Fuel Cell Power
Office of Power Technologies
DOE

FUELCELLSUMMIT

Volume 1, Issue 2

A quarterly newsletter published by the U.S. Department of Energy for the U.S. fuel cell industry to foster development and adoption of codes and standards

Coming Soon: Fuel Cell Technician Training

By Al Ebron, National Alternative Fuels Training Consortium Executive Director

Since 1992, the Center for Alternative Energy Transportation at York Technical College in Rock Hill, South Carolina has developed educational programs for alternative fuel vehicles (AFVs) and plans to expand these training programs to include fuel cell vehicles as the technology becomes commercially available.

Technicians learn how to service an HVAC system.

The training programs at York Technical College are currently used nationwide to teach technicians how to operate, maintain, and repair AFVs. Working with the U.S. Department of Energy (DOE) and using a fleet of 21 electric vehicles, the college developed a comprehensive curriculum for electric vehicle technician training that is currently being reviewed by major U.S. vehicle manufacturers.

The college is participating in a DOE-sponsored consortium to build, test, and evaluate the commercial viability of an industrial fuel cell vehicle that uses onboard hydrogen stored in metal hydrides. The college is responsible for field testing and maintaining the vehicles.

The College of the Desert in Palm Desert, California is studying the training requirements needed to transition army personnel into 21st century technicians, focusing on hydrogen-powered fuel cell and hybrid electric drive systems in military vehicles. A curriculum, instructional materials, and teaching strategies will be developed to supplement the current training curricula.

Both colleges are members of the National Alternative Fuels Training Consortium (NAFTC), a network of 21 technical colleges and national training centers. With its headquarters and National Alternative Fuels Training Laboratory at West Virginia University in Morgantown, the consortium has developed and delivered training on alternative fuels to more than 3,000 technicians, trainers, and others nationwide.

The consortium is currently considering assembling technical advisory groups and teams to address the training needs of the fuel cell industry.

For further information, visit the NAFTC website at http://naftp.nrcce.wvu.edu or call (304) 293-7882.

ISO/TC-197 Accelerating Hydrogen Safety Standards Development

A decision was made at the ISO/TC-197 Plenary, held in conjunction with the National Hydrogen Association (NHA) annual meeting on April 6, 2000, to redirect this initiative slightly to prepare a “Publicly Available Specification” (PAS) rather than a standard. The PAS defines the safety-relevant properties of hydrogen and identifies the basic concerns associated with its use as a gas, as a liquid, and in chemical compounds.

The PAS is an ISO document that can be developed and published sooner because it requires a lower level of consensus. It can eventually be developed and published as a complete standard. PAS documents have six years, from date of publication, to be published as a standard or withdrawn.

Published ISO standards relevant to hydrogen fuel include:

- ISO 13984: Liquid Hydrogen – Land Vehicle Fuelling System Interface
- ISO 14687: Hydrogen Fuel – Product Specification

Hydrogen standards being developed within the ISO include:

- ISO/CD 13985: Liquid Hydrogen – Land Vehicle Fuel Tanks
- ISO/WD 13986: Tank Containers for Multimodal Transportation of Liquid Hydrogen
- ISO/WD 15594: Airport Hydrogen Fuelling Facility
- ISO/WD 15866: Gaseous Hydrogen Blends and Hydrogen Fuel - Service Stations
- ISO/WD 15869: Gaseous Hydrogen and Hydrogen Blends - Land Vehicle Fuel Tanks

- ISO/WD 15916: Basic Requirement for the Safety of Hydrogen Systems
- ISO/AWI 17268: Gaseous Hydrogen – Land Vehicle Fuelling Connectors.

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DER Electrical Protection: A Primer

By Lawrence A. Schienbein, CWT Technologies, Inc.

While small distributed generation (DG) installations are already commonplace, standardization of requirements for their interconnection to electric power systems is not. Standard IEEE P1547, "Standard for Distributed Resources Interconnected with Electric Power Systems," aims to provide a uniform standard for the interconnection of DG systems to electric power systems. The standard will provide requirements addressing performance and testing in addition to the operation and safety considerations discussed here.

