



FUEL CELL SUMMIT

Volume 5, Issue 1

A quarterly newsletter from the U.S. Department of Energy to supply information on U.S. regulation of hydrogen and fuel cells.

Hydrogen Safety Review Panel: Utilizing a Wealth of Experience

Steven C. Weiner

An essential element for realizing the “hydrogen economy” is safe operation – from production through storage, distribution, and use; from research, development, and demonstration to commercialization. The safety pyramid captures the essence of incorporating safety into all aspects of the U.S. Department of Energy’s (DOE) Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program.



The pathway from research, development, and demonstration to successful commercialization of insurable systems is enabled by recognizing the important role that safety must play along the way.

Safety’s paramount importance is also reflected in DOE’s Multi-Year Research, Development and Demonstration (RD&D) Plan, which emphasizes hydrogen safety in every project in the DOE portfolio:

- drafting comprehensive safety plans in collaboration with industry and other government agencies
- integrating safety procedures into all DOE project funding procurements
- publishing a handbook of Best Management Practices for Safety.

And there is a wealth of experience upon which to build! Whereas the early uses of hydrogen were limited to military and aerospace applications, commercial uses for hydrogen have now increased the potential commercial market to many times larger than the government market in a variety of applications – petroleum refining, fats and oils hardening, metals processing, glass production, semiconductor manufacturing, chemicals and pharmaceuticals manufacturing, and others.

DOE has formed a Hydrogen Safety Review Panel that will bring a broad cross-section of experience to bear on the success of the program as a whole.

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The Next Revolution in Portable Power: Bringing Together Regulators and Industry

Micro fuel cells are just around the corner, anticipated to be the first large-scale commercial application of fuel cell technology. But, as with other applications, much work remains to be done regarding their certification and market standardization. UL and DOE responded to this need last October by calling a workshop of key stakeholders, designed to provide an open forum for discussing needs and pathways for market entry of micro fuel cell devices. Twenty-five representatives of manufacturers, regulators and other interested parties participated in the workshop, held October 28, 2003, at the offices of Pacific Northwest National Laboratory in Washington, DC.

Hosted by Harry Jones and Bob Pence of Underwriters Laboratories, Inc., the workshop focused on objectives to

- understand the perceived hazards associated with micro fuel cell devices, fuel delivery, and transportation
- review the status of the technology, the perceived markets, and the timetables involved
- provide a means for federal agencies and industry to network, collaborate, and facilitate solutions
- consider the current status of standards development relevant to these devices, such as IEC/TC105 (International) and UL2265 (US)
- apply feedback from this workshop to the ongoing efforts in IEC/TC105 and UL2265 to ensure timely development of appropriate safety requirements.

The workshop opened with a series of invited presentations:

- *Proposed Rulemaking at the United Nations and US Department of Transportation Issues* – John Paterson, Consultant to the US Fuel Cell Council
- *DOT-Research and Special Programs Administration (RSPA), Activities Related to Fuel Cells* – Charles Ke
- *Methanol Perspective on Micro Fuel Cells* – Gregory Dolan, Methanol Institute
- *Federal Aviation Administration Office of Security and Hazardous Materials* – Jon Carter
- *US Consumer Product Safety Commission, An Overview of the Agency with Perspective on Fuel Cells* – Janet Buyer
- *DOE R&D Projects for Safety Consideration* – Jim Ohi, National Renewable Energy Laboratory.

See summaries of these presentations by Bob Pence, categorized by key regulatory concern, i.e., transportation, hazmat, security, environmental, packaging, etc. at www.ul.com/dge/fuelcells/.

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DOE to Establish National Training Facility for Hydrogen Safety

Linda Fassbender, Pacific Northwest National Laboratory, and Bret Akers, Volpentest HAMMER Training Center

Hydrogen is being hailed as the fuel of the future, both for vehicular and stationary (e.g., building) applications. Although hydrogen has been used for decades in the chemicals and aerospace industries, its use as a commercial energy carrier is essentially a new application. As a result, codes, standards, and safety procedures must be developed, formalized, and taught to the various communities that will use them for, despite our best efforts, accidents will sometimes occur.

