



U.S. DEPARTMENT OF  
**ENERGY**

# **Hydrogen Safety, Codes & Standards**

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**2006 DOE Hydrogen Program  
Merit Review and Peer Evaluation Meeting**

**May 19, 2006**

# Goals and Objectives

**Safety:** Develop and implement the practices and procedures that will ensure safety in the operation, handling and use of hydrogen and hydrogen systems for all DOE funded projects and to utilize these practices and lessons learned to promote the safe use of hydrogen throughout the emerging hydrogen economy.

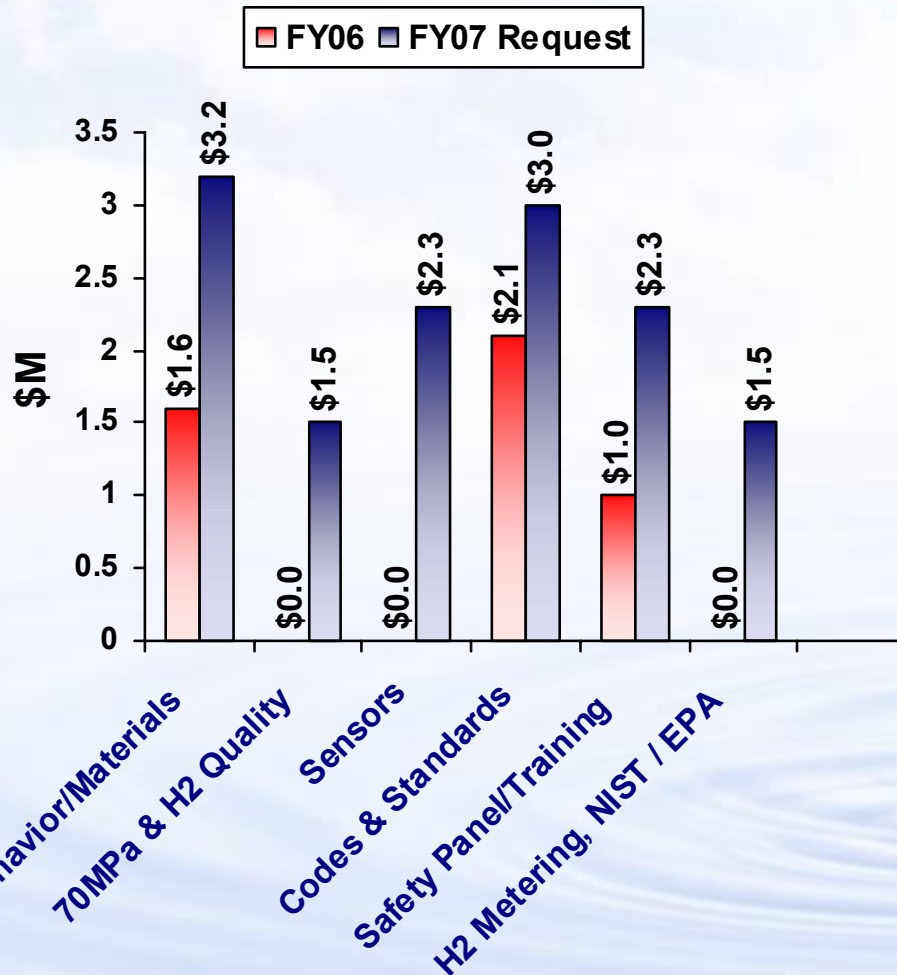
**Codes & Standards:** Perform underlying research to enable codes and standards to be developed for the safe use of hydrogen in all applications. Facilitate the development and harmonization of international codes and standards

- Establish Program safety policy and guidance and continue activities of the Safety Review Panel to provide expert guidance.
- Promote widespread sharing of safety-related information, procedures and lessons learned to first responders, jurisdictional authorities and other stakeholders.
- Publish a handbook of Best Practices for Safety. The Handbook will be a “living” document that will provide guidance for ensuring safety in future hydrogen endeavors, by 2008.
- R&D to provide critical hydrogen behavior data and hydrogen sensor and leak detection technologies; provide a sound basis for model code development and adoption.
- Support and facilitate the drafting and adoption of model building codes for hydrogen applications in key US regions
- Facilitate development of Global Technical Regulations (GTR) for H<sub>2</sub> vehicle systems under the United Nations Economic Commission for Europe, World Forum for Harmonization of Vehicle Regulations, and Working Party on Pollution and Energy Program (ECE-WP29/GRPE).

