3.B. National Evaluation Service Memo: Status of Codes and Standards and Identification of Additional Needs to Support their Enhancement, Further Development, Deployment, and Use

National Evaluation Service, Inc.

5203 Leesburg Pike, Suite 600 Falls Church, Virginia 22041-3401
Phone: 703-931-2187 Fax: 703-931-6506
www.nateval.org

May 25, 2001

To: US DOE Fuel Cell Summit V Attendees
Parties Interested in Fuel Cells

From: David Conover

Subject: Status of Codes and Standards and Identification of Additional Needs to Support their Enhancement, Further Development, Deployment, and Use

I have been asked to assist DOE by preparing this summary document on the status of codes and standards and making a presentation on the subject at Fuel Cell Summit V. In addition I have been asked to identify needs to support deployment of current codes and standards documents and development of future codes and standards to support this technology. I had prepared and released communications on March 16th and May 1st, 2001 that were intended to secure input on the status of codes and standards activities as well as activities needed in the future to facilitate fuel cell technology deployment and implementation. I received comments on and input to the status of codes and standards and have prepared the information below. As the nature of these activities is dynamic and it is likely some relevant information was not identified or provided, it is expected that this document will be further enhanced as a result of discussions at Summit V.

Codes and Standards Activities Relevant to Fuel Cells

Table 1 below identifies specific documents and organizational efforts that provide standards and code criteria applicable to fuel cells. Note that Table 3 provides additional detail for a number of the specific items mentioned in Table 1. For the purposes of Table 1, a stationary fuel cell is considered to be a unitary or field assembled fuel cell power plant that is non-portable. A portable fuel cell is considered anything non-stationary but not used in a vehicle or for propulsion. A vehicular fuel cell is one that is used on board a vehicle. The ICC Ad Hoc Hydrogen Committee on Hydrogen submitted the definitions below to the International Codes of the International Code Council (ICC). The ICC Code Development Committees recommended these definitions for approval in March 2001. Final action will take place on them this fall.

PORTABLE FUEL CELL APPLIANCE. A fuel cell generator of electricity, which is not fixed in place. A portable fuel cell appliance utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.

STATIONARY FUEL CELL POWER PLANT. A self-contained package or factory-matched packages which constitute an automatically-operated assembly of integrated systems for generating useful electrical energy and recoverable thermal energy that is permanently connected and fixed in place.

At the present time Table 1 does not include fuel cells that might be used in small portable applications such as for battery packs and cell phones. An attempt was made to determine if the table should also include such smaller applications for fuel cells. No input was received on that issue and the table does not specifically address such fuel cell applications, although they could be included within the category of portable fuel cells. The need for standards for such much smaller portable fuel cell devices continues to be an open issue that needs further discussion.

The purpose of this table is to identify codes and standards activities in the United States and at the international level (e.g. ISO and IEC). The darkened boxes indicate where there would be no logical entry possible.

Table 1

SUBJECT AREA	STATIONARY	PORTABLE	VEHICULAR
Terminology/definitions	IEC TC 105 WG 1 USFCC	IEC TC 105 WG 1 USFCC	IEC TC 105 WG 1 USFCC SAE Information report J 2574 (Draft), Fuel Cell Vehicle Terminology (to be mainlined directly to ISO TC 22/SC 21, IEC TC 69, JEVA and JAMA)
Fuel Cell safety	ANSI Z21.83 CSA U.S. Requirements No. 1.01, Residential Fuel Cell Power Generators IEC TC 105 WG 3 (liaison with IEC TC 31 on electrical apparatus for explosive atmospheres)	CSA Requirements No. 3.01, Portable Fuel Cell Appliances (Draft) IEC TC 105 future WG UL (considering development of a standard)	IEC TC 105 future WG 6 (liaison with ISO TC 22 SC 21 on electric road vehicles and IEC TC 29 on electric vehicles) SAE J2578 (to be mainlined directly to ISO TC 22/SC 21, IEC TC 69, JEVA and JAMA)
Fuel cell module	IEC TC WG 2 CSA CAS No. 33	IEC TC 105 WG 2 CSA CAS No. 33	IEC TC 105 WG 2 SAE Fuel Cell Standards Committee (dialogue started to determine the direction it will pursue in this area related to I/E performance requirements by suppliers to the OEMs)
Fuel cell performance	ASME PTC 50 ANSI Z21.83 IEC TC 105 WG 4	ASME PTC 50 CSA Requirements No. 3.01, Portable Fuel Cell Appliances (Draft)	ASME PTC 50 SAE Fuel Cell Standards Committee (3 work items to be draft documents by the end of summer, 2001)

SUBJECT AREA	STATIONARY	PORTABLE	VEHICULAR
Installation of a stationary fuel cell power plant	NFPA 853 Model Building Codes NES Fuel Cell Protocol IEC TC 105 WG 5		
Use of a stationary or portable fuel cell in, on or adjacent to buildings	NFPA 853 Model Building Codes	Model Building Codes	
Electrical components associated with the fuel cell	UL Standards are referenced in ANSI Z21.83 NFPA 70 NESC	NFPA 70	SAE
Inverters, controllers, and controllers	UL 1741	UL 1741	UL 1741
Interconnection of the fuel cell with the grid	IEEE 1547 UL1741 (to be harmonized with IEEE 1547 when it is finished) NESC	IEEE 1547 UL1741 (to be harmonized with IEEE 1547 when it is finished) NESC	IEEE 1547 UL1741 (to be harmonized with IEEE 1547 when it is finished) NESC
Parking, servicing, locating a non-stationary fuel cell in, on or adjacent buildings		Model Building Codes NFPA Standards	Model Building Codes NFPA Standards ICC Ad Hoc Committee for Hydrogen Gas
Hydrogen processing, storage and delivery		Model Building Codes NFPA Standards ISO TC 197	Model Building Codes NFPA Standards ISO 197
Service station hydrogen delivery components		ISO TC 197 NFPA Standards	ISO TC 197 SAE Fuel Cell Standards Committee Interface Working Group workshops bringing together vehicle manufacturers and connector suppliers addressing both hardware type and communication protocols. Draft document in process.
Hazardous fluids in fuel cell vehicles			SAE J2579

Future Needs

Some of the codes or standards in Table 1 may need revision and enhancement. In addition, there may be other standards and codes needed in the future to facilitate uniformity, communication, safety, etc. associated with fuel cells and the wide range of potential applications for the technology. Table 2 is intended to provide a framework for thought about what might be needed to support development of future codes and standards (both new and revisions to existing ones) as well as deployment and use of fuel cell technology. In addition a row has been included at the end of the table to allow for identification of codes and standards development and deployment initiatives that may be needed in the future.