Our vision is to establish the National Training Facility for Hydrogen Safety at the Volpentest Hazardous Materials Management and Emergency Response Training Center (HAMMER) on the U.S. Department of Energy's Hanford Site in southeastern Washington.



Entrance to HAMMER Facility

The need for a National Training Facility for Hydrogen Safety is recognized in both the public and private sectors, across a range of disciplines. For example, building code officials need to learn about codes and standards applicable to hydrogen and fuel cell applications, how the various technologies work, and how to determine that the technologies have been properly installed and implemented. Various tools of the trade, such as hydrogen leak-detection sensors, also must be properly installed and used to ensure safe operation of the equipment. Manufacturers need to be apprised of the operating characteristics their equipment must achieve in order to be approved by the permitting officials. Emergency-response personnel need to know the proper way to handle gaseous and liquid hydrogen leaks as well as vehicle fires at fueling stations.

Such a facility does not exist in the U.S. at present; however, ongoing safety training classes at HAMMER could be expanded to provide all of these services. The intent is that the facility will become a forum in which manufacturers and safety personnel gather to have one-on-one communication regarding hydrogen and hydrogen-using technologies.

Named for local community leader Sam Volpentest, HAMMER is a one-of-a-kind worker safety and emergency operations training facility featuring the largest number of training props currently available at one location. HAMMER is owned by the U.S. Department of Energy (DOE), managed by Fluor Hanford, and configured to serve clients throughout the Hanford Site, the nation, and the world.

HAMMER began as a community effort and grew into a diverse partnership between DOE and its contractors, other federal agencies, state and tribal governments, labor unions, academic institutions, private industry, local governments, professional associations, and the Tri-Cities Industrial Development Council (TRIDEC). After a year of intense application preparation and on-site reviews, HAMMER was awarded the prestigious DOE Voluntary Protection Program (VPP) "Star" status. This award was given in recognition of HAMMER management's leadership in safe operations and its strong commitment to worker safety and health.

Congress authorized HAMMER in 1994 and construction began in 1995. Construction was completed in 1997 at a cost of about \$30 million. The facility consists of an 80-acre main campus with a 75-acre expansion area. It contains 19 classrooms, two computer-based training centers, two conference rooms, four indoor open-bay areas, 29 outdoor training props, satellite/distance learning capabilities, staff offices, a learning resource center, and a restaurant. Current training opportunities at HAMMER are focused on fire operations, law enforcement, emergency operations, homeland security, occupational safety and health, environmental and waste management, and transportation.

HAMMER is a unique facility featuring an expanding line of life-sized training props. Using these props, students train in a controlled environment, eliminating dangerous situations often found during on-the-job training. The main campus training areas include a six-story training tower, a burn building, a collapsed structure and rubble pile, a vehicle burn prop, a fuel truck burn pad, a flammable liquid burn pad, a storage tanks prop, an overturned tanker trailer, and rail tank cars, among its 29 outdoor training props.

For example, the 24-foot-square flammable liquid burn prop, which is set on a 75-foot-square concrete base, is divided into four separate, independently controlled burn zones. As liquid petroleum gas percolates through rocks placed over the burners, trained operators control the growth, spread, and extinguishing of the flammable liquid fire simulation. Students learn about extinguishing agent selection and application while responding to a flammable liquid fire.

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Standards Committee Activity Updates

