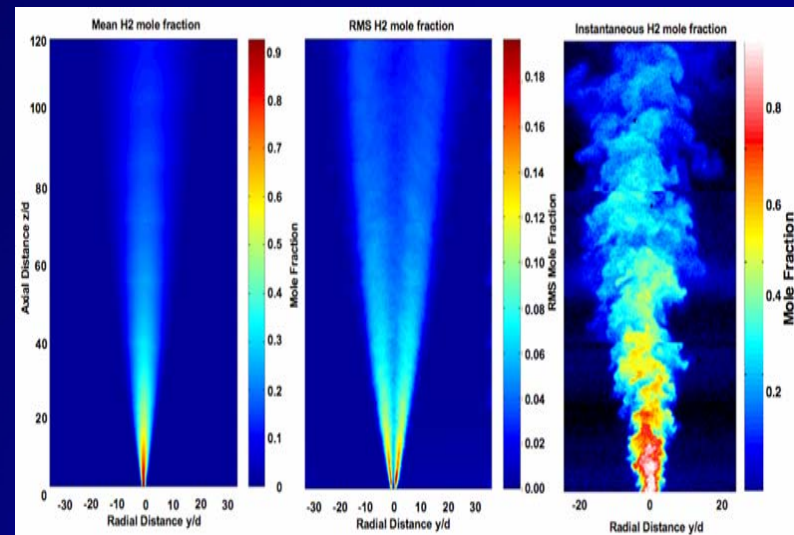


International Energy Agency Hydrogen Implementing Agreement

Executive Committee Meeting
Essen, Germany – May 21, 2010

Task 19
Hydrogen Safety

Bill Hoagland



Participants

- Canada
- EC/JRC (2004-2007)
- France
- Germany (2007-2010)
- Greece (2007-2010)
- Italy
- Japan
- The Netherlands
- Norway
- Switzerland (2007-2010)
- United Kingdom
- United States



Task Management

- Operating Agent – **Bill Hoagland**
(funded by Canada and United States)
- Subtask A, Risk Management
Angunn Engebø (Norway)
- Subtask B, Experimental research/testing
Mark Royle/Deborah Willoughby (UK)
- Subtask C, Information
Steven Weiner (United States)



Overall Goal

To **reduce or eliminate the safety related barriers** to the widespread commercial adoption of hydrogen energy systems through a collaborative program of:

1. **Risk Management** (QRA, modeling, mitigation)
2. **Experimental research** and testing; and
3. **Information dissemination**



Task 19 Logical Approach

- Existing information
- Incidents DB
- RA methodologies
- Frequency data
- Probability data

**Subtask A
Risk
Assessment**



**Subtask B
Experimental
Testing**

- Knowledge Gaps
- Testing methods
- Databases
- Raw data
- Consequences
- Mitigation effects

Subtask C. - Targeted Information Packages

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Desired Outcome:

Technically sound and credible basis for *Risk Informed Codes and Standards*

That:

- Are **not unnecessarily restrictive**
- Allow **informed choices of design**
 - Most economic mitigation measures, equipment and safety factors
- **Can be modified** to meet national requirements
- Facilitate **approvals, permits and insurability**

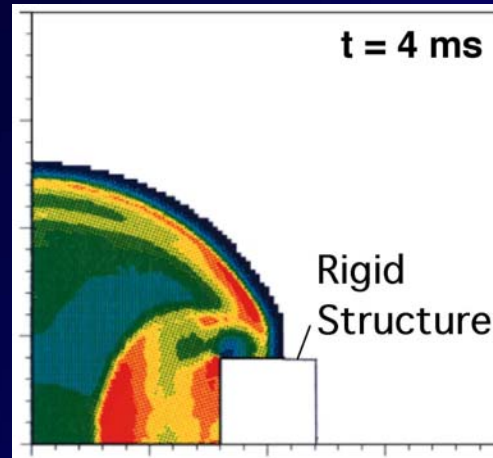


Scope 2004-2010

Fundamental Data



Modeling



Component Testing

Mitigation



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2004-2007 Research Directions