The standard's protection logic focuses on:

- Reducing potentially damaging transients when connecting and disconnectine DG units to the network. Transients are mitigated by the proper selection, installation, maintenance, and control of the transfer switch subsystem and the auto synchronizer, which are highly standardized and mature products that can be readily selected for the specific DG system.
- Protecting the utility feeder, loads, and utility personnel by ensuring that none of the DG units continue to supply a utility feeder and its loads after that feeder has been disconnected from the utility network or during a general utility network outage. This phenomenon is called "islanding" or "run on."

The requirements (and therefore the complexity and cost) of protection and control systems for DG systems, beyond the requirements of various codes and standards, depend primarily on:

- The size of the DG system with respect to the minimum total customer load on the feeder ("penetration").
- The number, size, and location of other DG units on the feeder.
- Whether the unit is intended to operate primarily in a grid-connected or grid-independent mode.
- The type of DG system–diesel generator, gas turbine generator, fuel cell etc.
- The specific configuration of the feeder (including laterals to the loads)–the size, location, operating mode and type of relays, breakers and fuses; the feeder voltage; and the location, size and configuration of all transformers.
- Network operator requirements specific to that network and any additional safety requirements of local jurisdictions.

Typical utility guidelines and requirements for operating, metering, and protective relaying for the interconnection of small power generators (less than about 200 kVA) can be summarized as:

- The power supplied must be 60Hz AC.
- Basic designs must meet applicable minimum electrical standards as adopted by, but not limited to, national, state, and local governing bodies including the National Electrical Code and others.
- A manual and lockable disconnecting device must be installed at the point of interconnection in series with a protective fuse and a fused disconnect.
- A line voltage relay/contactors must be installed to disconnect the generator from the de-energized feeder and to prevent its reconnection until the line is reenergized by the utility. Under-voltage, over-voltage, under-frequency and over-frequency sensors must be installed and connected to the relay (the "anti-islanding" requirement).
- All reactive power requirements for induction generators or power inverters must be supplied by the utility to reduce the possibility of self-excited operation if the feeder is de-energized.

However, many utility guidelines were developed with the expectation that few interconnected generators would be installed on a given feeder and the penetration would be very low, typically less than 10 percent. Therefore, it was assumed there would be no appreciable effect on relays and breakers designed and set up for current flow in one direction only, and also no effect on the feeder's overall stability. Furthermore, where penetration was low, it was assumed that if the feeder were isolated from the network for any reason, the DG units could not under any circumstance continue to supply the load, the voltage would collapse, and the DG units would shut down automatically (on an under-voltage trip). This again brings up the issue of islanding.

Islanding is possible if the DG controller misinterprets or does not detect the opening of the utility's feeder breaker so the DG unit continues to feed power to the intended customer and to the "dead" feeder line. Some or all of the other loads may remain connected to the feeder. They would be fed potentially damaging power of poor voltage and

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2000 Calendar of Events

SEPT

11-13 **Hybrid Electric Vehicles 200–New Opportunities for Powering Transport**. Windsor, Ontario, Canada. Tel: (207) 781-9800.

11-15 **HYFORUM 2000, The International Hydrogen Energy Forum 2000**. Munich, Germany. Website: www.hyforum2000.de.

20-2 **2 POWER-GEN Asia**. PennWell Conferences & Exhibitions, Bangkok. Tel: (918) 831-9160.

22-24 **Forum on Converting to a Hydrogen Economy**. University Park Holiday Inn, Fort Collins, CO. Website: http://www.hydrogennow.org.

24-27 **21st Annual North American Conference of the USAEE/IAEE**. Philadelphia. E-mail: usaee@usaee.org.

25-27 **The Market and Technical Outlook for Distributed Power: Strategies and Business Opportunities for the Use, Cost and Quality of DP**. Sheraton National Hotel, Washington, D.C. Website: www.intertechusa.com.

25-28 **National Electrical Contractors Association Show and Exposition**. Tampa. Tel: (847) 480-9628.