- ▶ **ICC Ad Hoc Committee for Hydrogen Gas.** The committee submitted 10 public comments on hydrogen-centric provisions in ICC as it prepares the Final Action Hearings to be held May 17- 20 (see www.iccsafe.org/springmeeting). The next meeting of AHC will be May 3-4 in Sacramento, CA, at the California Fuel Cell Partnership (CaFCP), following NHA's 15th Annual U.S. Hydrogen Conference in Los Angeles, CA. After Sacramento, the next AHC meeting will be June 18-19, following the Hydrogen and Fuel Cells Summit VIII, in Coral Gables, FL. NFPA has agreed to be a member of the AHC's Subcommittee on Separation Distances. Contact: Darren Meyers (ICC), (800) 214-4321 ext. 307, dmeyers@iccsafe.org or Russ Hewett (NREL), (303) 384-7463, Russell_hewett@nrel.gov. See: www.iccsafe.org.
- ▶ **NFPA 5000, Building Construction and Safety Code.** The 2006 Edition of NFPA 5000, Building Construction & Safety Code, is currently under development. For a timetable for this edition, see www.nfpa.org/PDF/processingsched.pdf?src=nfpa. For more information, contact Renee Spiegel at NFPA, (617) 984-7263, rspiegel@nfpa.org. The 2003 Edition of the code was endorsed by the California Building Standards Commission as the basis for the next edition of the California Building Code. The code is now under review by the state agencies for proposed amendments. For more information, contact Karen Stein at NFPA's Sacramento Office, (916) 440-1060, kstein@nfpa.org.
- ▶ **NFPA 55, Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks.** NFPA 50, 50A, and 50B will be incorporated into the 2004 Edition of NFPA 55. This process is well on its way but has not yet been completed. This 2004 Edition will also likely contain requirements for underground storage of hydrogen. Contact: Carl Rivkin (NFPA), (617) 984-7418, crivkin@nfpa.org.
- ▶ **ASME PTC 50, Performance Test Code on Fuel Cell Power Systems.** PTC 50 provides test procedures for performance characterization of all components of fuel cell power systems. The code is available at (800) 843-2763 or www.asme.org/catalog. Contact: Jack Karian (ASME), (212) 591-8552, karianj@asme.org.
- ▶ **NFPA 853, Installation of Stationary Fuel Cell Power Plants.** The 2003 Edition of NFPA 853 has been expanded to stationary fuel cells below 50 kW. The new chapter, "Fuel Cell Power Systems 50 kW or Less," gives requirements for both outdoor and indoor installations as well as ventilation and fire protection for these smaller systems. The 2003 Edition is available at (800) 344-3555 or www.nfpa.org. Contact: Carl Rivkin (NFPA), (617) 984-7418, crivkin@nfpa.org.
- ▶ **NFPA 70, National Electrical Code - Article 692, Fuel Cell Plant.** The NEC code making panel 13 met in San Diego in December of 2003 to review comments on proposals for Article 692 of the 2005 NEC. They accepted one comment and rejected two. These actions are subject to action by the NEC Technical Correlating Committee, which will meet the week of Feb. 23, 2004, in Biloxi, MS, and to any floor actions presented at the Technical Committee Session at the Annual Meeting in Salt Lake City May 27, 2004. Contact: Jean O'Connor (NFPA), (617) 984-7421, (617) 984-7070 (fax), joconnor@nfpa.org.
- ▶ **IEEE P1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.** The Standards Board of the Institute of Electrical and Electronics Engineers (IEEE) approved IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems in June 2003. It was published in July 2003 and approved to start in December 2003 along with new projects: P1547.1 - Draft Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, P1547.2 - Draft Application Guide for IEEE P1547 Draft Standard for Interconnecting Distributed Resources with Electric Power Systems, P1547.3 - Draft Guide for Monitoring, Information Exchange and Control of DR Interconnected with EPS, and new project P1547.4 - Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems. IEEE's standards coordinating committee FCC21 held a meeting in New Orleans in Nov 2003. The next meeting of FCC21 and all of its working groups 1547.1 - 1547.4 is planned for San Francisco April 20-22, 2004. Contact: Richard DeBlasio (NREL), (303) 275-4333, ddeblasi@tcplink.nrel.gov; or Tom Basso (NREL), (303) 275-3753, thomas_basso@nrel.gov.

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2004**MAR****Calendar of Events**

