PNNL-13507

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Assessment of Code Officials' Needs in Tri-Cities, Washington, to Accelerate Permitting Process for Fuel Cells in Buildings

T.C.C. Hillman
A. P. Melendez
J. J. McCullough
A. M. Borbely-Bartis

April 2001

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

This document was printed on recycled paper.
(8/00)

PNNL-13507

Assessment of Code Officials' Needs in Tri-Cities, Washington, to Accelerate Permitting Process for Fuel Cells in Buildings

T.C.C. Hillman
A. P. Melendez
J. J. McCullough
A. M. Borbely-Bartis

April 2001

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Preface

The U.S. Department of Energy (DOE) has sponsored an annual Fuel Cells Summit since 1997 to help eliminate institutional barriers and foster a receptive codes and standards environment for fuel cell technologies. These summits bring together fuel cell manufacturers, code body representatives, insurance organizations, government representatives, and many others with an interest in fuel cells and their implementation.

An issue raised at these summits concerns the level of knowledge local code officials have related to fuel cell technology; i.e., what level of familiarity with fuel cell technology will the person(s) have who will be responsible for actually approving the installation of a fuel cell in an individual setting? The assessment discussed in this report was done to "test the waters" on a relatively small scale. The Tri-Cities (Richland, Kennewick, and Pasco) in Washington State were selected because of their proximity to the Pacific Northwest National Laboratory and because they cover multiple-city and -county jurisdictions, and thus a variety of building codes and regulations in a fairly small area. While the results of this assessment are not of sufficient statistical validity to be extrapolated to the United States as a whole, they do provide a useful starting point for considering various actions that may be undertaken to address problems or gaps in knowledge suggested herein.

Summary

Fuel cell technologies originally developed for space applications are now being developed to provide electricity and heat to buildings. Although most fuel cell products will not be fully commercialized until at least 2005, prototypes and some earlier commercial rollouts are currently being introduced to the market. Local building inspectors and fire marshals must be prepared to permit these new technologies.

Very few approved and adopted building codes and standards reference fuel cells. Some codes and standards are currently being modified and adopted, but this process is often on a three-year cycle (e.g., most national model codes). Because most current building codes and standards do not address fuel cells, permitting these systems is a slow or circuitous process that may ultimately seriously hinder the market penetration of fuel cells and other distributed energy resource (DER) technologies. (See Section 2.0 for the status of fuel cell requirements in codes and standards.)

To promote market penetration of fuel cells, the U.S. Department of Energy (DOE) has expressed interest in developing an education and outreach program for building code officials across the United States. To help develop an effective agenda for this national education program, Pacific Northwest National Laboratory (PNNL), under DOE's direction, assessed the needs of building code officials and code inspectors in Tri-Cities, Washington, to effectively and efficiently permit fuel cell systems.

During this assessment, each participant completed a questionnaire and participated in a group interview. (See Appendix A for a copy of the questionnaire and Appendix B for a list of code officials who participated.) The questionnaire was designed to assess participants' current knowledge of fuel cells. The interview included a brief introductory presentation on fuel cells, a fuel cell demonstration, and a discussion on potential issues. The group interview helped identify the participants' major issues if required to inspect a fuel cell installation in local jurisdictions, and determine the most effective training tools to educate participants on fuel cells and assist them in code compliance.

The code officials identified several issues related to permitting a fuel cell installation (see Table 4.1). The three most urgent and potentially hindering issues that must be addressed are

- fuel supply and storage, as it relates to the type of fuel being used and storage location
- utility interconnect, as it relates to requirements for connecting and supplying electricity back to the local power grid
- fire fighter intervention when responding to a fire with a fuel cell installed in or around the building.

Our assessment indicates that code officials will need a great deal of education to become "up to speed" on fuel cells and their relevant codes and standards. None of the code officials participating in this study had previous knowledge of fuel cells or of relevant codes and standards.

Based on our findings, incorporating a half-day workshop into regularly scheduled conferences would be the most effective and efficient way to reach and educate code officials throughout the United States. Not only do code officials attend conferences across the country, but these conferences were also rated the highest and most beneficial training tool. A sample half-day education agenda that could be used at one of these conferences is provided in Appendix C. In addition, reference materials, such as a field guide and an educational video, should be available at these workshops so that code officials can take the information back to their respective jurisdictions.

To develop and implement the most effective national education program, we also recommend that:

- similar evaluations be conducted in larger metropolitan areas to provide more comprehensive results at the national level

- appropriate agenda items be developed by assessing
  - the type of information the particular group needs to receive
  - the most effective way to get that information to the participants.