25-29 **Distributed Generation Association of Energy Engineers.** Milwaukee. Tel: (770) 447-5083.

26-27 **Fuel Cell 2000 Technology Research and Development Conference**. Strategic Research Institute, Philadelphia. Website: www.srinstitute.com; Tel: (212) 967-0095, ext. 239; E-mail: bmilicevic@srinstitute.com.

OCT

1-6 **International Symposium on Metal Hydrogen Systems (MH2000): Fundamentals and Applications**. Noosa, Queensland, Australia. E-mail: Dr. Evan Gray, E.Gray@sct.gu.edu.au; Website: www.ccm.com.au/mh2000/mh2000.html.

8-11 **Gasification Technologies Conference**. Gasification Technologies Council, San Francisco. Tel: (703) 276-0110.

8-12 **Southern Building Code Congress International Annual Conference**. Nashville. Tel: (205) 591-1853; E-mail: info@sbcci.org.

13-18 **International Electric Vehicle Symposium & Exposition**. Montreal. Tel: EVAA (202) 508-5995; E-mail: ElectricEvent17@aol.com.

15-19 **Bioenergy 2000: Moving Technology into the Marketplace**. Buffalo. Tel: (202) 624-8464, E-mail: Christina Caffo at nrbp@sso.org.

17-19 **F-Cells Week**. Holiday Inn, London. Website: http://www.iqpc.com; E-mail: fcellsweek@iqpc.co.uk.

18-20 **The Environmental Superconference**. Capitol Hilton, Washington, D.C. Tel: (301) 587-6300 ext. 441 or ext. 320; Fax: (301) 565-9769; E-mail: bpiconferences@bpinews.com.

18-21 **American Society of Engineers Annual Conference**. Seattle. Tel: (703) 295-6300.

21-25 **World Energy Council 18th Congress & Exhibition**. Buenos Aires. Tel: +54-1-8143590.

NOV

30-2 **The 2000 Fuel Cell Seminar, Fuel Cells—Powering the 21st Century!** Oregon Convention Center, Portland. Tel: (202) 973-8671; E-mail: FUELCELL@courtesyassoc.com; Website: www.gofuelcell.com.

5-10 **International Mechanical Engineering Congress and Exposition, Winter Annual Meeting of ASME**. Walt Disney World Dolphin, Orlando. E-mail: imece@ASME.org; Website: www.asme.org/conf/congress00.

13 **National Electrical Manufacturers Association Annual Meeting**. Chicago. Tel: (703) 841-3279.

DEC

14-16 **POWER-GEN International**. Orange County Convention Center, PennWell Conferences & Exhibitions, Orlando. Tel: (918) 831-9160 or (800) 331-4463; Fax: (918) 831-9497.

20-22 **International Symposium on Fuel Cells for Vehicles**. Nagoya, Japan. E-mail: takeda@chem.mie-u.ac.jp.

2001 JAN

5-8 **DOE Distributed Power Program Review and Planning Meeting**. Washington, D.C. Tel: (303) 275-4358; Fax: (303) 275-3885; E-mail: kimberly_taylor@nr; Website: www.nrel.gov.

7-8 **The Construction Superconference**. San Francisco. Tel: (800) 274-0122 or (301) 587-6300; Fax: (301) 565-9769; E-mail: bpiconferences@bpinews.com.

16-18 **E-World of Energy International Trade Fair.** Essen, Germany. Contact: Klaus Reich,

Standards Committee Activity Updates

ANSI - Z21.83 - 1998/CSA 12.10, Fuel Cell Power Plants A second meeting is planned for late August or early-September to finalize draft change proposals to the standard. Contact: Steven E. Kazubski (CSA International), Tel: (216) 524-4990 ext. 8303; E-mail: steve.kazubski@csa-international.org.