Table 2

	STATIONARY	PORTABLE	VEHICULAR
Research	▪ Basis for designation of a fuel cell as stationary, portable, or vehicular ▪ I.D. of necessary safety concerns for each type of fuel cell and how to address them	▪ Basis for designation of a fuel cell as stationary, portable, or vehicular ▪ Safety related to hydrogen production ▪ I.D. of necessary safety concerns for each type of fuel cell and how to address them	▪ Basis for designation of a fuel cell as stationary, portable, or vehicular ▪ Safety related to hydrogen production ▪ I.D. of necessary safety concerns for each type of fuel cell and how to address them
Testing	▪ Hydrogen piping and use in buildings ▪ Basis for acceptance as an emergency power source ▪ Standardization of data	▪ Fail safe controls ▪ Standardization of data ▪ Dealing with hydrogen leakage, especially with indoor applications	▪ Ventilation needs for all parking garages ▪ How combustible liquids and flammable gases can co-exist in the same interior spaces or be stored on the same site ▪ Standardization of data
Documentation	▪ Protocol for verifying compliance with building codes	▪ Basis for acceptance as an appliance in buildings ▪ How much hydrogen can be stored where and in what for sale (work on the transport of the fuel supply for portable applications). The portable WG of the USFCC has commissioned a report from Rocky Mountain Environmental Strategies Inc. on this topic	▪ Basis for the acceptability of fuel cell vehicle storage, fueling, and use within the current building infrastructure
Education/Outreach (see information below on activities undertaken by the Hydrogen community)	▪ Presentations and videos for code officials on the technology and how to inspect and approve installations ▪ Commentary on fuel cells to support existing educational efforts for code officials ▪ Operational guidelines for building operators and consumers	▪ Operational guidelines for consumers	▪ Operational guidelines for consumers and distributors ▪ How to address hydrogen safety ▪ Servicing and maintenance protocols are being explored by SAE in cooperation with the Service Technicians Society (STS)
	STATIONARY	PORTABLE	VEHICULAR

Service/Field Support	▪ Availability of one trained technician to do all related design, permitting, installation and commissioning functions in lieu of a number of different experts on individual steps in the process	▪	▪
Future codes and standards	▪ Secure adoption by reference of NFPA 853 in the model building codes ▪ Develop standards for verifying or testing as-installed performance, which may be required for interconnection to the utility. The requirements for verifying as-installed performance can vary depending on the capacity of the unit, interconnection voltage, line PQ etc. Having some sort of as-installed test standard that recognizes these needs could avoid unnecessary testing or simplify testing of as-installed equipment ▪ Need for scope revision of NFPA 853 to cover equipment < 50 kW.	▪ This product will be asked to perform under a variety of environmental conditions and applications since conditions can vary significantly depending on the application. Standardized testing will be needed so the performance for a given range of conditions (e.g. temperature, humidity, etc.) can be stated or the recommended operating range of conditions can be identified and verified. ▪ CSA Requirements No. 3.01, Portable Fuel Cell Appliances (Draft)	▪ SAE has started a dialogue with the Performance Review Institute (PRI) for potential mobile unit certification

- Almost 5000 copies of the H2 Safety video (Hydrogen – The Matter of Safety) along with a companion booklet have been distributed to building code and fire safety officials throughout the U.S., Canada and even in Europe.
- Russ Hewett of NREL has prepared a draft of a simplified H2 Source Book aimed directly at building code and fire safety officials. Currently the draft is being reviewed by six focus groups (BOCA, ICBO, SBCCI, UL, Fairfax, Virginia Building Code Enforcement Office, and Marietta, Georgia Fire Department.
- Mike Swain has performed comparative tests on gasoline and H2 automobiles simulating an accidental fire. The tests have been captured on a dramatic video. Additional tests may be performed. Once all testing is completed a comprehensive safety video, demonstrating that H2 is not more dangerous than gasoline, will be produced.
- Additional fire testing of residential garages is tentatively planned for July 2001. It will involve almost a full-scale garage, with a full tank of H2 in an automobile. Test protocols are currently being refined. Once the work is complete, it will provide guidance for the ICC H2 AHC and may be incorporated in future educational materials for the code community.
- Mike Swain is making a presentation on his work at the NFPA conference in mid-May.
- The existence and availability of the H2 Source Book is a source of educational information on H2.
- A seminar and hands on demonstration is being planned for the joint BOCA/ICBO conference in Cincinnati. This is the first of what will be a series of seminars for code officials. Once there is a significant H2 content in the codes, it is anticipated that these seminars will offer continuing education credits.
- A new interactive CD Rom was intended primarily to be part of the science curriculum for high school and/or middle school students and is being considered for dissemination to the code community.

Summary Information on Codes and Standards

A summary on the status and/or contents of the codes and standards identified in Table 1 above is presented in Table 3.

