



# ***Hydrogen Safety Review Panel***

presented by

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for the

**DOE Hydrogen Program Review**

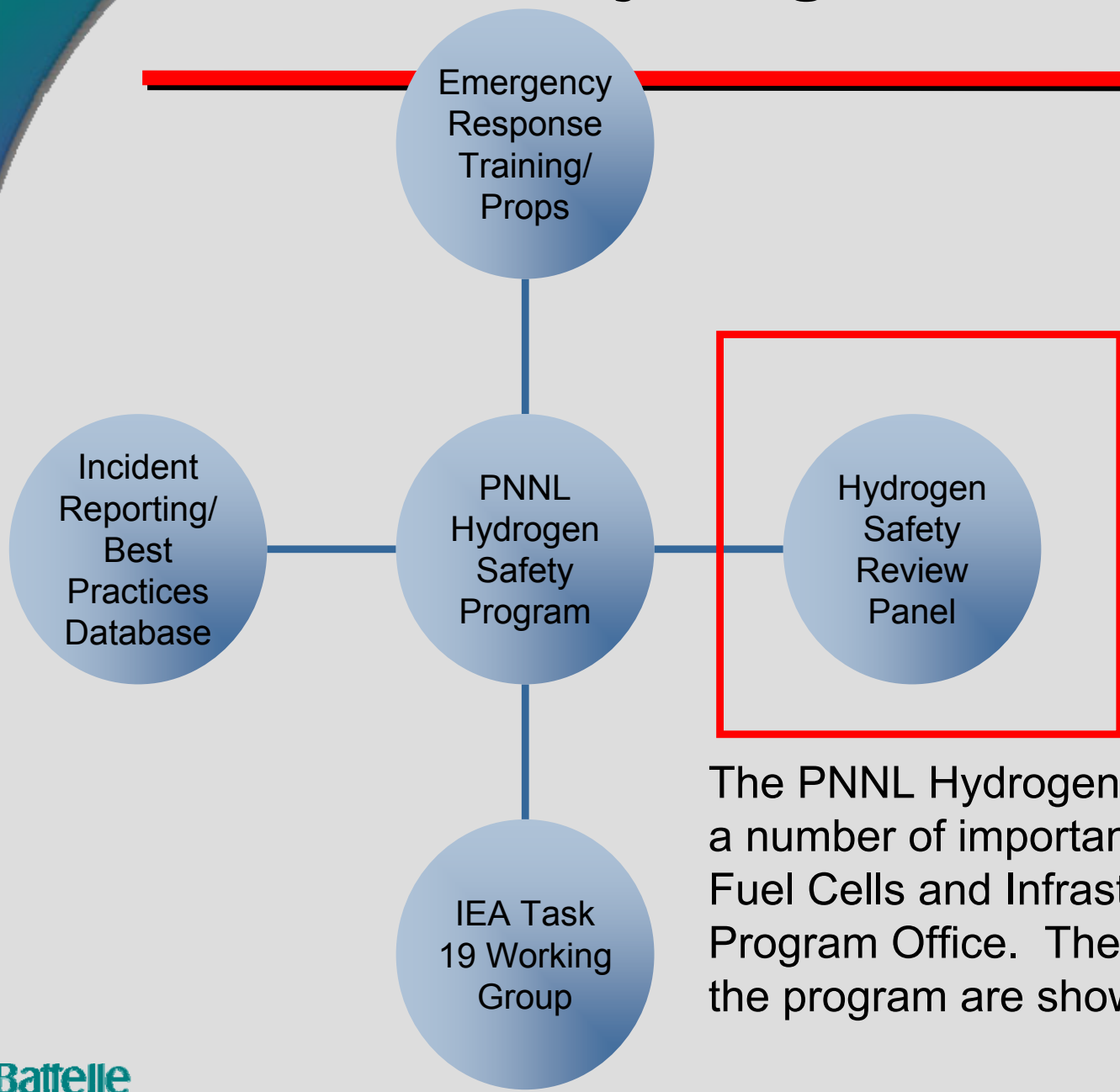
**May 19, 2006**

**Project SA5**

This presentation does not contain any proprietary or confidential information



# ***PNNL Hydrogen Safety Program***



The PNNL Hydrogen Safety Program contributes a number of important activities to the Hydrogen, Fuel Cells and Infrastructure Technologies Program Office. The current main elements of the program are shown here.