ASME PTC 50, Performance Test Code for Fuel Cell Power Systems The object and scope have been completed and approved by ASME. A first draft was completed in April 1999. Work continues, and 2002 is the target date for completion and publication. The next meeting will be September 18-20 in Johnstown, Pennsylvania at the U.S. Department of Defense Fuel Cell Test and Evaluation Center. PTC 50 covers Phosphoric Acid, Proton Exchange Membrane, Molten Carbonate and Solid Oxide fuel cells for all applications. It provides test procedures, methods, and definitions to address the performance characterization of fuel cell power systems (overall) with respect to inputs and outputs at steady-state conditions. Contact: Tony Leo (Fuel Cell Energy), Tel: (203) 792-1460.

IEC TC 105, Fuel Cell Technologies The German National Committee of the IEC hosted the first meeting of the Technical Committee on February 23-24, 2000, in Frankfurt, Germany. A strategic policy statement was developed along with a framework for a set of fuel cell standards to be developed by the committee. The next meeting will be in summer 2001–Florence, Italy and Vancouver, Canada are locations under consideration. Contact: Steven E. Kazubski (CSA International), Tel: (216) 524-4990 ext. 8303; E-mail: steve.kazubski@csa-international.org.

IEEE P1547, Distributed Resources Interconnected with Electric Power Systems Draft 5, which represents a significant revision of previous drafts and now includes minimum performance requirements, was completed in August 2000; after the Golden, Colorado meeting August 23-24, the next working group meeting will be October 18-20 in Palo Alto, California. Draft 6 is expected to be the final draft, to be submitted for approval by March 2001. Contact: Richard DeBlasio (NREL), Tel: (303) 384-6490; E-mail: dick deblasio@tcplink.nrel.gov.

ISO TC 197, Hydrogen Technologies Standards under development include: ISO 13985, Liquid Hydrogen–Land Vehicle Fuel Tanks, expected August 2002 ISO; 13986, Tank Containers for Multi-Modal Transport of Liquid Hydrogen, expected January 2003; ISO 15866, Gaseous Hydrogen Blends and Hydrogen Fuel - Service Stations, expected November 2001; ISO 15869, Gaseous Hydrogen Blends and Hydrogen Fuel - Land Vehicle Fuel Tanks, expected January 2002; ISO 15916, Basic Considerations for the Safety of Hydrogen Systems, expected June 2001. The next meeting will be September 2000 in Munich, Germany. Contact: Karen Miller (NHA), Tel: (202) 223-5547; E-mail: kmiller@ttcorp.com.

National Evaluation Service (NES) Protocol, Fuel Cell Installations NES is developing an evaluation protocol by which stationary fuel cell power plants can be evaluated and a National Evaluation Report can be issued on a subject technology. A National Evaluation Report verifies and supports compliance with adopted codes and standards and is used by state and local code officials to enforce building regulations. Comments and revisions received to date have been incorporated into a white paper. The first draft of the evaluation protocol should be available for comment by the NES Fuel Cell Advisory Panel (FCAP) in August. At that time, the FCAP will comment on the accuracy of the first draft; the protocol should be finalized by September 2000. Contact: Darren Meyers (BOCA), Tel: (708) 799-2300; E-mail: dmeyers@bocai.org.

NFPA 70 - Article 691/2, Fuel Cell Systems Article 691 was accepted in principle at the code-making panel meetings in January 2000. In May 2000, the NEC Technical Correlating Committee (TCC) directed that a new title, "Fuel Cell Systems," be used and the article be renumbered as Article 692. The Report on Proposals, including the proposed new Article 691, is now available for public review and comment. All comments must be received in writing by 5 p.m. Eastern Standard Time October 27, 2000. Code-Making Panel 3 will address these comments and others December 7-9, 2000, in Phoenix, Arizona. The panel's actions will be reviewed at the TCC meeting March 5-9, 2001, and a Report on Comments will be available in April. NFPA members will vote on the standard May 13-17 in Anaheim, California. The NFPA Standards Council will issue the 2002 NEC on July 20, 2001, and make it available in September. For information on submitting comments, call Jean O'Connor at NFPA, Tel: (617) 984-7421.

NFPA 853, Installing Fuel Cells In May 2000, the NFPA membership voted to accept NFPA 853. The article will be printed and made available by September 2000. Contact: Don Drewry (Hartford Steam Boiler), E-mail: Don_Drewry@hsb.com.