Table 3

TITLE AND CONTACT	STATUS	DESCRIPTION
ANSI Z 21.83-1998 *Fuel Cell Power Plants* Steven E. Kazubski Project Manager, Standards CSA International 8501 E. Pleasant Valley Rd. Cleveland, OH 44131-5575 216-524-4990 x 8303 steve.kazubski@csa-international.org www.csa-international.org	The CSA Fuel Cell Working Group continues to prepare proposed revisions to the Standard on *Fuel Cell Power Plants, ANSI Z21.83*, in preparation of the standard being maintained by a new CSA Canvass Group and Technical Committee on Fuel Cells. At their last March 14-15, 2001 meeting, the working group formed seventeen Task Group assignments for the drafting of additional proposed coverage to various sections of *ANSI Z21.83*. As part of this process the standard is being revised to cover all types of fuel cells (as it was originally written with only two types in mind). The working group's goal is to finish their task assignments and reach consensus before August by holding a series of teleconference meetings. In parallel to the activities of the working group, preparations for the formation of CSA Fuel Cell Canvass Groups and a parent CSA Fuel Cell Technical Committee are being made. The first meeting of the new CSA Fuel Cell Technical Committee will be in late August or early September. An Initiation of Canvasses posting was published in the April 6, 2001 edition of the *ANSI Standards Action* newsletter. Four CSA Canvass Groups are being formed for the following CSA fuel cell standards projects, of which all are intended to become ANSI standards when completed: ▪ CSA FC 1, Fuel Cell Power Plants (revise and re-designation of ANSI Z21.83-1998) ▪ CSA FC 2, Residential	The standard applies to packaged, self-contained or factory matched packages of integrated systems of fuel cell power plants for use with natural or LP gas and having a maximum output voltage of 600 VAC and power output of 1,000 kW operating at no less than –20F (-29C). Criteria are provided for both construction and performance of applicable fuel cells. For construction the following are addressed: • Materials • General construction and assembly • Enclosures and associated construction • Heaters and vessels • Piping systems • Drain, venting, and ventilation exhaust systems • Automatic ignition systems and gas-air control • Flame safeguards • Fuel gas controls and equipment • Air/fluid handling and moving equipment • Electrical equipment and wiring • Protection of service personnel • Safety circuit analysis • Instructions and marking For performance issues such as ultimate strength, allowable leakage, protection, emissions, burner operation, automatic ignition, exhaust gas and surface and component temperatures, electrical tests, rain and wind, and adhesion/legibility of markings are addressed.

TITLE AND CONTACT	STATUS	DESCRIPTION
ANSI Z 21.83-1998 *Fuel Cell Power Plants (con't)*	Fuel Cell Power Generators (new standard) ▪ CSA FC 3, Portable Fuel Cell Power Generators (new standard) ▪ CSA FC 4, Fuel Cell Modules (new standard)	
CSA CAS No.33 *(CSA Component Acceptance Service No. 33 for PEM Fuel Cell Modules)* Todd Strothers CSA International Manager, Charlotte Office 5970 Fairview Road #416 Charlotte, NC 28210 (704) 552-5125 todd.strothers@csa-international.org www.csa-international.org	This is a 'Component Acceptance' document and not a 'Requirements' document, as a fuel cell module is not an appliance but only a component Published in September-2000, this document is currently being used by the U.S. and Canadian CSA Certification and Testing Departments for evaluating Fuel Cell Modules. This document will be used as a seed document for the creation of a U.S and Canadian national standard for *Fuel Cell Modules, ANSI/CSA FC 4*.	This document contains requirements for providing CSA International component acceptance service for Proton Exchange Membrane (PEM) fuel cell stacks (modules) using hydrogen as the fuel supply. The end product in which the fuel cell stack will be incorporated must be evaluated to additional requirements. Contents: Definitions - Cell reversal - Fuel cell - Fuel cell stack - Maximum operating pressure - Allowable working pressure Monitoring Systems - Temperature monitoring - Voltage monitoring - Gas leakage rate Verifications and tests - Specification verification - Gas leakage rate - Ultimate strength - Pressure withstanding test of cooling system - Abnormal test - Dielectric strength - Vibration Marking
CSA U.S. Requirements No. 1.01, Residential Fuel Cell Power Generators Todd Strothers CSA International Manager, Charlotte Office 5970 Fairview Road #416 Charlotte, NC 28210 (704) 552-5125 todd.strothers@csa-international.org www.csa-international.org	This document is currently in draft form and is expected to be finalized in June 2001. This supplemental guide to ANSI Z21.83-1998 mirrors many of the proposed coverage that the CSA Fuel Cell Working Group has been developing for updating the Z21.83 standard as such coverage pertains to residential fuel cell power generators. As it will take more than a year for the next version of ANSI Z21.83 to be approved, in the interim CSA International is issuing this supplemental standard to better provide coverage for residential fuel cells.	CSA U.S. Requirements No. 1.01 supplements the provisions contained in ANSI Z21.83-1998. This standard applies to packaged, self-contained residential fuel cell power generators for outdoor installation. The standard defines a residential fuel cell power generator as a unit serving a single family or two family dwelling not exceeding 50kW in total AC power output. Light commercial installations such as professional offices, shops, etc. which can be adequately powered by units not exceeding 50kW are also to be considered residential applications. Provisions are listed for a user's information manual and appliance markings. When certifying a residential fuel cell power generator design, CSA will use ANSI Z21.83-1998 and the CSA U.S. Requirements

TITLE AND CONTACT	STATUS	DESCRIPTION
CSA U.S. Requirements No. 1.01, Residential Fuel Cell Power Generators (con't)	As ANSI Z21.83 has yet to be fully approved in Canada, this CSA Requirements document is being developed only for the U.S. at this time.	No. 1.01 as a supplemental standard. Once ANSI Z21.83-1998 is updated with specific provisions for residential fuel cells or CSA FC 2 is developed and approved as an ANSI standard, CSA U.S. Requirements No. 1.01 will be withdrawn.
CSA Requirements No. 3.01, Portable Fuel Cell Appliances Todd Strothers CSA International Manager, Charlotte Office 5970 Fairview Road #416 Charlotte, NC 28210 (704) 552-5125 todd.strothers@csa-international.org www.csa-international.org	CSA International is currently creating the first draft of this document. A draft version of CSA Requirements No. 3.01 will be available for full industry review and comment by July 2001. When completed, this document will be used as a seed document for the creation of a U.S and Canadian national standard for *Portable Fuel Cell Power Generators, ANSI/CSA FC 3*.	It is the intent that this joint U.S. and Canadian standard will cover portable fuel cell power generators that incorporate various fuel cell technologies.
NFPA 853, Standard for the Installation of Stationary Fuel Cell Power Plants Mr. Richard P. Bielen, PE NFPA International 1 Batterymarch Park Quincy, MA 02669 617-770-3000 rbielen@nfpa.org www.nfpa.org Mr. Donald Drewry (Chair of Task Group on Fuel Cells) Hartford Steam Boiler don_drewry@hsb.com	NFPA 853 was developed over a 3-year period and was completed in May 2000. The standard is now available from the NFPA. The next revision of the standard will be completed by May 2003. The committee will be accepting public proposals until December 28, 2001 and will meet in the spring of 2002 to consider any proposals that were submitted.	The scope of the standard is the design, construction, and installation of stationary (non-portable) fuel cell power plants with a gross electrical generation that exceeds 50 kW; including (1) A singular prepackaged, self-contained power plant unit (2) Any combination of prepackaged, self-contained power plant units (3) Power plant units comprised of two or more factory matched modular components intended to be assembled in the field and (4) Engineered and field-constructed power plants that employ Fuel cells. Chapter 2 provides a description of various configurations of fuel cells, to which various criteria are applied. These configurations include pre-packaged self-contained, pre-engineered, and engineered and field constructed fuel cell power plants. Chapter 3 provides criteria related to the siting of fuel cells in all locations as well as specific indoor, outdoor, and rooftop installations and interconnections with other building systems. Chapter 4 covers fuel supplies including natural gas, LPG, biogas, fuel oil, and hydrogen. Chapter 5 addresses ventilation and exhaust of the installation. Chapter 6 covers fire protection. Chapter 7 lists other referenced publications. These include other NFPA standards, ANSI Z21.83, and certain ASME pressure and