# Safety Codes and Standards Budget

FY 2007 Budget Request = \$13.8M

FY 2006 Available Funds = \$ 4.7M



- **Emphasis:**

- Technically validated performance data needed for new codes and standards
- Performance based standards which do not limit technologies
- Restart hydrogen sensors R&D
- Hydrogen quality and high pressure refueling
- Conduct risk assessment and establish protocols to identify and mitigate risks
- Establish consensus R&D for global harmonization of hydrogen quality standards

- **2007 Budget Obligations:**

Hydrogen Metering (NIST)	\$ 1.5M
Restore Laboratory R&D	\$ 4.7M
Ensure Safety of DOE R&D	\$ 2.3M
Support Codes & Standards (Domestic and International)	\$ 3.0M
Renew Sensors R&D	\$ 2.3M
<b>Total</b>	<b>\$13.8M</b>

# Technical Risks/Major Barriers



- **Insufficient Technical Data Available**
- **Jurisdiction**
  - Large Number of Authorities Having Jurisdictions (AHJ's)
    - Approximately 44,000 Federal, State and Local AHJ's
  - Non-uniform training of AHJ's
  - Non-uniform requirements
- **International Standards**
  - Competing Organizations (ASME, ASTM, EN, ISO, IEC, etc)
  - Disorganized approach
  - International competition
- **Harmonization of Domestic and International Standards**

# Approach

- Perform R&D that focuses on basic hydrogen properties and behavior, as well as the testing of materials and components to support the development of hydrogen codes and standards.
- Continue execution of a national template which identifies organizations and responsibilities in the hydrogen codes and standards development process.
- Work domestically and internationally to facilitate the development of performance-based standards and to ensure that U.S. consumers can purchase products that are safe and reliable, regardless of their country of origin, and that U.S. companies can compete internationally.
- Conduct safety reviews of current and future projects, including practices and procedures.
- Maintain and expand Bibliographic and Incident Reporting databases and other data on safety, including component reliability, materials, sensors and hydrogen releases.
- Develop the training tools and hardware for a safety training program of emergency responders and authorities having jurisdiction.



# Accomplishments

## Hydrogen Incidents Database

[www.h2incidents.org](http://www.h2incidents.org)

Reports contain summaries, at-a-glance information, and links to related information such as full reports, photos or videos, etc.

**H2Incidents**  
Hydrogen Incident Reporting Tool

### Incident Report

Introduction of Stainless Steel Spatula Elicits Flame

11 January 2005

<b>NO FUNDING SOURCES DEFINED</b>	Severity: <b>Incident</b>	Was Hydrogen released? <b>No</b>	Was there Ignition? <b>Yes</b>
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**Description**

During preparation of a new hydrogen storage material, ammonia borane (AB) loaded onto mesoporous carbon, an unexpected incident was observed. As with all procedures with new materials the work is conducted on a small scale and in a laboratory fume hood. They followed the procedures that they had used for absorption of ammonia borane onto mesoporous silica without incident.

To absorb the solid AB into a scaffold material they dissolve AB in a dry aprotic polar solvent, THF. The saturated solution of AB in THF is added to the mesoporous carbon material in a round bottom flask, stirred for 10 minutes to saturate the mesoporous scaffold with AB and then the solvent is slowly removed under vacuum. At this point the sample is assumed to be prepared and ready for transfer to a sample vial for storage.

The material (1:1 mesoporous carbon:AB) was exposed to the atmosphere for close to five minutes without incident and the round bottom flask containing the material was cool to the touch as they have always noted for the silica materials. In order to transfer the material from the round bottom flask to the storage vessel a stainless steel spatula was introduced to the round bottom flask. Upon touching the stainless steel spatula against the inside of the flask, the flask became warm to touch and then a small flame was observed to arise from the round bottom flask. The flask was immediately placed under a large glass crystallizing dish to remove oxygen and the flame was extinguished. After the flame was extinguished, the flask was then placed under nitrogen atmosphere.

Dry carbon materials have been reported to develop a static charge under vacuum. It is likely that using the metal spatula provided a non-ground source to release the flame. This static charge may have been responsible for the flame and not any hydrogen.

