

Achievements of the EC Network of Excellence "HySafe" Thomas JORDAN

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Networks of Excellence (NoE)?



NoE HySafe Objectives

- strengthen and focus, integrate fragmented research on hydrogen safety
 - → competitive scientific and industrial community
- Promoting public awareness and trust in hydrogen technologies
- development of an excellent safety culture

General Goal

Contribute to a safe transition to a sustainable development in Europe by facilitating the safe introduction of hydrogen technologies / applications

NoE HySafe - Integration of the EU Hydrogen Safety Research

Consortium

- 23 partners from 12 European countries
 + Kurchatov Institute, Russia + University of Calgary, Canada
- 13 research institutes, 7 industry partners, 5 universities
- ~150 scientists actively involved

Budget Total ~ 14 M€ ; EC grant ~ 7 M€

Time frame: 03/2004 - 02/2009

Key integration result: *"International Association for Hydrogen Safety - HySafe"* (Non profit, self-funded, Belgium based)

INERI

HySafe's Integration Activities Work packages, clusters, projects





Cluster Research Activities Related to Integration of Experimental



Facilities

MISTRA

cylindrical steel vessel

originally designed as 1/10th in linear scale of Pressurized Water Reactor containment

studies of H2 (simulated by He) release and distribution in a confined geometry

Free online catalogue (here just 6 out of > 100)^{ressures}

GexCon 168 m³ open geometry with internal obstructions

explosion vessel

large scale (168 m³)

studies on explosions in open, congested geometries





366m gallery/tunnel

Concrete test

enclosure/tunnel

V1. V2 and H4. H5

REKO-2







A1 Vesse

studies on turbulent combustion and detonations, vented explosions, hydrogen distribution, integrity of mechanical structures under high pressure load

Cluster Activities Integration Workshops "Experiments"



- to become more acquainted with the partners' experimental activities

- to share knowledge in the field of experimental work
- to support jointly planned and performed experiments

Achievements

- Eight 2-3 day workshops (2005-2008, biannual)
- Topics: practical aspects of experiments, measurement techniques, data acquisition and safety
- Technical facility tours
- Initiation of joint internal studies





Internal Project "InsHyde" addressing the priorities



- Investigation of realistic non-catastrophic releases in (partially) confined areas
- Determination of permeation and release limits
- Systematic assessment of mitigation (including detection) measures (sensors + venting + recombiner...)
- Simulations and experiments for critical releases
- Deriving "Recommendations",
 → see deliverable D113
- Proposing a dedicated EC project "HyGarage" (lead NCSRD)







"InsHyde" – Permeation Survey on Existing Allowable Rates



- Draft UN ECE regulation (EIHP draft & possibly the basis of the EU Regulation) and superseded versions of draft ISO/DIS15869:
 - For Type 4 containers, the steady state permeation rate < 1.0NmL/hr/L internal vol.
 - The test is conducted at ambient temperature and nominal working pressure.
- > ISO/DIS 15869.2 & .3:
 - For Type 4 containers, the steady state permeation rate < 2.0NmL/hr/L water capacity at 35 MPa, and 2.8NmL/hr/L water capacity at 70 MPa.
 - The test is conducted at ambient temperature and nominal working pressure.
- > SAE J2579, Jan. 2008:
 - The steady state hydrogen discharge rate due to leakage and permeation from the hydrogen storage system shall not > 75NmL/min <u>at 85°C</u> and nominal working pressure for a standard passenger vehicle.
 - The rate may be increased in proportion to the enclosure volume for large vehicles.



HyTunnel - Experimental Layout

Objective:

Critical conditions for FA and DDT in semi-confined gas mixture layer

Expected data: Dependence of critical σ^* and λ^* on gas layer height δ

I – ianition point: L=12 m P. I – pressure and light gauges. L = 12 m - A1 length;D = 3.5 m - A1 diameter: $V = 100 \text{ m}^3$ (+30 m³)– total volume; BR = 0.6 (0.3) by obstacle laden grid P, 1 C_{H_2} –hydrogen concentration; δ – layer thickness CH2

HySafe

Some results of the experimental program



Hydrogen stratified layer experiments completed by FZK:

- Summary included in HyTunnel Deliverable D62
- Full report in deliverable D87
- 10 experiments conducted



Accident Database HIAD

Collecting experience



Education and Training Offers Academic and industry level



Progress in Hydrogen Safety



FAQS

Staff





Further courses in 2008/2009 series Hydrogen regulation, codes and standards January 2009

Safety of hydrogen fuelled vehicles April 2009

The hydrogen and fuel cell infrastructure June 2009



Supported by

Hydrogen Safety Engineering and Research, University of Ulster

Dissemination via the unique conference

Pisa September 8-10,

Probria

CORT

Vizzavona

Sartàna

BONIFACIO

lenza

Porto

lecchio



Hus

ITSafe ICHS

2nd International Conference on Hydrogen Safety

International Conference on Hvdrogen Safety



CHS





the Hadroom Long

Contact: ICHS@hysafe.org **INTERNATIONAL CONFERENCE ON HYDROGEN SAFETY**

STORH

Hydrogen Safety, Codes and Standard Program

Italian National Firecorps

Canadian Hydrogen

Safety Program

IMPLEMENTING AGREEMENT

ATURALHY

HyFLEET: CUTE

uscany Keolo

120 Deliverables Selected list of the 65 public reports generated



No	Title	<u>WP</u>	Lead
D9	Report on compiled facility descriptions	WP2	FZJ
D22	Report on Specification and definition of the HySafe - Hydrogen incident and accident database cont	WP5	DNV
D23	Status report on compilation of results of SBEPs	WP3	UPM
D24	Report on phenomena / scenario ranking	WP4	CEA
D25	Report on CFD models in the simulations of the problems related to H2 safety.	WP6	FZK
D26	Summary on HySafe Risk Assessment methodologies/approaches including and priorities	WP12	DNV
D27	Sub-task 16.3 List of authorities	WP16	INERIS
D31	Proceedings of the first ICHS	WP14	UNIPI
D33	Website presentation of the facilities	WP2	FZJ
D34	Report on available information including existing standards for bonfire tests of H2 tank structures	WP9	BAM
D41	Database of Literature on Hydrogen Safety	WP1	INERIS
D44	Report describing established definitions and classifications of incidences and accidents	WP12	DNV
D51	Second Status report on code validation and applicability based on the results of SBEPs	WP3	FZK
D54	Report on sensor evaluation	WP11	INERIS
D64	Report on HZ methodology for H2 including calculation examples	WP12	NH
D66	Report on CFD code validation (SBEP)	WP6	GEXCON
D75	List of Basic Test Problems	WP6	FZK
D80	The 1st "HySafe Hydrogen Accident Statistical Report"	WP5	DNV
D81	Specifications of the set of SBEPs for the 4th period	WP6	FZK
D84	Report on internal safety distances	WP12	DNV

Final Integration



A huge majority (21 / 24) NoE partners founded the International Asociation HySafe (see ww.hysafe.net/IAHySafe)

hysafe INTERNATIONAL ASSOCIATION FOR HYDROGEN SAFETY

International focus of Hydrogen Safety Research

- Research Coordination
- International Conference on Hydrogen Safety ICHS
- Education and Training
- Biennial Report on Hydrogen Safety BRHS
- Hydrogen Incidence and accident database HIAD





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The network is contributing to the implementation of the Key Action "Integrating and strengthening the ERA" within the Energy, Environment and Sustainable Development.

Thanks to all HySafe colleagues...

... and thank you for your attention.