TITLE AND CONTACT	STATUS	DESCRIPTION
NFPA 853, Standard for the Installation of Stationary Fuel Cell Power Plants (con't)		process piping standards.
NFPA 70 *National Electric Code* National Fire Protection Association 1 Batterymarch Park Quincy, MA 02269-9101 Jean O'Conner Phone: 617-984-7421 Fax: 617-984-7070 joconner@nfpa.org www.nfpa.org	A proposal to add a new Article 692 to the NEC dealing with fuel cells has been submitted to NFPA for consideration in the NEC and approved in principal. At a December 2000 meeting the Article was titled Fuel Cell Systems. Public comment was solicited on the proposal and 5 comments were received. It was to be considered for final action in May 2001 by the NFPA. NEC / NFPA 70 Article 705 update. The revision is in a holding pattern. The report on proposals came out in July 2000. Public comment extends until October. At the Annual Meeting in May 2001nothing further happened regarding fuel cells on the floor of the Technical Session on the adoption of the NEC. Therefore, it will remain as it read in the draft. Publication is likely in September of 2001.	The NEC provides criteria that would apply to certain electrical installations related to fuel cell power plants. At the present time it does not contain any fuel cell-specific criteria. The draft Article 692 covering self-contained fuel cells addresses the following: • Installation requirements • Circuit requirements • Overcurrent protection • Wiring requirements associated with and outside the fuel cell • Grounding • Marking • Connections to other systems Fuel cells with outputs over 600 volts ac are required to meet Article 490 of the NEC.
UL 1741 , Standard for Inverters Converters and Controllers for use in Independent Power Systems Tim Zgonena (UL) 847-272-8800 x 43051 timothy.p.zgonena@us.ul.com	UL 1741 has been harmonized with IEEE 929. Utility Interactive products listed to the published UL 1741 are being accepted by many utilities across the nation for utility grid interconnection. UL 1741 is slated for harmonization with IEEE P1547, Distributed Resources Interconnected with Electric Power Systems, once IEEE 1547 is published. This harmonization should occur in the Fall of 2001 and will allow manufacturers to have their products evaluated once, to comply with the necessary national electrical safety and utility interconnection performance requirements.	
ASME PTC 50 *Performance Test Code for Fuel Cell Power System Performance*	The Object and Scope have been completed and approved by ASME. A first draft was completed in April 1999. Work continues with a targeted	*An outline of the standard is as follows:* 1. Object, Scope, and Measurement Uncertainty 2. Definitions and Descriptions of Terms

TITLE AND CONTACT	STATUS	DESCRIPTION
ASME PTC 50 Performance Test Code for Fuel Cell Power System Performance (con't) Jack Karian ASME staff 212-705-8552 karianj@asme.org Tony Leo FuelCell Energy Inc. 3 Great Pasture Road Danbury, CT 06813-6135 Work Phone: 203-825-6068 Fax: 203-825-6135 E-mail: tleo@fce.com	date of 2002 for completion and publication. PTC 50 is currently compiling a list of potential reviewers for a draft of the standard. A meeting of PTC 50 is scheduled for June 12th and 13th in New York City.	3. Guiding Principles 4. Instruments and Methods of Measurement 5. Calculations and Results 6. Report of Results 7. Uncertainty PTC 50 covers PA, PEM, MC and SO fuel cells for all applications. Test procedures, methods, and definitions are provided to address the performance characterization of fuel cell power systems (overall) with respect to inputs and outputs at steady state conditions.
2000 International Mechanical, Fuel Gas, and Residential Code International Code Council 5203 Leesburg Pike Suite 708 Falls Church, VA 22041 703-931-4533 www.intlcode.org	The 2000 International Mechanical Code (IMC) has been published and provides criteria for the installation and use of mechanical equipment and appliances. Revisions to the 2000 International Fuel Gas Code (IFGC) were made in 2000 to include similar language to that in the IMC. The ICC AHC (see below) submitted proposals (M1-01, FG4-01, and RM9-01) in 2001 that define the terms STATIONARY FUEL CELL POWER PLANT and PORTABLE FUEL CELL APPLIANCE in the International Codes, while adding coverage for stationary fuel cell power plants in the International Residential Code by way of reference to ANSI Z21.83-1989. Those changes were recommended for approval in March 2001 hearings. Final disposition of the changes will be addressed in the Fall of 2001at hearings held in conjunction with the BOCA/ICBO and SBCCI annual business meetings.	Section 924 of the IMC covers stationary fuel cell power plants as follows: "924.1 General. Stationary fuel cell power plants having a power output not exceeding 1,000 kW, shall be tested in accordance with ANSI Z21.83 and shall be installed in accordance with the manufacturer's installation instructions." Fuel cell power plant installations greater than 1,000 kW output would have to be approved under a section of the IMC on alternative methods and materials wherein the technology proponent would have to provide test data, calculations, and other documentation showing that what they proposed was "equivalent in performance from a safety and health standpoint" to other technologies specifically provided for in the code.
Evaluation Protocol for Stationary Fuel Cell Power Plants	The NES developed the evaluation protocol with the assistance of an expert panel comprised of individuals familiar with fuel cell	The Protocol is for use by the National Evaluation Service to facilitate the process of evaluating stationary fuel cell power plant technology for compliance with the above codes. The protocol sets forth general criteria

