



# 2005 Annual DOE Hydrogen Program Review

## *Safety, Codes and Standards*

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Project ID#  
SA1

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# Outline



- Goal and Objectives
- Budget and Priorities
- Barriers
- Approach
- Key Milestones
- Accomplishments
- Future Plans



# Goal & Objectives



## Codes & Standards

**Goal** : 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

## Objectives

- Support and facilitate the drafting of model building codes for hydrogen applications (i.e., NFPA 5000) by the National Fire Protection Association (NFPA)
- Facilitate in the adoption of the ICC codes in key US regions:
- Complete R&D on hydrogen release scenarios; provide a sound basis for model code development and adoption.
- Support and facilitate the completion of ISO standards for refueling and on-board storage and the completion of bulk storage standards (e.g., NFPA 55) with experimental data and input from the Tech Validation program element.
- 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).



# Goal & Objectives



## Hydrogen Safety

**Goal** : 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.

### Objectives

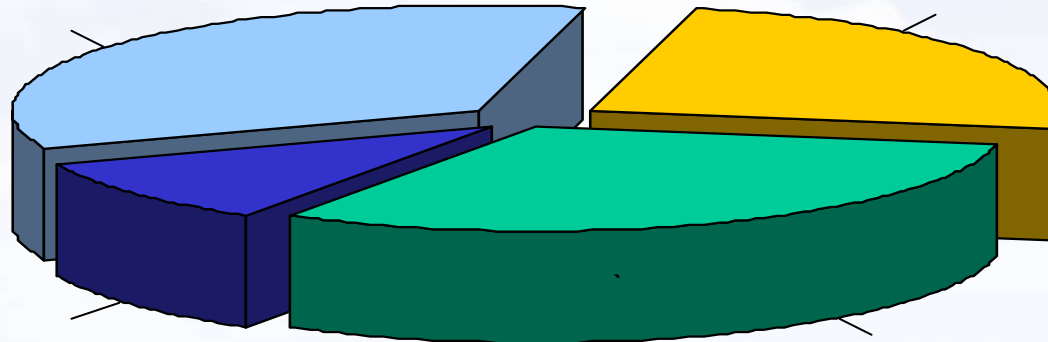
- **Develop a comprehensive Program Safety Plan, establishing Program safety policy and guidance and continue activities of the Safety Review Panel to provide expert guidance.**
- **Integrate safety procedures into all DOE project funding procurements.**
- **Publish a handbook of Best Management Practices for Safety. The Handbook will be a “living” document that will provide guidance for ensuring safety in future hydrogen endeavors, by 2007.**
- **R&D to provide critical hydrogen behavior data and hydrogen sensor and leak detection technologies. This data will support the establishment of setback distances in building codes.**
- **Promote widespread sharing of safety-related information, procedures and lessons learned to first responders, jurisdictional authorities and other stakeholders.**



# FY05 Funding Distribution



**Domestic Standards (\$2.0M)**  
Harmonize processes  
National Template



**R&D (\$1.4M)**  
H2 Release R&D  
Materials Handbook

**International Standards (\$0.6M)**  
Analysis of Technical Requirements  
Harmonization of International Standards  
International GTR Development

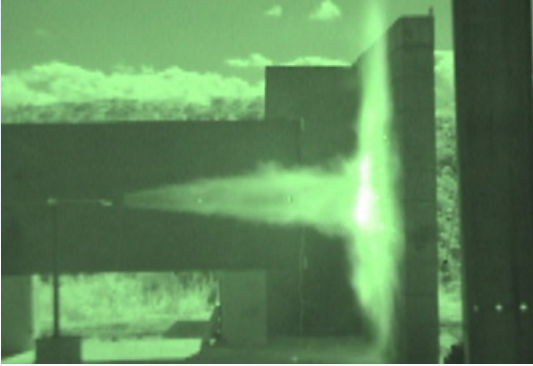
**Safety (\$1.9M)**  
Safety Review Panel  
HAMMER  
Interagency Collaboration

## Priorities

- Ensure the safe operation of hydrogen projects
- Safety R&D to support codes and standards development
- National template for domestic C&S and international harmonization of C&S
- Materials Handbook
- Safety Training at HAMMER



# Barriers



- Limited historical data / insufficient technical data to revise standards
- Training of officials
- Variation in standard practice of safety assessments for components and energy systems
- Complex system of Codes and Standards and competition between C&S Organizations
- Large Number of Local Government Jurisdictions
- Limited government influence on C&S process
- Limited DOE role in international C&S
- International Competitiveness
- 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.
- Develop and provide a database on safety, including component reliability, materials, sensors and hydrogen releases.
- Develop a safety training program for emergency responders and authorities having jurisdiction.



# Key Milestones



## Codes & Standards

<b>Milestone</b>	<b>Description</b>	<b>Date(FY)</b>
9	Initiate experimental validation of large hydrogen releases and jet flame tests completed	1Q, 2005
29	Roadmap for global technical regulations (GTR) published.	2Q, 2005
10	Final code changes that incorporate underground storage of liquid hydrogen and canopy-top storage of gaseous hydrogen for fueling stations (NFPC, ICC) completed	2Q, 2005
19	Draft standards for refueling stations completed (NFPA)	3Q, 2006
5	Complete analytical experiments and data collection for hydrogen release scenarios as needed to support code development (Phase 1).	4Q, 2006
21	Templates of commercially viable footprints for fueling stations that incorporate advanced technologies developed	1Q, 2007
25	Materials compatibility technical reference updated	2Q, 2008
30	General licensing agreement for ISO standards in place.	4Q, 2008
31	Draft regulation for comprehensive hydrogen fuel cell vehicle requirements as a GTR approved (UN Global Technical Regulation).	4Q, 2010