UL 1741, Static Inverters and Charge Controllers The scope of this PV standard is being increased to cover all inverters, converters, and equipment controllers with or without connection to the power grid. All DER technologies (microturbines, fuel cells, wind turbines, photovoltaic systems) will be covered. The new title and scope will take effect November 7, 2000. Proposed changes will be available for comment by late 2000. Contact: Tim Zgonena, Tel: (847) 272-8800, ext. 43051; E-mail: Timothy.P.Zgonena@us.ul.com.

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e-mail: am.borbely@pnl.gov.

regulated frequency until the distributed generators and/or loads were disconnected once the conventional, passive protection systems had detected the over/under-voltage or over/under-frequency.

The quality of the voltage and frequency delivered depends on the rating of the DG that remains connected and the size of the loads being supported when the feeder breaker opened. For example, the voltage could collapse almost immediately if the connected load demand far exceeds the rating of the connected DG. In this case, under-voltage and under-frequency will be detected. In particular, wind turbines driving induction generators have demonstrated that basic over/under-voltage and over/under-frequency sensors, relays, and control logic are quite adequate to prevent islanding where the penetration is low.

Draft 5 of IEEE P1547, Distributed Resources Interconnected with Electric Power Systems, was completed in August. This is a significant revision of previous drafts and now includes minimum performance requirements. The next working group meeting will be October 18-20 in Palo Alto, California.

the ratio of the total distributed generator capacity to the instantaneous demand load is relatively large. The results of tests recently conducted by Sandia National Laboratories on photovoltaic inverters showed that when several inverters (with different anti-islanding techniques) were operating on a single 120-V circuit, the inverters frequently continued to feed power from the photovoltaic arrays to the circuit loads for periods longer than 30 seconds after the circuit was disconnected from the network. In these cases, the ratio of generated power to load demand on the circuit was between 0.8 to 1.2. Sandia has proposed a method for designing an anti-islanding inverter that includes both active (frequency shift and voltage shift) and passive (over/under-frequency and over/under-voltage) techniques.

UL 1741 Expanding to include Fuel Cells

Static inverter standard revised to cover all DER technologies

UL 1741, originally written to cover static electrical inverters (converting DC to AC) for photovoltaic systems, is currently under review to include an expanded suite of DER technologies. Fuel cell inverters top the list of technology drivers for the revision, along with micro- and wind-turbine controller equipment.

The new scope and title of the standard, "Inverters, Converters, and Controllers for Use in Independent Power Systems," will become effective Nov. 7, 2000. Soon after, UL staff will complete the first revision draft and send out the proposed new requirements for comments. UL 1741 is being used in its present form to evaluate wind and fuel cell inverters, but the technologies are not yet referenced by name.

"Due to the similarities between PV inverters presently covered by UL1741 and the inverters, converters, and controller equipment used in other DER applications, we are opening a standards project to add requirements to UL1741 to cover fuel cell and rotating machine inverters, converters, and utility interaction controllers," noted Tim Zgonena, Senior Project Engineer in UL's Engineering Services Division. "We're currently identifying the specific features of each distributed resource that need to be addressed in these requirements. For instance, PV modules have high inherent source impedance and high open-circuit voltages, which differs from most other [DER] sources. Even though UL1741 was written for PV inverters, the requirements are easily applied to other types of equipment like wind and microturbine converters and fuel cell inverters." Membership in the UL1741 Standards Technical Panel is being expanded to include members and industry experts for all types of DER technologies.

For more information, contact Tim Zgonena at Timothy.P.Zgonena@us.ul.com or call (847) 272-8800, Ext. 43051.

DOE Publicaton RL-P00-006

Printed on Recycled Paper

DOE Publishes Report on Barriers to Distributed Power

On May 31, 2000, the U.S. Department of Energy released its comprehensive report on marketplace barriers to distributed generation (DG) systems. The report, *Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects*, includes a case study of a 200-kW fuel cell demonstration project at a Michigan automobile testing laboratory. The local utility required an additional back-up charge of $50/kW per year, or $10,000. No back-up charge had ever been required of the laboratory's 375-kW diesel emergency back-up unit, and the utility would not consider the fuel cell as a replacement for the diesel unit. The energy supplier concurrently offered the laboratory a 10-year, 5 percent rate reduction as an incentive to abandon the project.