TITLE AND CONTACT	STATUS	DESCRIPTION
Evaluation Protocol for Stationary Fuel Cell Power Plants (con't) *National Evaluation Service* *5203 Leesburg Pike, Suite 600* *Falls Church, VA 22041* *David Conover* *703-931-2187* *dconover@nateval.org* *www.nateval.org* *Darren Meyers* *708-799-2300 x 307* *dmeyers@bocai.org*	technology and health and life-safety issues. The protocol was published in May 2001 and is available for use by fuel cell proponents who want to determine what information and documentation they may need to verify their compliance with the U.S. model codes. If they desire an evaluation report from NES supporting their claim of compliance, NES staff will also use the protocol as a guide in performing the evaluation and issuing an NES evaluation report.	for testing and evaluation of the covered technology and its installation and integration with the built environment. Manufacturers and users of the technology can use it as a roadmap to testing, calculations, documentation and other supporting information necessary for obtaining approval for a particular installation under the codes above. An outline of the protocol is as follows: • Scope • Intent • Reference Standards ▪ Product Evaluation Criteria ▪ In-situ evaluation criteria • Definitions • Evidence required • General • Conditions of Use
IEEE Standards Coordinating Committee (SCC) 21 IEEE Standards Department 445 Hoes Lane, P.O. Box 1331 *Piscataway, NJ 08855-1331, USA* Richard DeBlasio (Chair SCC 21) National Renewable Energy Lab 303-384-6452 deblasid@tcplink.nrel.gov T. Basso (Secretary of P1547 Working Group) National Renewable Energy Laboratory – MS1614 1617 Cole Blvd Golden, CO, 80401-3393 303-384-6765 thomas_basso@nrel.gov P1547 website and archives http://grouper.ieee.org/groups/scc21/1547 http://grouper.ieee.org/groups/scc21/1547/archives/	The IEEE SCC has a number of different projects underway and is responsible for standards associated with fuel cells, photovoltaics, dispersed generation and energy storage *SCC 21 reports directly to IEEE Standards Board.* The *P1547 Draft Standard for Interconnecting Distributed Resources With Electric Power Systems* is a very active and fuel cell-relevant activity. Draft 7 of that standard was balloted, ending 3/28/01 and did not receive the 75% affirmative vote required by IEEE. The April 18th through 20th meeting of P1547 addressed ballot resolution and was attended by 88 individuals. A working group will meet June 5th through 8th to re-word draft 7 to address negative comments. The resultant re-draft is scheduled for re-circulation this summer. The P1547 working group has met about every 2 months for 2-1/2 years and will meet during the summer in Golden CO. The standard is slated for completion in 2001. Six prospective new IEEE distributed resources activities were identified and discussed for consideration by the	Chapter 1 of the standard provides an introduction including scope and purpose. The standard establishes criteria and requirements for interconnection of distributed resources with electric power systems. The purpose of P1547 is to provide a uniform standard for interconnection of distributed resources with electric power systems, and requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. The criteria and requirements in P1547 are applicable to all distributed resource (DR) technologies and to the primary and secondary voltages of the electric power distribution systems. Installation of DRs on radial primary and secondary distribution systems are the main emphasis, although primary and secondary network distribution systems are considered. The requirements of P1547 are to be met at the point of common coupling, although the location of the protective devices may not necessarily be at that point. Chapter 2 lists references required to be used in conjunction with P1547 to meet the standard. Chapter 3 provides definitions and terminology pertinent to P1547 that is not already included in the IEEE Standard 100 Dictionary. Chapter 4 covers technical requirements and specifications associated with items such as voltage regulation, power quality, and abnormal operation. Chapter 5 provides test specifications and requirements, including interconnection tests, production tests, interconnection installation evaluation, commissioning tests, and periodic tests.

TITLE AND CONTACT	STATUS	DESCRIPTION
IEEE Standards Coordinating Committee (SCC) 21 (con't)	SCC21/P1547 members at their January and April 2001 meetings. Some of those activities include aspects directly pertinent to all dispersed generation including fuel cells. Project Authorization Requests (PARs) were established for: ▪ Standard for Testing Interconnected Systems for Distributed Resources ▪ Application Guide for Distributed Resources ▪ Recommended Practice for Monitoring and Control of Distributed Resources Future discussion will cover possible PARs for: ▪ DG and equipment – specifications and performance ▪ Network specifications and applications with DG ▪ Certification of DR and interconnection equipment	There also are informative annexes on testing, and a bibliography.
IEC TC 105 on Fuel Cells John Bossert, Canada (Chair) Werner Tillmetz, Germany (Secretary) Andreas Piepereit, Germany (Asst. Secretary) Kelvin Hecht (US Technical Advisory Group [TAG] Technical Advisor) International Fuel Cells 127 Craigemore Circle Avon, CT 06001 860-673-9181 kelvinhecht@home.com David Conover (US TAG Deputy Technical Advisor) NES, Inc. 5203 Leesburg Pike Suite 600 Falls Church, VA 22041 703-931-2187 dconover@nateval.org	IEC TC 105 has a scope to prepare international standards regarding fuel cell technologies for all fuel cell applications such as stationary, transportation and portable applications. Membership is from CA, CN, FR, DE, IT, JP, NL, CH, GB, and the US. Liaisons have been established with IEC TC 69 (electric vehicles), ISO TC 22 SC 21 (electric road vehicles), ISO TC 197 (Hydrogen technologies) and IES TC 31 (electrical apparatus in explosive atmospheres). SAE and IEC TC 105 have agreed to support each other's activities. IEC TC 105 had their first meeting February 23 and 24, 2000 will meet again September 6th and 7th in London. Some working groups of IEC TC 105 have had meetings during the past year. The US TAG had their first meeting on March 13, 2001. IEC TC 105 will meet in London on September 6 and 7, 2001. WG 2 will meet in advance of that meeting on the	The IEC TC 105 membership have developed the following program of work that is being conducted by various ad hoc working groups (WG) who are lead by specific country convenors. WG 1 – Definitions (US) with a draft being based on US FCC and Japanese definition documents WG 2 – Fuel Cell Module (DE), for stationary, portable and vehicular applications, with an outline available and meetings held to draft a standard WG 3 – Safety for stationary fuel cell systems (US) with an outline available that is based on the criteria contained in ANSI Z21.83, ISO, IEC and EN standards WG 4 – Performance of stationary fuel cell systems (JP) with a working draft of a standard available based on a Japanese Standards Association technical report on test methods for performance of phosphoric acid fuel cell power plants WG 5 – Installation of stationary fuel cell systems (US) with a work proposal to be developed and use of NFPA 853 as a starting point under development. A first WG5 meeting could occur by the end of 2001. WG 6 – Fuel cell systems for propulsion (DE) TC 105 has also identified work needing to be done on the following items but have yet