- 1 - 2 **CERI North American Natural Gas Conference & Calgary Energy Show 2004.** Telus Convention Centre, Calgary, Alberta, Canada. Contact: (403) 220-2380.
- 1 - 3 **IASTED International Conference on Alternate Energy Sources and Technology - AEST 2004.** Marina Beach Marriott, Marina del Rey, CA. Contact: (403) 288-1195 or (403) 247-6851 (fax).
- 2 - 4 **Global Alternative Fuels Forum for Automotive and Stationary Applications.** Hamburg Marriott Hotel, Hamburg, Germany. Contact: +44 (0) 1242 529 060.
- 5 - 9 **ASME International Mechanical Engineering Education Conference.** Sheraton Sand Key Resort, Clearwater, FL. Contact: (212) 591-7079 or (212) 591-7143 (fax).
- 7 - 10 **2004 NARUC Winter Committee Meetings.** Renaissance Washington Hotel, Washington, DC. National Association of Regulatory Utility Commissioners forum for commissioners, commission staff and industry to interact and exchange ideas and perspectives. Contact: Michelle Malloy (202) 898-2214.
- 8 - 11 **2004 SAE World Congress.** Cobo Center, Detroit, Michigan. Hosted by Ford Motor Company. Contact: (724) 772-8537, (724) 776-0210 (fax), or see www.sae.org/congress/.
- 14 - 16 **2nd Fuel Cell Investment Summit.** Mohegan Sun Casino in Uncasville, CT. Hosted by Connecticut Clean Energy Fund. Contact: Gladys Rivera (860) 563-5851 ext. 251, (860) 563-1602 (fax), or see www.fuelcellis.com.
- 15 - 17 **5th Annual European Fuels Conference.** The Hilton Paris Suffren, Paris, France. Contact: +44 (0) 1242 529 090.
- 23 - 24 **Advanced ESPC/Financing.** Golden, CO. U.S. DOE Federal Energy Management Program's Super Energy Savings Performance Contracting process. Contact: Danette Delmastro (202) 586-7632.
- 24 - 25 **Globalcon Expo.** Hynes Convention Center, Boston, MA. Association of Energy Engineers. Contact: (770) 447-5083.
- 25 - 26 **4th Annual Fuel Cell Investor Conference.** Sheraton Society Hill, Philadelphia, PA. Contact: (888) 666-8514, (646) 336-5891 (fax), or see www.srinstitute.com.
- 25 - 26 **Micro Fuel Cell Regulations & Compliance.** Washington, DC. Contact: (800) 817-8601, (781) 939-2400, or (781) 939-2490 (fax).

APR

- 30 - 1 **ASME Power 2004** (collocated with) **Electric Power 2004.** Baltimore Convention Center, Baltimore, MD. Current trends and technologies in the power generation industry. Contact Christy West or Melanie McTaggart (832) 242-1969 or (832) 242-1971 (fax).
- 19 - 20 **North American Gas Strategies Conference.** Houstonian Hotel, Houston, TX. Contact: (800) 853-6252 or (403) 261-4631 (fax).
- 19 - 24 **Hannover Fair 2004.** Hannover Fairgrounds, Hannover, Germany. Contact: Arno Evers +49 (0) 8151-99892 3, +49 (0) 8151 99892 43 (fax), arno@fair-pr.com or see www.fair-pr.com.
- 20 - 22 **15th Global Warming International Conference & EXPO.** Westin Hotel, San Francisco, CA. Contact: Billie Jefferson (630) 910-1551 or (630) 910-1561 (fax).
- 26 - 27 **APPA Washington DC Institute.** Wyndham City Center, Washington, DC. American Public Power Association. Contact: Heidi Lambert (202) 467-2921 or (202) 467-2976 (fax).
- 27 - 30 **15th Annual U.S. Hydrogen Conference and Expo.** Hollywood Renaissance Hotel, Los Angeles, CA. The National Hydrogen Association. Contact: (202) 223-5547 or (202) 223- 5537 (fax).
- 28 - 29 **Hands-On Distributed Energy Resources (DER) Training.** Sandia's Distributed Energy Technologies Laboratory (DETL), Albuquerque, NM. U.S. DOE Federal Energy Management Program. Contact: (505) 844-4383.

MAY

- 2 - 4 **Fuel Cells 2004: Fuel Cells On the Move.** Holiday Inn Select, Stamford, CT. Contact: Sharon Faust (203) 853-4266 ext. 304 or see www.bccresearch.com/fuel_cells2004/.
- 3 - 6 **Third Annual USDOE/NETL Conference On Carbon Capture & Sequestration.** The Hilton Alexandria Mark Center, Alexandria, VA. Contact: (202) 296-2814 ext. 109 or (202) 296-2805 (fax).
- 16-20 **2004 ICC Spring Meeting and Expo.** Sheraton Overland Park Hotel, Kansas. Final Action Code Hearings—participate in the final disposition of changes to the International Codes submitted in the 2003/2004 Code Development Cycle. Contact: (800) 214-4321 ext 229, (708) 799-2307 (fax), or see www.ICCsafe.org/news/springmeeting/index.html.