# Overview

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## Timeline

- First Panel meeting: Dec 11, 2003
- Continuing

## Budget

- FY05 = \$465K
- FY06 = \$450K

## Partners

- Energetics, Inc.
- Panel member organizations

## Barriers addressed

- A. Limited historical database
- B. Proprietary data
- C. Validation of historical data
- D. Liability issues
- E. Variation in standard practice of safety assessments for components and energy systems**
- F. Safety is not always treated as a continuing process**
- G. Expense of data collection and maintenance



# Hydrogen Safety Review Panel

Don Frikken, Chair	Becht Engineering
Addison Bain	NASA
Harold Beeson	NASA White Sands
David Farese	Air Products and Chemicals
Richard Kallman	City of Santa Fe Springs, CA
Michael Pero	Hydrogen Safety, LLC
Harold Phillippi	ExxonMobil Research and Engineering
Jesse Schneider	DaimlerChrysler
Andrew Sherman	Powdermet Inc.
Rody Stephenson	Motor Vehicle Fire Research Institute
Bob Zalosh	Worcester Polytechnic Institute

# Objectives

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- ▶ Provide expertise and guidance to DOE and assist with identifying safety-related technical data gaps, best practices and lessons learned
- ▶ Help DOE integrate safety planning into funded projects to ensure that all projects address and incorporate hydrogen safety practices

# *Approach*

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- ▶ Bringing a cross-section of relevant experience to bear on the success of the Hydrogen Program as a whole
- ▶ Focusing safety reviews on engagement, learning and discussion rather than as audit or regulatory exercises
- ▶ Reviewing safety plans to encourage thorough and continuous attention to safety aspects of projects
- ▶ Identifying project-specific findings/learnings and bringing a broader benefit to the Hydrogen Program

# ***Technical Accomplishments, Progress and Results***

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- ▶ Conducted 19 safety reviews (8 in the past year) of production, storage, fuel cells and technology validation projects (March 3, 2004 – first site visit)
  - Site visits
  - Telephone interviews
  - Implemented recommendations and lessons learned are a resource of safety knowledge for broader value
- ▶ Reviewed 50+ safety plans for new projects
  - Hydrogen Storage
  - Production and Delivery

# ***Technical Accomplishments, Progress and Results (continued)***

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- ▶ Completed revision to *Guidance for Safety Aspects of Proposed Hydrogen Projects* (October 2005)
  - Defined safety events (incidents and near-misses) and reporting requirement
  - Added safety plan approval/sign-off form
- ▶ Developed a checklist to improve safety plan quality and relevance to work being conducted (April 2006)
- ▶ Developed and used safety template for Hydrogen Program Review (May 2005) to assess safety vulnerabilities, risk mitigation, accident scenarios across the program and received 175 responses



## ***Technical Accomplishments, Progress and Results (continued)***

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- ▶ Supported DOE-led investigation of safety incident: laboratory-scale synthesis of hydrogen storage material (September 2005)
  - Investigation and reporting with recommendations
  - Safety plan review and revision
  - Lessons learned communicated broadly throughout the Hydrogen Storage sub-program
- ▶ Provided other recommendations to DOE:
  - Safety event reporting (September 2005)
  - Fueling station tests (September 2005)
  - Extinguishing agents for metal powders (November 2005)
  - Safety plan checklist (April 2006)

# ***Technical Accomplishments, Progress and Results (continued)***

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- ▶ Provided technical guidance for other Hydrogen Safety sub-program elements
  - Emergency responder training: facilities and curriculum
  - Incident reporting/best practices database

# ***Technical Accomplishments, Progress and Results (continued)***

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- ▶ Captured safety practices and lessons learned from project safety and safety plan reviews for broader benefits (Ongoing)
  - Safety planning
  - Hydrogen storage/handling facilities
  - Equipment maintenance and sensor calibration
  - Management of change
  - Asphyxiating gases
  - Hydrides and other hydrogen storage materials
  - Safety event reporting

# ***Safety Planning***

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“Living” plans require the comprehensive identification and analysis of safety vulnerabilities, effective measures to mitigate risks and ongoing communications to enhance and implement safety practices and lessons learned.

# ***Hydrogen Storage/Handling Facilities***

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The design and siting of hydrogen systems present several options. The safety vulnerability analysis for handling, moving and distributing hydrogen should include the likelihood that increasing quantities of hydrogen will be required for future work in a given facility/location.

# ***Equipment Maintenance and Sensor Calibration***

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Written procedures and logs for equipment maintenance and calibration of safety-related sensors serve a similar functionality as standard procedures for experiments and operations. Procedures should follow manufacturer recommendations or other accepted standards.