TITLE AND CONTACT	STATUS	DESCRIPTION
IEC TC 105 on Fuel Cells (con't) CSA America, Inc. U.S. TAG Administrator Steve Kazubski (Secretary) 8501 E. Pleasant Valley Rd. Cleveland, OH 44131-5575 216-524-4990 x 8303 steve.kazubski@csa-international.org	4th and 5th of September. WG 3 will meet on July 19th and 20th in Boston. IEC and ISO have also been working to address coordination of efforts between IEC TC 105 and ISO/TC 197 (hydrogen) and a coordination meeting was requested. The ISO has also encouraged ISO/TC 197 to participate in IEC TC 105 working group meetings.	to form working groups to address them. • Fuel cell system integration into road vehicles (with ISO TC 22) • Auxiliary power units for fuel cell systems in transportation • Portable fuel cell systems
Society of Automotive Engineers (SAE) SAE International 400 Commonwealth Drive Warrendale, PA 15096 Tony Androsky 724-772-8557 androsky@sae.org Jane Hock 724-772-8557 jhock@sae.org	The Society of Automotive Engineers has established a very broad base Fuel Cell Standards Committee that addresses the needs of the producer, user, consumer, and regulator in regards to fuel cells for transportation applications. The SAE Technical Standards Board is currently addressing passenger vehicle applications. Because of the broad application potential of fuel cell technology work is being identified by the Aerospace Council, ConAg Council, Truck & Bus Council, ITS Division, Manufacturing Division, and the Fuels & Lubricants Division. In addition the Service Technicians Society (STS) is identifying servicing and maintenance need sand the Performance Review Institute (PRI) is exploring certification requirements.	The SAE Fuel Cell Standards Committee has established the following living scope of work and mission statement: "To establish standards and test procedures for fuel cell powered vehicles. The standards will cover the safety, performance, reliability, and recyclability of fuel cell systems in vehicles with emphasis on efficiency and environmental impact. The standards will also establish test procedures for uniformity in test results for the vehicles/systems/components performance, and define interface requirements of the systems to the vehicles." The Committee has establish the following Working Groups as covered below: ▪ Safety ▪ Terminology ▪ Performance ▪ Recyclability ▪ Interface ▪ Emissions & Fuel Economy ▪ Reliability
SAE Fuel Cell Standards Committee Safety Working Group Jane Hock 724-772-8557 jhock@sae.org	Draft document in work.	J2578 Recommended Practices for General Fuel Cell Vehicle Safety J2579 Recommended Practice for Hazardous Fluid Systems in Fuel Cell Vehicles
SAE Fuel Cell Standards Committee *Terminology Working Group* Jane Hock 724-772-8557 jhock@sae.org	Ballot process will begin in June 2001.	J2574 Fuel Cell Electric Vehicle Terminology (Developed jointly with JEVA, JAMA)
SAE Fuel Cell Standards Committee *Performance Working Group*	Draft documents in development.	Documents cover: Fuel Cell System Performance Testing

TITLE AND CONTACT	STATUS	DESCRIPTION
SAE Fuel Cell Standards Committee *Performance Working Group (con't)* Jane Hock 724-772-8557 jhock@sae.org		Fuel Processor Subsystem Performance Testing Fuel Cell Stack Subsystem Performance Testing
SAE Fuel Cell Standards Committee *Recyclability Working Group* Jane Hock 724-772-8557 jhock@sae.org	Draft document in development.	J2594 Fuel Cell Recyclability Guidelines
SAE Fuel Cell Standards Committee *Interface, Working Group* Jane Hock 724-772-8557 jhock@sae.org	Second design request letter being sent out in May 2001. Draft Document in work. Next workshop in planning process.	Several workshops have been conducted bringing together OEMs, plumbing and connector manufacturers, along with communications (RF, IR, and Default) protocol experts. These are focused on ensuring globally harmonized standards for compatible refueling activities.
SAE Fuel Cell Standards Committee *Emissions & Fuel Economy Working Group* Jane Hock 724-772-8557 jhock@sae.org	Ballot process to begin in September 2001.	J2572 Recommended Practice for Measuring the Exhaust Emissions, Energy Consumption and Range of Fuel Cell Powered Electric Vehicles Using Compressed Gaseous Hydrogen
ISO/TC 22/SC 21 on electric road vehicles (ERVs) Klaus Orchowski [Klaus.Orchowski@t-online.de] ISO XXXXX Fuel cell powered road vehicles-Safety specifications-Part 1...4 under development by ISO/TC 22/SC 21WG 1 (convenor Klaus Orchowski, klaus.orchowski@t-online.de)	Within ISO this subcommittee is responsible for all electrically propelled road vehicles on standards related to the vehicle as a whole. For components, off-board and specific aspects other ISO and non-ISO standardization committees have or share the responsibility with ISO/TC22/SC21. An agreement of cooperation designating working mode 4	ISO/TC22/SC21 has two working groups. WG 1 addresses vehicle operating conditions, safety and energy storage installation. WG 2 addresses definitions and performance measurement. WG 1 has developed a three-part ISO/DIS 6469-1 ERV safety specification covering onboard energy storage, functional safety means and protection against failures, and protection of persons against electric hazards. WG2 has developed three standards: ▪ ISO/DIS 8713 ERV Terminology ▪ ISO/DIS 8714 ERV Test procedure for energy consumption and range for