JUN

- 15 - 17 **Hydrogen and Fuel Cells Summit VIII.** University of Miami Convocation Center, Coral Gables, FL. Hosted by U.S. Department of Energy – Office of Hydrogen, Fuel Cells and Infrastructure. Status reports on: safety, codes and standards activities related to hydrogen fuels; RD&D in stationary, portable, and vehicular fuel cell technologies; and remaining institutional issues. Identification of action items and voluntary teams. Contact: Cecilia Mendoza (509) 372-4520, (509) 372-4990 (fax), or see www.pnl.gov/fuelcells.

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Flammable Liquid Burn Prop (LP Gas)

The vehicle burn prop recreates conditions encountered during control and suppression of automobile fires. The vehicle structure (14 feet long x 5 feet wide x 5 feet high) includes four individually controlled fires: engine, passenger compartment, trunk, and fuel spill. A smoke generator provides smoke to the engine and the passenger compartment. The vehicle has a single door on the driver's side and double doors on the passenger's side for a variety of training scenarios. The prop is operated remotely.



Vehicle Burn Prop (Propane)

Similar props are under consideration for hydrogen safety training activities, including

- a compressed hydrogen storage tank
- pipelines for compressed hydrogen distribution
- a compressed hydrogen refueling station
- a hydrogen fuel cell vehicle.

As the potential user community is quite large (e.g., 44,000 building code officials alone in the U.S.), the need for this training facility extends through many years. Our planning efforts have focused on three types of training:

- training sessions that could be done without props (for regulators, city planners, elected officials, and educators)
- training sessions that require props (for fire marshals, first-responders to potential hydrogen fires, building code officials, fleet managers for hydrogen fuel cell vehicles, hydrogen fueling station owners, and members of the general public who are early adopters of hydrogen fuel cell vehicles)
- equipment demonstrations and testing (for designers and manufacturers of hydrogen storage tanks, hydrogen leak-detection sensors, hydrogen production equipment, hydrogen fuel cells, and hydrogen fuel cell vehicles).

We have prepared a five-year roadmap to guide the development and enhancement of the National Training Facility for Hydrogen Safety. Some of the key activities planned for each of the five years are shown in the following table.

Year 1	<ul style="list-style-type: none">• Design props to be constructed in Year 2.• Conduct four hydrogen safety classes at HAMMER that do not require props.
Year 2	<ul style="list-style-type: none">• Construct the following props: 1) hydrogen fueling station, including storage tank and associated piping, and 2) hydrogen vehicle frame with onboard fuel storage tank.• Develop curriculum and plan demonstrations for hydrogen safety training using fueling station and vehicle props.
Year 3	<ul style="list-style-type: none">• Modify props for equipment demonstration and testing activities as needed.• Develop videoconference and web-based hydrogen safety training modules.• Deliver additional hydrogen safety training classes for equipment designers, manufacturers, and users, and for fire marshals, building code officials, city planners, and first-responders.
Year 4	<ul style="list-style-type: none">• Modify props for equipment demonstration and testing activities as needed.• Conduct hydrogen safety training classes for all potential audiences.• Purchase a modest-sized reformer to produce hydrogen at the HAMMER facility.
Year 5	<ul style="list-style-type: none">• Produce hydrogen safety tips CD/DVD for all new hydrogen vehicles.• Conduct hydrogen safety training classes for all potential audiences, including early adopters of hydrogen vehicles among the public.• Purchase a hydrogen vehicle and a hydrogen fueling station for demonstrating fueling safety.

For more information, contact the authors or visit the HAMMER website at www.hammertraining.com.

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Hydrogen Safety Review Panel: Utilizing a Wealth of Experience *(cont'd from page 1)*

As noted in the multi-year plan, the Panel will review supported projects and assess the needs for further analysis, making recommendations to DOE regarding alternative approaches to evaluate safety-related issues.