Acknowledgments

This study was supported by the U.S. Department of Energy, Office of Power Technologies. Assistance from several key individuals with experience and expertise in building codes and standards contributed to the completion of this assessment. We wish to acknowledge the contributions and valuable input provided by the building code officials in the Tri-Cities, Washington. Specifically, we would like to thank the following individuals:

Rick Hopkins	Building Inspector Supervisor, City of Richland
Mitch Nickolds	Inspection Services Manager, City of Pasco
Rick Wright	Building Official, City of Kennewick
Daryl Brown	Building Official, Franklin County Building Department
Steve Brown	Building Official, Benton County Building Department
Joe Terpenning	Fire Inspector, Kennewick Fire Department
Dene Koons	Electrical Field Supervisor, Washington Department of Labor and Industries

We appreciate their patience and willingness to help with our assessment.

In addition, we would like to thank the Chief Electrical Engineer for the city of Richland, Wayne Collop, for his time and support.

Contents

Figures

Tables

1.0 Introduction

Very few approved and adopted building codes and standards reference fuel cells. Some codes and standards are currently being modified and adopted, but this process is often on a three-year cycle (e.g., most national model codes). Because most current building codes and standards do not address fuel cells, permitting these systems is a slow or circuitous process that may ultimately seriously hinder the market penetration of fuel cells and other distributed energy resource (DER) technologies.

To promote market penetration of fuel cells, the U.S. Department of Energy (DOE) has expressed interest in developing an education and outreach program for building code officials across the United States. To help develop an effective agenda for this national education program, Pacific Northwest National Laboratory (PNNL),[a] under DOE's direction, assessed the needs of building code officials and code inspectors in Tri-Cities, Washington, to effectively and efficiently permit fuel cell systems.

During this assessment, each participant completed a questionnaire and participated in a group interview. The questionnaire was designed to assess participants' current knowledge of fuel cells. The group interview helped identify the participants' major issues if required to inspect a fuel cell installation in local jurisdictions, and determine the most effective training tools to educate participants on fuel cells and assist them in code compliance.

Section 2.0 provides information on the fuel cell technology and the status of fuel cell requirements in current building codes and standards. Section 3.0 contains a brief overview of the requirements to become a code official in the state of Washington, their responsibilities, and the educational resources available to them. An overview of the Tri-Cities building code environment is provided in Section 4.0. Our assessment of participants' knowledge of the fuel cell technology and major issues if required to inspect a fuel cell installation, as well as a rating of the most effective training tools to help educate participants, are provided in Section 5.0. Section 6.0 contains our conclusions and recommendations. Section 7.0 contains a list of the references cited in this report. Appendix A contains a copy of the questionnaire used on our assessment and Appendix B contains a list of the code officials who participated in the assessment. A sample of a half-day education agenda that could be used at conferences to help educate code officials on the fuel cell technology is provided in Appendix C.

(a) The Pacific Northwest National Laboratory is operated by Battelle for the U.S. Department of Energy.

2.0 Status of Fuel Cell Technology in Codes and Standards

Currently, only a few codes and standards directly reference fuel cells, and other codes and standards that contain information about fuel cells are still being modified and adopted (this process is often on a three-year cycle; e.g., most national model codes). Because most current building codes and standards do not address fuel cells, permitting these systems is a slow or circuitous process that may ultimately seriously hinder the market penetration of fuel cells and other DER technologies.

This section provides a brief description of fuel cells and lists the current codes and standards that relate to fuel cells.

2.1 Description of Fuel Cells

Fuel cells are electrochemical devices that convert a fuel's energy directly to electrical energy. They have two oppositely charged electrodes that produce electricity, water, and heat from a fuel and an oxidant. Fuel cells operate much like continuous batteries when supplied with fuel to the anode (negative electrode) and oxidant (e.g., air) to the cathode (positive electrode). Unlike batteries, fuel cells do not store energy but rather convert energy as long as reactants are being supplied. Fuel cells chemically combine the molecules of a fuel and oxidizer without burning, eliminating the inefficiencies and pollution from traditional combustion. Thus, fuel cells are a high-efficiency, low-emission alternative to conventional combustion.

The operating conditions for a fuel cell are largely determined by the electrolyte (fuel cells are classified by the type of electrolyte). Several fuel cell technologies are currently being developed: Phosphoric Acid (PA), Solid Oxide (SO), Molten Carbonate (MC), Proton Exchange Membrane (PEM) or Polymer Electrolyte (PE), and Alkaline Cells Membrane (ACM).

2.2 Fuel Cell Codes and Standards

In the United States, three model code organizations develop and maintain building codes for use by local jurisdictions–the International Conference of Building Officials (ICBO), the Building Officials and Code Administrators International (BOCA), and the Southern Building Code Congress International (SBCCI). These organizations also provide technical, educational, and administrative support to governmental departments and agencies engaged in building codes administration and enforcement.