- **QRA analysis**
 - Robust uncertainty/sensitivity analysis
 - Examine all risk prevention and mitigation measures
 - Separations distances, mean time between failures, walls, maintenance schedules, redesigns ...
 - Analysis of hydrogen infrastructure
- **Experimental data**
 - Barriers
 - Ignition, Flammability
 - Auto-ignition, turbulent flame stability, ...
 - Unintended leaks in confined areas
 - Garages (domestic and parking), tunnels, ...
 - Liquid spills and leaks

2004-2007 Research Directions

- **Wall jets:**
 - Effects of horizontal and vertical surfaces on horizontal and vertical jets flammable extents, thermal flux and pressure effects
- **Hydrogen venting:**
 - Chamberlain thermal effects model update for hydrogen
 - Vent stacks, flow rates, velocities sized for commercial hydrogen release scenarios
- **Outflow modeling:**
 - Hydrogen dispersion
 - Hydrogen release from metal hydride storage and comparison with compressed gas storage releases

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Planned Work Products

- Demonstrate International Leadership by:
 - Establishing a Task 19 endorsed risk-informed methodology for CDO's to use as a template in evaluating risk prevention and mitigation measures
 - Establish a database that has been vetted by the technical community (refereed literature)
 - Position Paper
 - White Papers
 - Forums/Workshops

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Activities Since Last ExCo

- Planning and completion of current task work products
- Definition of new subtask
- Scheduled task experts meeting in conjunction with ICHS4 Scientific Committee meeting in Rome April 21-23
- Task experts meeting in Essen 19 May



New Task Proposal

Hydrogen Safety Research and Risk Management Tools

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New Task on Hydrogen Safety

- **Logical progression** of current Task 19
 - Continues to fill knowledge gaps/database
 - Further develops risk informed criteria and simplified methodologies
- More focused on **real systems**
- Expanded to **stationary systems**
- Products that are focused on **stakeholder groups** (approval authorities, insurers, public and system developers)

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New Task Definition

I. Physical phenomena and knowledge gaps:

Outflow and dispersion

A) Gaseous phase properties

Surface effects : Experiments and theory,
Turbulence, Crosswinds and jet properties

B) Liquid phase properties

D) CFD validation and information exchange



New Task Definition

II. Consequences and ignition

- A) Auto-ignition
- B) Ignition modeling
- C) Thermal radiation in the presence of a crosswind : experiments and further development of engineering correlations
- D) Additional work on overpressure and explosions



New Task Definition

III. Materials safety issues

- A) Safety issues arising from solid state storage (metal hydrides, chemical storage, adsorption)
- B) Materials issues with respect to pressurized and low temperature storage (liquid, cryo-compression)
- C) Sensors/leak detection



New Task Definition

IV. Early markets hazard analysis and risk characterization

- A) Failure statistics
- B) Further development in safety assessment and hazard analysis
- C) Systems safety analysis of forklift facilities, portable applications, distribution infrastructure (pipelines)



New Task Definition

V. Knowledge analysis, dissemination and global relevance:

- *Outreach (knowledge analysis and recommendations) to relevant ISO and IEC standard development activities:*
 - *Update of ISO/TC 15916 Basic considerations for safety of hydrogen systems*
 - *Contribution to ISO 20100 international standard development for hydrogen refueling stations*
 - *Hazardous areas – link with IEC TC 31*
- *Database maintenance of products resulting from Task 19*



Participation

Current Members

- Canada
- France
- Germany
- Greece
- Italy
- Japan
- The Netherlands
- Norway
- Switzerland
- United Kingdom
- United States

New

- EU/JRC
- Brazil
- FM Global
- Air Liquide
- Shell
- Finland
- Korea
- ...