Hydrogen Safety Review Panel

Addison Bain, Chair	NASA (ret.)
Carol Bailey	Sentech
Harold Beeson	NASA White Sands
Bill Doerr	FM Global Research
Don Frikken	Becht Engineering
Jim Hansel	Air Products and Chemicals
Richard Kallman	City of Santa Fe Springs, CA
Harold Phillippi	ExxonMobil Research and Engineering
Jesse Schneider	DaimlerChrysler
Rody Stephenson	Jet Propulsion Laboratory (ret.)
Bob Zalosh	Worcester Polytechnic Institute

The Panel held an introductory meeting December 11-12, 2003, in the offices of the Pacific Northwest National Laboratory, Washington, DC. The Panel was welcomed by Steve Chalk, Program Manager for the Hydrogen, Fuel Cells and Infrastructure Technologies Program. Neil Rossmeissl, Technology Manager, Safety and Codes/Standards, provided an overview of the Panel's role and his perspectives on how they can contribute to the success of the DOE hydrogen program. Panelists then provided their input to a draft charter for Panel operations. Jim Ohi,

National Renewable Energy Laboratory, gave a presentation on DOE's codes and standards program.

A principal activity of the Panel will be to review DOE hydrogen projects from a safety perspective. The Panel heard from Ed Skolnik, Energetics, Inc., who shared his recent experiences conducting hydrogen project reviews. The reviews are expected to begin this year. DOE will select a portfolio of projects across the program – production, storage, fuel cells, technology validation, and codes and standards. Review teams will be formed with Panel participation and leadership to work with project teams through scheduled site visits. Initial emphasis will be placed on developing and refining a protocol for such reviews that can advance the understanding of safety across the DOE program for broad benefit.

The Panel is already at work, reviewing the DOE document *Guidance for Safety Aspects of Proposed Hydrogen Projects*, which provides safety-related guidance and requirements for solicitations. For example, the responsibility of selecting a specific methodology for safety analysis and safe operating practices falls upon the principal investigator and collaborators.

Safety will play a critical role in the success of the DOE hydrogen program and now a wealth of experience is helping shape that contribution.

More information about the DOE Safety, Codes and Standards program is available at www.eere.energy.gov/hydrogenandfuelcells/codes/. For more information about the Hydrogen Safety Review Panel, please contact Steven C. Weiner, Panel Coordinator, (202) 646-7870, sc.weiner@pnl.gov.

The Next Revolution in Portable Power: Bringing Together Regulators and Industry *(cont'd from page 1)*

Harry Jones reported that the IEC/TC 105 technical committee covering fuel cell technologies organized an ad hoc group in June 2003 to begin developing a draft international safety standard for micro fuel cells in advance of the formal process. They have completed a first draft using the US-draft UL2265 and a Japanese draft. Jones elaborated on UL Standards Technical Panel (STP) progress for UL2265, *Hand-held, Hand-transportable Fuel Cell Power Units with Fuel Containers*.

Gregory Dolan gave highlights of a study co-sponsored by the US Fuel Cell Council and DOE, *Fuel Cells for Portable Power: Markets, Manufacture and Cost*. The study suggests a potential \$2 billion market for hand-held products by 2011 with the energy density advantage over batteries being the most important driver for market penetration.

Bob Pence led discussions outlining the initial steps to ensure a smooth transition from prototype to mass production and marketing.

This roadmap incorporates

- timing of significant activities already underway
- qualification of the most probable first products to market
- knowledge gaps that need to be addressed
- regulatory activities underway.

Participants suggested that the lithium ion battery precedent could serve as a guideline for the roadmap and that parallels exist for using catalytic converter experience on issues like recyclability and disposal. UL staff have provided the workshop report and roadmap to the STP for UL2265, affirming that this form of collaboration promotes the development of safety regulations and standards in the best interests of "The Next Revolution in Portable Power!"

The workshop report, presentation files, and *Roadmap for Micro Fuel Cells Market Entry* are available at www.ul.com/dge/fuelcells/. For more information please contact Harry Jones at Underwriters Laboratories Inc., (847) 664-2948, harry.p.jones@us.ul.com.