"Hundreds of millions of dollars and hundreds of thousands of work hours are lost each year due to power supply disruptions that could otherwise be avoided if the barriers to distributed electricity generation were removed," said Energy Secretary Bill Richardson. "When facilities such as hospitals and businesses with computers or other critical electronic technology can get power from either the grid or their own generating equipment, energy reliability and security will be greatly improved."

The report was prepared in response to interconnection barriers–including technical issues, institutional practices, and regulatory policies–cited by customers, vendors, and developers of DG technologies as the principal obstacles separating them from commercial markets. It presents case studies that focus on the difficulties proponents of DG systems faced in trying to connect them to the electric grid.

Of the 65 projects examined, ranging in size from 26 MW to less than 1kW, 25 percent experienced delays longer than four months; 29 were completed and interconnected; 9 were meeting only the customer's load and not sending any power to the grid; 2 had disconnected from the grid; 7 had been installed but were still seeking interconnection; 13 were pending; and 5 had been abandoned. Only 7 projects reported no major utility-related barriers and were completed and interconnected on a satisfactory timeline.

The report provides a 10-point action plan for reducing the technical, business practices, and regulatory barriers that may impede the deployment of distributed power technologies. The report (NREL/SR-200-28053) is available electronically: http://www.eren.doe.gov/distributedpower/barriersreport.

IEC/TC105 Develops Strategic Policy, Forms Working Groups

The German National Committee of the International Electrotechnical Commission hosted the first meeting of Technical Committee 105 on February 23-24, 2000, in Frankfurt, Germany. The committee developed a Strategic Policy Statement, designated initial ad hoc working groups, and agreed on modes of cooperation with other ISO technical committees. Technical Committee 105 will cover fuel cell technologies in stationary power plants, portable systems, and transportation applications. Both propulsion systems and auxiliary power units will be addressed.

The initial working groups include:

1. Definitions
2. Fuel Cell Module
3. Safety (Stationary Fuel Cell system)
4. Performance (Stationary Fuel Cell System)
5. Installation (Stationary Fuel Cell System)
6. Fuel Cell system for Propulsion (Fuel Cell System in Transportation)

Delegates to the meeting agreed in principle to find ways to cooperate with other standards bodies in both the automotive and hydrogen industries to avoid overlap. A joint Working Group "Integration of Fuel Cell Systems into Road Vehicles" will be set up with ISO Technical Committee 22 (Road Vehicles). Experts of the ISO Technical Committee 22 subcomittee 21 will take part in Working Group 6 on Fuel Cell Propulsion Systems. Industry and academic experts involved in Technical Committee 105 will support ISO Technical Committee 197 (Hydrogen Technologies and Infrastructure Issues) wherever necessary. Agreements with committee officers from IEC Technical Committee 31 (Electrical Apparatus for Explosive Atmospheres) and IEC Technical Committee 69 (Electric Vehicles) are being discussed. The Society of Automotive Engineers and IEC Technical Committee 105 will support each others' activities.

Technical Committee 105 standards will cover the market demand of fuel cell manufacturers, system integrators, installers, and users. Moreover, the standards must consider the specific interests of authorities, approval organizations, component manufacturers, fuel suppliers, and interests related to the infrastructure of fuel cell systems. International standards must be elaborated at this early stage to facilitate commercialization, international trade, and to harmonize and ease approval procedures for fuel cell units. However, the relatively young technology should not be restricted from further development.

Voting member countries of Technical Committee 105 are Canada, China, France, Germany, Italy, Japan, Netherlands, Switzerland, United Kingdom, and the United States. The U.S. delegation is Kelvin Hecht, David Conover, Steve Kazubski, George Earle, Andrew Skok, and Anthony Androsky.