TITLE AND CONTACT	STATUS	DESCRIPTION
ISO/TC 22/SC 21 on electric road vehicles (ERVs) (con't)	working mode 4 (collaboration) has been signed with IEC TC 105 to facilitate integration of fuel cells into road vehicles. ISO will take the lead in standardization associated with integrating the fuel cell into the vehicle and IEC will take the lead in standardization associated with fuel cells for propulsion (IEC TC 105 WG 6). A joint steering committee will coordinate activities and resolve issues. Early stage of development	passenger cars and light commercial vehicles ▪ ISO/DIS 8715 ERV road operating characteristics This standard will prescribe the necessary minimum of fundamental safety requirements specific to fuel cell powered road vehicles. The various parts deal with hazards related to hydrogen, higher voltage levels, vehicle operational modes specific to fuel cells as part of the propulsion system.
ICC Ad Hoc Committee (AHC) for Hydrogen Gas Darren Meyers, Secretariat BOCA International 4051 East Flossmoor Road Country Club Hills, IL 60478 708-799-2300 x 307 dmeyers@bocai.org	The AHC (balanced membership of hydrogen users, producers, manufacturers and regulator interests) is undertaking a review of current codes and standards applicable to the vehicular and portable hydrogen infrastructure in buildings. They are focused on the acceptance and safe deployment of portable and vehicular hydrogen-based technologies in the built environment. Six (6) subcommittee working groups have been established and are working closely with the AHC during the draft development stages of proposed changes to the ICC International Codes: WG1 Private Garages WG2 Public Garages WG3 Hydrogen Refueling and Generating Stations WG4 Portable Hydrogen Appliances WG5 Integrating hydrogen as a fuel into IFGC WG6 Standards The next meeting of the AHC is at NREL in Boulder CO on June 4th and 5th, 2001.	Preliminary conclusions regarding hydrogen fire impingement tests and hydrogen gas dispersion characteristics as they pertain to home-based refueling of hydrogen vehicles were presented at the AHC meeting in Portland OR in March 2001. An effort to promote a joint U.S. Canadian, harmonized standard for portable fuel cell power plants was also discussed at that meeting. Dr. Mike Swain, University of Miami, is conducting a variety of tests to establish ventilation and fire protection needs and design parameters for residential garages and presented the results of his research at the March meeting. The AHC remains focused on current and anticipated topics involving the acceptance and safe deployment of portable and vehicular hydrogen-based *technologies in the built environment.* *The AHC has also developed definitions for portable and stationary fuel cell power plants to help differentiate between a consumer product that may be addressed by building codes differently than a more stationary piece of equipment.*

TITLE AND CONTACT	STATUS	DESCRIPTION
National Hydrogen Association 1800 M Street NW, Suite 300 Washington, DC 20036-5802 Karen Miller, Vice President phone: (202) 223-5547 fax: (202) 223-5537 email: kmiller@ttcorp.com www.HydrogenUS.com	NHA's technical goal is to create draft standards for hydrogen systems and components using the expertise of the NHA membership. NHA will identify areas where codes and standards for the safe use of hydrogen energy systems are needed and coordinate their being addressed. Only when hydrogen safety issues are not being properly addressed would the NHA would want to initiate new standard. NHA has seven (7) working groups, in various stages of activity. WG1: Connectors WG2: a.Containers; b. Hydrides WG3: Refueling Stations WG4: Safe use of electrolyzers in customer sites, including homes. WG5: Self-service refueling (liquid and gaseous hydrogen). WG6: Coordination with the SAE on hydrogen safety with respect to the on board hydrogen systems. WG7: Maritime applications of hydrogen (identify unique applications).	*A draft standard has been developed by WG1 for gaseous hydrogen connectors. It was accepted by ISO/TC-197 and is undergoing international development.* *Related to WG2, the initial NHA draft standard for tanks included only materials used in CNG that were compatible with hydrogen. The international standard does not exclude composites and other materials, as long as they meet a stated performance standard. The NHA encourages members to join the ISO/TC-197 WG 5 and continue to advance the item internationally.* *Under WG 3 the NHA developed a draft standard on hydrogen refueling stations for ISO TC 197. The work item was accepted, but it has not advanced due to lack of US support for convening this working group.* The scope of WG 4 is to develop a standard for installation, safety and use of electrolyzer hydrogen generators in end use applications, including the residential commercial and industrial sectors. Activities will include identifying appropriate group participants in addition to NHA members, assessing the existing relevant codes; establishing parameters and developing a technical envelope for the WG. A code/building and zoning review will also be important to this WG. Finally, the NHA would like to develop a draft standard based on an appropriate template document and scope. WG5 will specify design criteria for safe self-service refueling with Liquid and Gaseous hydrogen. This will include consideration for vehicle grounding, venting of fuel lines and elimination of possible ignition sources. This activity is in conjunction with the SAE Interface and safety working groups. The Scope of WG6 is to verify the performance of on board hydrogen systems. The hydrogen system includes storage, generation, distribution, power source, and controls. The NHA is actively working with SAE Fuel Cell Standards Forum C&S safety task force. The SAE has the lead on this issue. The Scope of WG 7 is to identify maritime unique applications of hydrogen. This was done in cooperation with the Maritime Hydrogen Technology Development Group as well as other interested standards bodies. The MHTDG has published a report on the subject.