# ***Management of Change***

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Any proposed change to materials, technology, equipment, procedures or facility operation should be reviewed for its effect on the analysis of safety vulnerabilities. This principle applies to hazardous work at the frequently changing laboratory scale.

# *Asphyxiating Gases*

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Nitrogen (and other gas) asphyxiation incidents occur in a variety of facilities including industrial plants, laboratories and medical facilities. The use of enclosed spaces, such as laboratories or glove boxes, requires the assessment of the quantity, storage and flow rate of asphyxiating gases, the adequacy of ventilation and the need for oxygen depletion sensors.



# ***Hydrides and Other Hydrogen Storage Materials***

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Small quantities of hydrogen-containing materials, which are not well characterized, should be handled with procedures that assume a “worst case” for that class of materials, intermediates or precursors. To ensure integrity, hazard analysis might include calculating the maximum volume of hydrogen that could evolve from an otherwise sealed container.

# ***Safety Event Reporting***

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A reporting system delivers valuable lessons learned to participants in the DOE Hydrogen Program and others. This system requires information sharing, degrees of confidentiality and a commitment to create higher learning value from incidents and near-misses.

# *Future Work*

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## ▶ Remainder of FY2006

- Review project safety plans
- Conduct project safety reviews
  - Telephone interviews
  - Site visits and reporting
- Revise safety guidance document
- Conduct 6<sup>th</sup> Panel meeting (June 27-28, 2006)

## ▶ FY2007

- Utilize Hydrogen Safety sub-program and Panel member input for establishing FY2007 work plan
- Review project safety plans; conduct project safety reviews
- Conduct 7<sup>th</sup> and 8<sup>th</sup> Panel meetings



# ***Publications and Presentations***

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1. Weiner, S.C., “Hydrogen Safety Review Panel: Utilizing a Wealth of Experience,” Fuel Cell Summit Newsletter, Vol. 5, Issue 1, Spring 2004.  
([http://www.pnl.gov/fuelcells/docs/newsletter/volume5/vol5\\_issue1.pdf](http://www.pnl.gov/fuelcells/docs/newsletter/volume5/vol5_issue1.pdf))
2. Weiner, S.C., Kinzey, B. and Skolnik, E.G., “Hydrogen Safety Review Panel: Shaping Safety Awareness,” 20<sup>th</sup> Annual Center for Chemical Process Safety International Conference, Atlanta, GA, April 12, 2005. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>
3. Weiner, S.C., Kallman, R.A., Ruiz, A. and Schneider, J.M., “Hydrogen Safety: From Policies to Plans to Practices,” Paper 100068, International Conference on Hydrogen Safety, Pisa, Italy, September 8-10, 2005. <http://conference.ing.unipi.it/ichs/ICHS-Papers/index.htm>
4. Weiner, S.C., “Hydrogen Safety Review Panel: Safety Planning, Practices and Lessons Learned, National Hydrogen Association Annual Hydrogen Conference,” Long Beach, CA, March 12-16, 2006. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>
5. Weiner, S.C., “Safety Practices and Lessons Learned: The Work of the Hydrogen Safety Review Panel,” Hydrogen Safety and Risk Workshop, University of Nevada, Las Vegas, April 10, 2006. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>

# Summary

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- ▶ The Panel's contribution to the Hydrogen Program is about raising safety consciousness most directly at the project level.
- ▶ Active and continuing project safety reviews provide a resource of safety knowledge that can have broader impact across the Hydrogen Program.
- ▶ Safety must be treated as a continuing process.



# ***Back-up Slides***

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# Responses to 2005 Reviewers' Comments

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- ▶ Share the checklist used by the Panel for safety plan reviews with program participants.
  - *A checklist for use in preparing and updating safety plans has been prepared by the Panel and forwarded to DOE.*
- ▶ A requirement for regular reporting on the incident and near-miss checklist should be added.
  - *Safety event reporting is a requirement for all DOE-funded projects. Reportable events are defined and discussed in "Guidance for Safety Aspects of Proposed Hydrogen Projects."*
- ▶ Safety needs to be highlighted and tracked during DOE demo program...safety stats from the demo program need to be analyzed, summarized and marketed.
  - *The Panel agrees and encourages greater sharing of safety-related lessons learned from the demo program.*
- ▶ Many of the safety aspects related to hydrogen can be used for other inert, toxic or flammable gases, e.g., ventilation, cylinder handling, etc. [*and vice versa*] to enlarge project advantages.
  - *The Panel agrees and this point is often noted in safety plan reviews and discussed in project safety reviews.*