Work Plan

- **Match** new work to participants' programs and capabilities
- Determine **participation** (who and LOE)
- Fix task **structure**
- Assign **subtask leaders**
- **Schedule**, milestones and products



Summary Status/Schedule

- Task received ExCo approval to begin task definition at Seville ExCo meeting
- Task Definition/Proposal presented to ExCo at Essen meeting
- Work Plan by October 2010
- Full approval at Fall ExCo meeting
- NPL's January 2011



Summary

Action Items

- Completion of **Work Products**
 - HyTEX database
 - QRA methodology
 - Position papers/White papers
 - Final report
- **New Task** Definition
 - Task Structure
 - Task Participation
 - Work Plan/Information Plan



Summary

- Problems
 - None
- Items requiring ExCo Action:
 - Approval of new task pending submission of an acceptable work plan



Thank You

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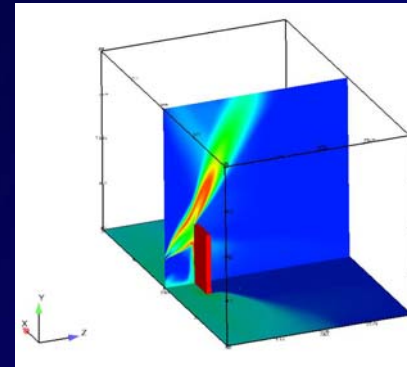
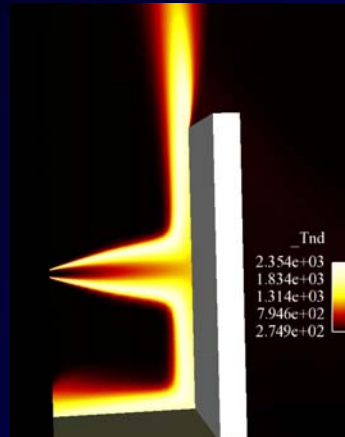


Full-scale jet flame impingement experiments provided valuable insight on barrier behavior as well as modeling validation data.

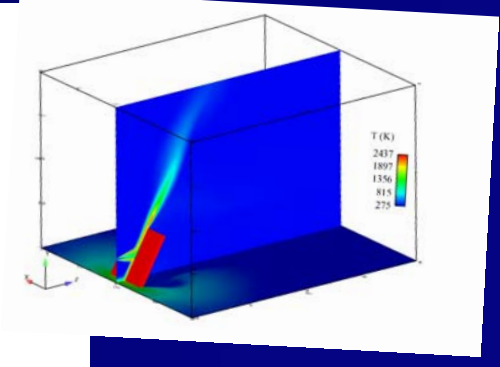
Experiment



Simulation



Vertical Wall - +45deg impingement

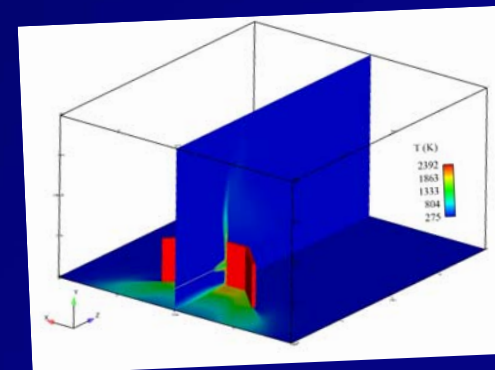
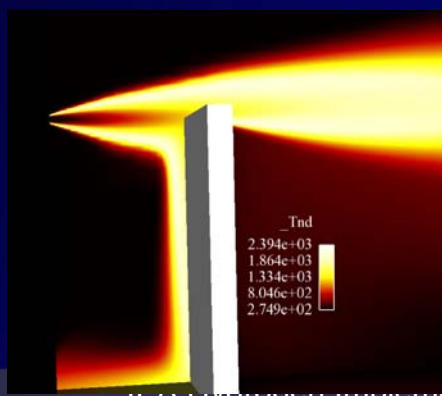


60° Tilted Wall

Experiment



Simulation



3 Wall Configuration (135° between walls)

IEA Hydrogen Implementing Agreement ExCo meeting, San Francisco, May 27-29, 2009





IEA Hydrogen Implementing Agreement ExCo meeting, Essen Germany, May 21, 2010