TITLE AND CONTACT	STATUS	DESCRIPTION
ISO TC 197 on Hydrogen Tappan Bose (Chair ISO/TC 197) Sylvie Gingras (Secretary, ISO/TC 197) 418-982-2238 The NHA above acts as the U.S. Technical Advisory Group Administrator on ISO TC 197	WI 15916 Basic Considerations for the Safety of Hydrogen Systems: final editorial changes were approved for circulation to P members of TC 197until May 20th. Three work items are being advanced by ISO TC 197 that are based on NHA work items. ▪ WI 15869 Gaseous Hydrogen and Hydrogen Blends-Land Vehicle Fuel Tanks: To be circulated as a Draft International Standard for a five-month voting period in the next month or two. ▪ WI 17286 Gaseous Hydrogen-Land Vehicle Filling Connectors: This work item is being advanced, addressing design issues of potential cross-connection. It is still in the working group. ▪ WI 15866 Gaseous Hydrogen Blends and hydrogen Fuel-Service Stations: This item is still at the working group level. Issues regarding the baseline document and convenor availability are being worked. The 10th plenary meeting of ISO/TC 197 will be held on Paris in October 2001. An agreement of cooperation has been signed with IEC TC 22. As noted above under IEC TC 105, the ISO has suggested ISO TC 197 participate in working group activities of IEC TC 105. IEC TC 105 has responsibility for fuel cells and ISO/TC 197 has responsibility for hydrogen infrastructure issues. ISO/TC 197 members receive standards drafts from IEC TC 105 and review and comment on them. Final drafts are considered approved by ISO/TC 197 if 2/3 of their voting members are in favor of the standard.	The ISO TC 197 structure includes five working groups. ▪ WG 2 on tank containers for multimodal transportation of liquid hydrogen ▪ WG 4 on airport hydrogen fuelling facilities ▪ WG 5 on gaseous hydrogen and blends and hydrogen fuels – service stations ▪ WG 6 gaseous hydrogen and hydrogen blends – land vehicle fuel tanks ▪ WG 7 basic considerations for the safety of hydrogen systems

TITLE AND CONTACT	STATUS	DESCRIPTION
European Integrated Hydrogen Project project coordinator Reiner Wurster (wurster@lbst.de) vehicle registration related matters Dieter Stoll (dieter.stoll@bmw.de). http://www.eihp.org/.	In total 47 EC directives are applicable for vehicles. The directives for emissions, fuel consumption and engine power cannot be fulfilled by hydrogen vehicles because of the absence of a standardised reference fuel or the absence of a procedure for testing the engine power. Requirements regarding the safety of the hydrogen on board storage system however are missing. Therefore each country is applying their national requirements regarding the safety of the hydrogen onboard storage system. These national requirements are differing significantly.	The European Integrated Hydrogen Project was established in 1998 and co-sponsored by the former GD XII Science, Research and Development under Contract N° JOE3-CT97-0088. *The objectives of the project are:* *- To create a Pan European database of existing regulations and codes of practice* *- To contact other pertinent authorities outside Europe* *- To identify weak spots in today's technology* *- To define the areas requiring regulation* *- To create a basis for an ECE regulation for hydrogen vehicles*

Summary: (EIHP Project Summary Phase II, start in 2001)

Draft regulations for the approval of hydrogen fuelled road vehicles have been developed during the last two years and are presently in the submission process to the relevant European regulatory bodies. These draft regulations shall be developed to such a level that they can be harmonised on a global level, initially between the EU and North America. By applying these draft regulations to the design and approval of fuel cell vehicles with direct onboard hydrogen storage they will be validated by taking into account not only hydrogen related vehicle components and systems but also safety requirements, refuelling procedures and periodic inspections.

For the relevant hydrogen refuelling infrastructure components and systems, for which existing standards, codes of practice and regulations are only partly identified, the applicable national standards and regulations will be identified and necessary requirements for new draft standards and possibly draft regulations for approval will be developed. These activities among others will also comprise refuelling procedures, safety aspects, periodic inspections and the layout of refuelling stations. The interface between the refuelling station and the vehicle (receptacle and nozzle) will be an important issue. The eligibility for EU-wide harmonisation will be checked. It will also be investigated to what extent certain elements of the refuelling systems are suitable for harmonisation on a global regulatory scale, e.g. components.

Comparative risk and safety analyses with respect to the release of hydrogen in confined and semi-confined environments, such as tunnels, garages, refuelling stations, and inner city streets will be undertaken. These shall provide data in sufficient depth in order to enable the partnership to define the required inputs for hydrogen-related standards and regulations.

EIHP 2 - Partners

L-B-Systemtechnik GmbH, Ottobrunn, Germany
Adam Opel AG, Ruesselsheim, Germany
Air Liquide S.A., Sassenage, France
Air Products, Walton-on-Thames, United Kingdom
Bayerische Motoren Werke AG, Munich, Germany
BP Amoco, Sunbbury-on-Thames, United Kingdom
Commissariat a I'Energie Atomique, Bruyeres le Chatel, France

DaimlerChrysler AG, Stuttgart, Germany
National Centre for Scientific Research Demokritos, Aghia Parakevi-Attikis, Greece
Det Norske Veritas, Department for Strategic Research, Hoevik, Norway
EC-Joint Research Centre, Ispra, Italy
Ford Werke-Aktiengesellschaft, Koeln, Germany
Forschungszentrum Karlsruhe GmbH, Karlsruhe, Germany
Hydrogen Systems N.V., Turnhout, Belgium
Instituto Nacional de Técnica Aerospacial, INTA, Madrid, Spain
Messer Griesheim GmbH, Krefeld, Germany
Norsk Hydro SA, Oslo, Norway
Shell Research Ltd., Chester, United Kingdom
AB Volvo Technological Development, Göteborg, Sweden
Raufoss ASA, Raufoss, Norway

Results:

- *Development of a worldwide harmonised regulation for hydrogen fuelled road vehicles.*
- *Development of procedures for periodic vehicle inspections (roadworthiness).*
- *As far as possible development of a worldwide standard or regulation and of periodic inspection procedures for the relevant refuelling infrastructure, subsystems or components.*

These draft regulations and standards will enable vehicle and infrastructure industry to save enormous resources in bringing hydrogen fuelled fuel cell vehicles onto the road. Many countries will for the first time have the legal basis to approve the operation of hydrogen fuelled vehicles on public roads and refilling at public refuelling stations. In addition, the access of European vehicle and infrastructure component manufacturers to the EU market as well as the North American market will be facilitated in the medium and long term.