



**STORHY**  
Train-IN 2006

## Session 1.4: Introductory Lectures

Automotive Design Aspects and  
Requirements  
J-F. Ranjard

25<sup>th</sup> – 29<sup>th</sup> September 2006  
Ingolstadt





## 1.4 Automotive Design Aspects and Requirements

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Responsible for H<sub>2</sub> activities for the last 4 years within the PSA Fuel Cell Program:

- H<sub>2</sub> storage mainly compressed H<sub>2</sub> storage systems but also advanced storage materials.
- H<sub>2</sub> safety issues for the overall vehicle including H<sub>2</sub> storage and FC systems.
- H<sub>2</sub> production and distribution.



## 1.4 Automotive Design Aspects and Requirements

- Main Safety Challenges of Onboard High Pressure Hydrogen Storage,  
J-F. Ranjard (PSA)

### Abstract:

Public acceptance of H<sub>2</sub> as a new fuel will be strongly linked to the industry ability to ensure high level of safety for their H<sub>2</sub> powered vehicles. This issue is even trickier regarding high pressure H<sub>2</sub> storage since H<sub>2</sub> inflammability risk is not alone and comes with high pressure risk.

Our role is to minimize both risks through vehicle integration, H<sub>2</sub> architecture and safety components.

The high pressure is mainly managed by a burst safety ratio of tanks defined by regulation and becomes the main issue in case of fire.

Other issues are related to H<sub>2</sub> leaks management in normal vehicle use and in case of vehicle crash or H<sub>2</sub> storage system dysfunction: onboard monitoring, detection and possible actions are still studied.



## Table of Content

- **High pressure management in case of fire.**
- **Hydrogen leaks management.**
- **Onboard H<sub>2</sub> storage system monitoring.**
- **Conclusion.**



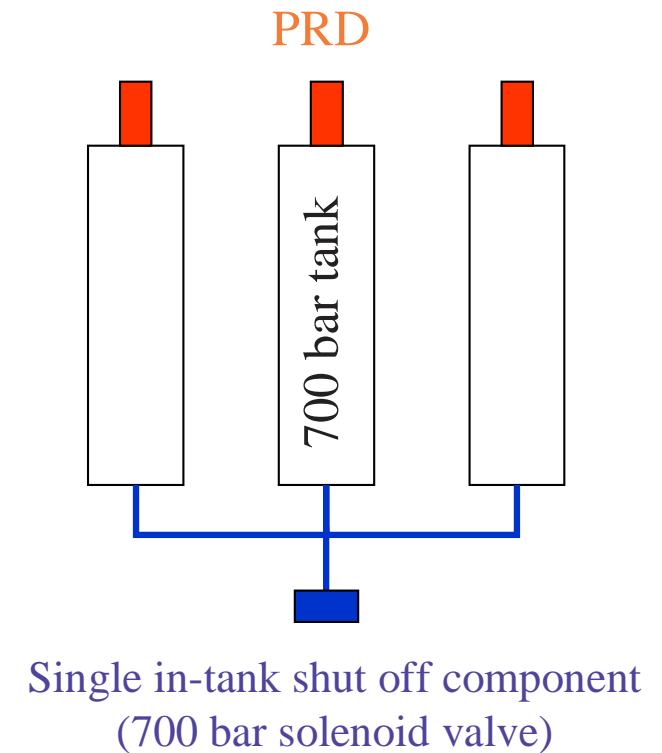
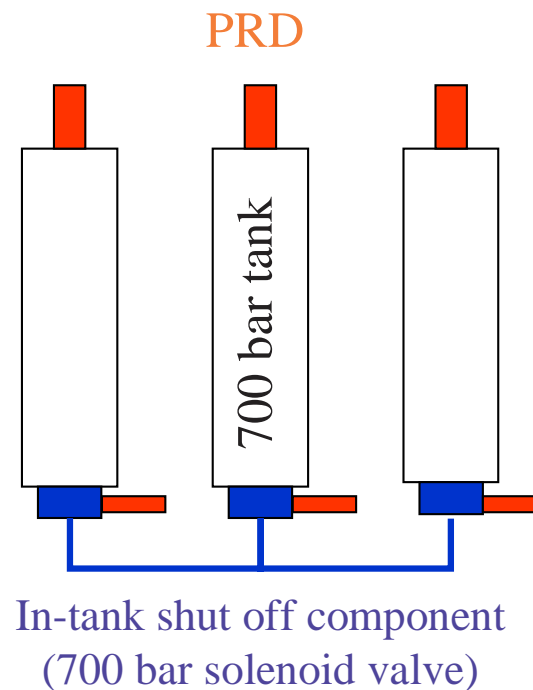
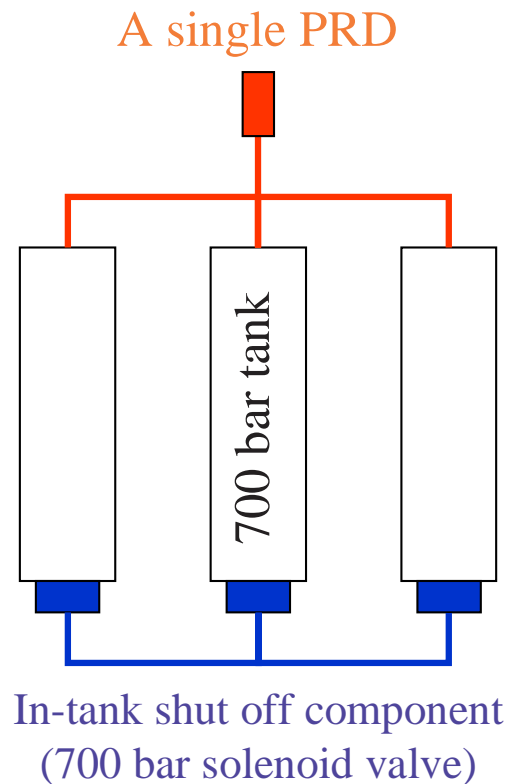
## High Pressure Management in case of fire:

