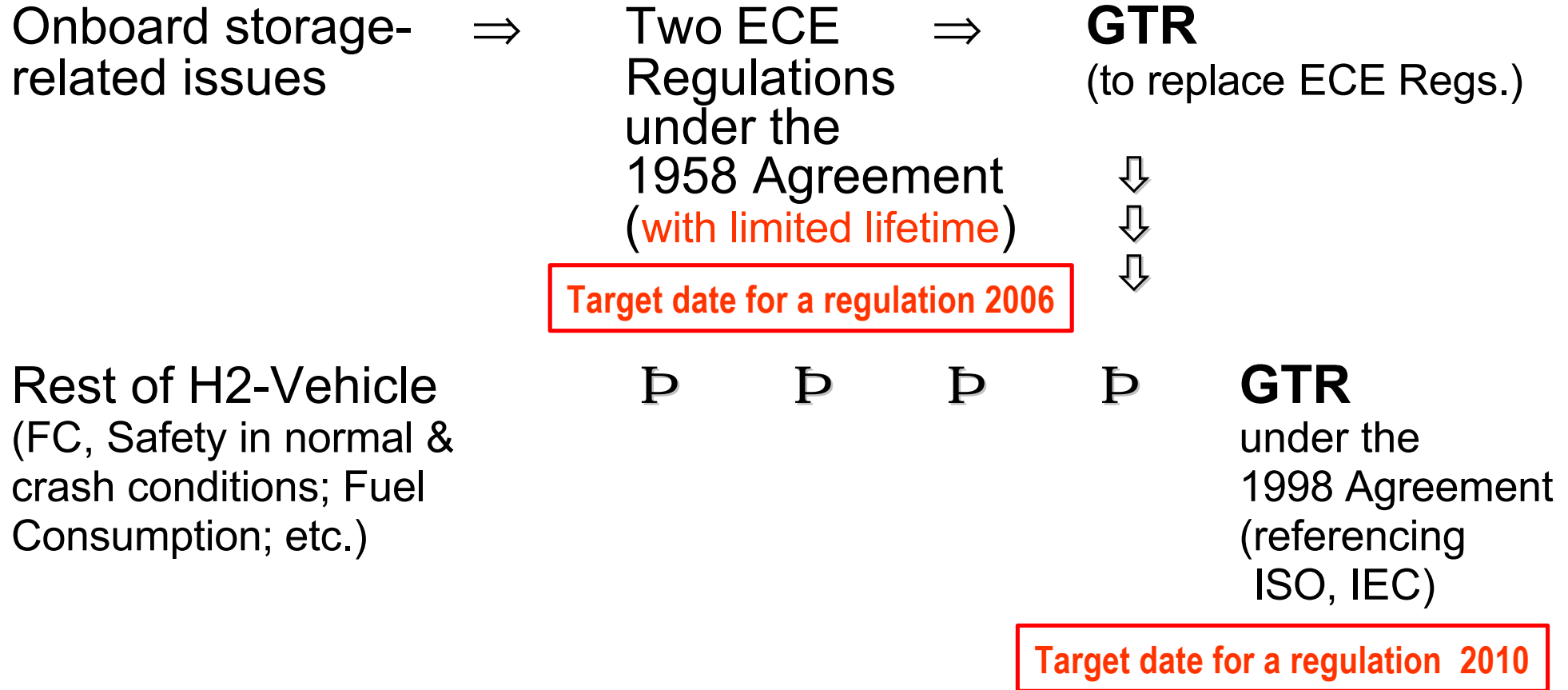




# Globally Harmonized Vehicle Approval – Possible Pathway



# Globally Harmonized Vehicle Approval – Parallel Development



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



# Globally Harmonized Standards - an Example

Example: CGH<sub>2</sub> Filling Connector

EIHP2 provided comments to the development of the national US standards and support to ISO/TC197 to transfer it into an international ISO standard

SAE J2600 ⇒ ISO/DIS 17268

Gaseous hydrogen – Land vehicle filling connectors



# Results Achieved in EIHP2 (3)

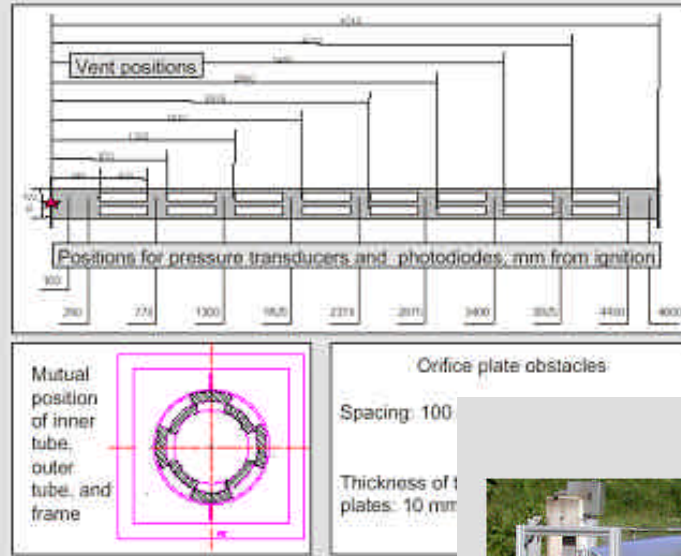
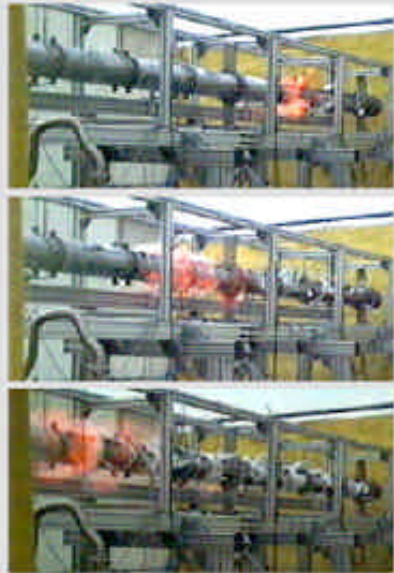
## WP5: Safety