## Hydrogen Bibliographic Database

[www.hydrogen.energy.gov](http://www.hydrogen.energy.gov)

This searchable database provides references for information on hydrogen safety.

**Hydrogen Safety Bibliographic Database — Search Results**

Click on the document title to view a document summary or click on the PDF icon, if available, to see full text. Some documents may be available as Adobe Acrobat PDFs. [Download Adobe Reader](#)

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Records 1 to 10 of 95

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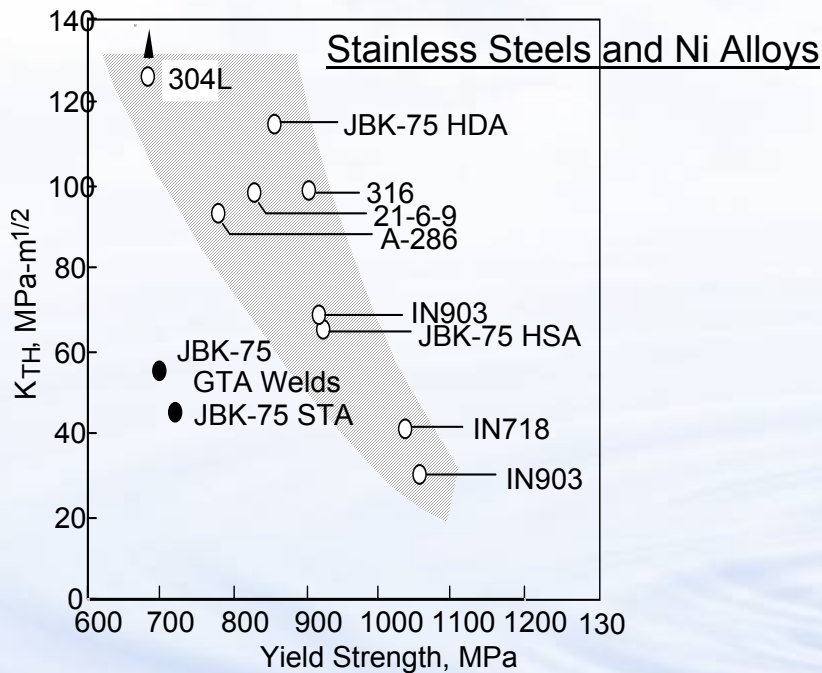
# Accomplishments

Materials R&D: 9 of 15 Chapters now available of hydrogen material classes

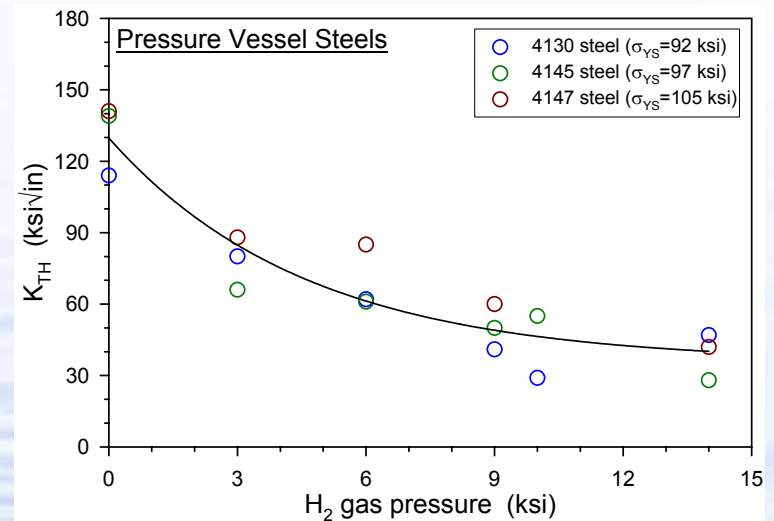
[www.ca.sandia.gov/matIsTechRef](http://www.ca.sandia.gov/matIsTechRef)



## Effect of Strength on Cracking in H<sub>2</sub>



## Effect of Pressure on Cracking in H<sub>2</sub>



- Increased material strength lowers threshold for H<sub>2</sub>-assisted crack growth

- Increased H<sub>2</sub> gas pressure lowers threshold for H<sub>2</sub>-assisted crack growth

# For More Information

## Safety, Codes and Standards Team

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