# Key Milestones



## Hydrogen Safety

<b>Milestone</b>	<b>Description</b>	<b>Date(FY)</b>
<b>20</b>	<b>Publish guidelines for safety plans.</b>	<b>4Q, 2004</b>
<b>22</b>	<b>Establish annual review criteria for safety.</b>	<b>2Q, 2005</b>
<b>17</b>	<b>First hydrogen safety class (non-prop) offered at HAMMER.</b>	<b>3Q, 2005</b>
<b>1</b>	<b>Prepare draft failure modes and risk mitigation protocol.</b>	<b>4Q, 2005</b>
<b>13</b>	<b>Safety Review Panel to prepare draft of Best Management Practices Handbook.</b>	<b>2Q, 2007</b>
<b>23</b>	<b>Publish final annual review criteria for safety on DOE Web site.</b>	<b>2Q, 2008</b>
<b>8</b>	<b>Conduct research as needed to fill data gaps on hydrogen properties and behaviors.</b>	<b>2Q, 2010</b>



# Accomplishments



## Training: HAMMER Facility



- **First HAMMER facility training in August. ICC sending a select group of fire professionals to take/evaluate the course.**
- **Coordination of US ISO and IEC Technical Advisory Groups to develop US consensus position on international standards.**

- **Developed a national template which identifies organizations and their responsibilities in the hydrogen codes and standards development process**
- **Materials R&D: 6 of 15 Chapters now available of hydrogen material classes.**



<http://www.ca.sandia.gov/matlsTechRef/>



# Risk Assessment (RA) Workshop



- Engage stakeholders to explore risk assessment tools and discuss viability of RA work to support the development of hydrogen codes and standards

*Subjective, cheap, fast,  
less quantitative*

*More objective, costly, time  
consuming, quantitative*

**Expert  
Panels**

**Failure Modes and Effects  
Analysis - FMEA**

**Probabilistic Risk  
Assessment - PRA**

## Conclusions:

- CDO/SDO communities favor different RA methods
- Obtaining data is a critical barrier to successful RA (several working groups formed)
- How safe is safe enough? A question that is discussed outside of the US, but generally not spoken of within the US.

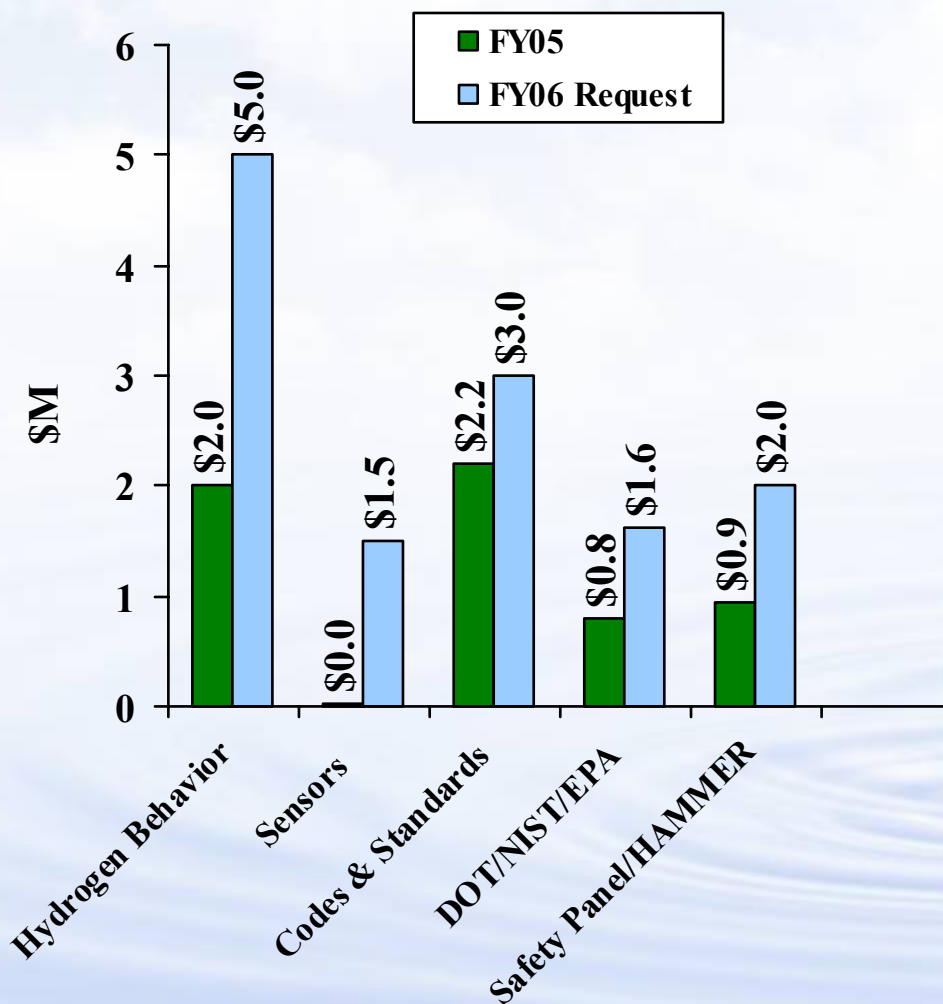


# Future Plans



FY 2006 Budget Request = \$13.1M

FY 2005 Appropriation = \$ 5.9M



## • Emphasis:

- Technically validated performance data needed for new codes and standards
- Performance based technical standards which do not limit technologies
- Renew hydrogen sensor R&D
- Safety Panel Reviews
- Safety Reporting
- Complete hydrogen materials handbook for initial 15 material classes
- Best Practices Manual



# For More Information



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