- In WP5.1 a **state of the art review** of existing safety data of hydrogen and other fuels reached the conclusion that a ranking of the relative safety of different fuels will depend on each specific application and potential accident scenario.
- In WP5.2 a **Rapid Risk Ranking (RRR) methodology** was developed and applied to different re-fuelling station concepts, identifying risk-reducing measures. Acceptance criteria for hydrogen re-fuelling station risk analysis were also developed. Recommendations for standards and codes of hydrogen re-fuelling stations were identified.
- In WP5.3 the **numerical simulation of various hydrogen release scenarios for commercial vehicles** was performed. The work has proven CFD modelling techniques to be a useful tool for investigating the release of hydrogen in real world situations
- In WP5.4, an **extensive experimental programme** was completed in order to improve the understanding and knowledge of gas combustion (hydrogen, methane and propane) in semi-confined geometries.
- In WP5.5. the **comparative study of hydrogen and other fuels** has shown that the accident consequences depend strongly on the initial and boundary conditions. Therefore each scenario requires a separate analysis. For the worst-case scenarios that were considered in the analysis such as the combination of large hydrogen release rates in confined environments, mitigation and risk-reducing measures have to be developed.



# EIHP2 Combustion Tests in Semi-confined and Vented Tubes

Tests in vented tube

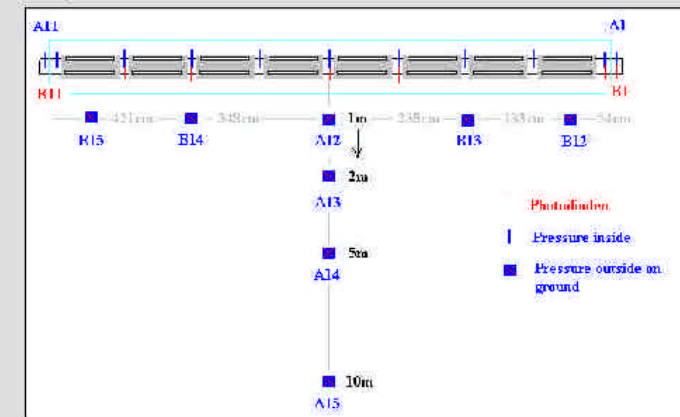


Supporting experiments on safety implications of hydrogen use in road transport

Tests in semi-confined geometry



Positions for pressure transducers and photodiodes. Top view.



Source: FZK in [www.eihp.org](http://www.eihp.org)



## Results Achieved in EIHP2 (4)

### WP6: Links "EU-USA" + other Cluster Activities

- Various US bodies including DoE and IHIG are now fully aware of the role and purpose of EIHP. This has been enabled by the unique ability of global companies to span regional divides
- Initial meetings with delegations from the Japanese Electric Vehicle Association and the Japanese Hydrogen Forum have provided a useful first view of the RC&S landscape in Japan
- Summaries of RC&S activities in Europe and the US have been produced and a preliminary high-level gap analysis of European C&S for hydrogen infrastructure has been carried out and shared with key stakeholders in the US

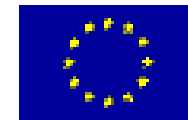
### Some high level conclusions resulting from the above initiatives are stated here:

- The leadership of the DoE in the US has provided a much-needed framework for RC&S activities in the US which is enabling a focused approach
- Japan is viewed as the most advanced and coordinated with respect to RC&S activities, driven by their desire to commercialise hydrogen vehicles in 2005
- EIHP2 is viewed as a significant strength within Europe by the US but the view still persists that its main function is to create competitive advantage
- Comparison of US and EU gap analyses for infrastructure RC&S activities reveals a great deal of similarity in key areas requiring progress. This is a good basis for future international collaboration.



## Further Work on Safety and RC&S Initiated from EIHP2

- EC-funded Network of Excellence “Safety of Hydrogen as an Energy Carrier” - HySafe
- UNECE GRPE Informal Group "Hydrogen/ Fuel Cell Vehicles" [<http://www.eihp.org/unece/index.html>]
- HarmonHy - Harmonization of Standards and Regulations for a sustainable Hydrogen and Fuel Cell technology
- Expression of Interest “Hyapproval” Handbook for certification of public hydrogen filling stations



# Conclusions from EIHP2 on RC&S

- ⇒ 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 of local authorities all over the world (e.g. fire authorities, work safety authorities, environmental authorities) responsible for issuing permits





# Thank You !

## Thank you for your attention!



For the **Final Report** and for **any upcoming information** please visit

[www.EIHP.org](http://www.EIHP.org)