- **Current strategy is to release H<sub>2</sub> to the atmosphere through a thermally activated device in order to avoid any cylinder burst considered as more dangerous than H<sub>2</sub> combustion or explosion.**
- **Remaining challenges are:**
  - **Pressure Relief Device (PRD) reliability.**
  - **Number of PRD (one per cylinder?) and position.**
  - **PRD high pressure line management in case of rupture.**
- **Other strategy should be further studied like storage system protection against fire.**

# Main Safety Challenges of Onboard High Pressure Hydrogen Storage

## High Pressure Management in case of fire: a real dilemma !

- Only one PRD and dedicated HP line between tanks: in-tank shut off component can be used.
- One PRD per tank and HP line between tanks: with in-tank shut off component it's like with a single PRD and without in-tank shut off component a H<sub>2</sub> leak on the HP line may not be stopped.





## **H<sub>2</sub> external leakage management:**

- **Common issue to all H<sub>2</sub> systems: H<sub>2</sub> components can be chosen regarding their tightness performance.**
- **Vehicle integration must avoid any H<sub>2</sub> accumulation (ventilation is required).**
- **Unexpected H<sub>2</sub> leakage (component failure or rupture) must be detected through Pressure Transmitter (PT) and/or H<sub>2</sub> sensors:**
  - **PT might not detect a small failure.**
  - **Current H<sub>2</sub> sensors are not suitable for automotive application (response time, selectivity and stability).**



## Main Safety Challenges of Onboard High Pressure Hydrogen Storage



- **After detection of abnormal H<sub>2</sub> concentration in the atmosphere or crash occurrence, the system must be able to shut down H<sub>2</sub> flow. H<sub>2</sub> should be kept safely inside the cylinders and high pressure H<sub>2</sub> line should be isolated to reduce potential H<sub>2</sub> leaks:**
  - **700 bar in-tank solenoid valve suitable for automotive requirements is not available.**
- **Permanent detection might be required during lazy state of the vehicle:**
  - **Energy consumption may be too high.**
  - **What can be done if abnormal H<sub>2</sub> concentration is detected?**



## Main Safety Challenges of Onboard High Pressure Hydrogen Storage



- **Reliable onboard H<sub>2</sub> storage system (cylinder, connection, valves...) monitoring would help to get adequate maintenance operations:**
  - **It would be safer since a component could be changed before the rupture.**
  - **It would help to reduce cost with since lowered safety ratio.**



## Conclusion

- **No insurmountable drawbacks.**
- **More engineering challenges even if some 700 bar components are still not available.**
- **Main challenge: high pressure management in case of fire.**



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