Historically, ICBO, BOCA, and SBCCI have operated regionally with states within their regions adopting their model codes. In 1994, these three organizations worked cooperatively to form the International Codes Council (ICC) to develop nationwide codes to help create consistency across the country. Each jurisdiction must adopt the ICC codes before they can be implemented, which is a slow process. Thus, many jurisdictions will continue to use existing codes until a need for change exists or they must adhere to specific code-adopting schedules. Table 2.1 lists the codes and standards that relate to fuel cells, the status of each code and standard, and a brief description of each fuel cell requirement.

Table 2.1. Codes and Standards that Relate to Fuel Cells

Title and Contact	Status	Description
ANSI Z 21.83-1998/CSA 12.10 "Fuel Cell Power Plants" Steven E. Kazubski Project Manager, Stds. 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 first edition of the standard was published in 1998. It is a harmonized standard between the United States and Canada. A fuel cell technical working group is revising the standard to address comments from fuel cell manufacturers.	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, having a maximum output voltage of 600 VAC and power output of 1,000 kW operating at no less than –20°F (-29°C). Criteria are provided for both construction and performance of applicable fuel cells. The following construction issues 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. Performance issues are addressed, 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.

Table 2.1. (contd)

Title and Contact	Status	Description
ASME Boiler and Pressure Vessel Codes The American Society of Mechanical Engineers Three Park Ave. New York, NY 10016 (800) 843-2763	Regularly maintained and updated.	Fuel cell power plants that employ pressure vessels or power piping may be subject to the ASME Boiler and Pressure Vessel Codes, as well as regular inspections of those components.
ASME PTC 50 "Performance Test Code for Fuel Cell Power System Performance" Jack Karian, Staff Secretary ASME (212) 591-8552 (212) 591-8501 Fax karianj@asme.org Frank Holcomb, Army Corps of Engineers, CERL (217)-352-6511x7412 f-holcomb@cecer.army.mil http://www.dodfuelcell.com Mark Williams (chair) U.S. Department of Energy Federal Energy Technology Center (304) 285-4747 mwilli@fetc.doe.gov	The Object and Scope have been completed and approved by ASME. A first draft was completed in April 1999. Work continues with a targeted date of 2002 for completion and publication.	Outline of the standard: • Object, Scope, and Measurement Uncertainty • Definitions and Descriptions of Terms • Guiding Principles • Instruments and Methods of Measurement • Calculations and Results • Report of Results • 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.

Table 2.1. (contd)

Title and Contact	Status	Description
2000 International Mechanical Code International Code Council 5203 Leesburg Pike Suite 708 Falls Church, VA 22041 (703) 931-4533 Larry Simpson P.E. (Secretariat) (205) 591-1853 lsimpson@sbcci.org 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.	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.
International Standards Organization Technical Committee (ISO/TC) 197 Dr. Tapan Bose (chair) (819) 376-5139 (819) 376-5164 Fax Silvie Gringas, Secretary	ISO/TC 197 is preparing the international standards, mainly the safety standards that are required to ensure a worldwide dissemination of hydrogen technologies. The scope of ISO/TC-197 is, "Standardization in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen."	Published international standards: ISO 13984: "Liquid Hydrogen - Land Vehicle Fueling System Interface" ISO 14687: "Hydrogen Fuel - Product Specification" International standards under development: 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 Fueling 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 Requirements for the Safety of Hydrogen Systems" ISO/AWI 17268: "Gaseous Hydrogen - Land Vehicle Fuelling Connectors"

Table 2.1. (contd)

Title and Contact	Status	Description
NFPA 70 "National Electric Code" National Fire Protection Association 1 Batterymarch Park Quincy, MA 02269-9101 (617) 770-3000 Jean O'Connor (recording secretary for Code Making Panel #3) (617) 984-7421	A proposal to add a new Article 691 to the "National Electric Code" (NEC) dealing with fuel cells has been submitted to NFPA for consideration and approved in principal. Public comment will be solicited on the proposal and it will be considered for final action in May 2001 by the NFPA.	The NEC provides criteria that would apply to certain electrical installations related to fuel cell power plants. Currently, it does not contain any fuel cell-specific criteria. The draft Article 691 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.
NFPA 853 "Standard for the Installation of Stationary Fuel Cell Power Plants" Rich Beilen (or Jackie Beard, Secretary) National Fire Protection Association 1 Batterymarch Park Quincy, MA 02269-9101 (617) 770-3000 x 7279 www.nfpa.org Donald Drewry (chair) Hartford Steam Boiler Don_Drewry@hsb.com	The standard has been accepted by the National Fire Protection Association and is available to the public.	The scope of the standard is the design, construction, and installation of stationary (nonportable) 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 prepackaged, self-contained; pre-engineered; and engineered and field-constructed fuel cell power plants. Chapter 3 provides criteria related to the site for fuel cells in all locations, as well as specific indoor, outdoor, and rooftop installations and interconnections with other building systems.

Table 2.1. (contd)

Title and Contact	Status	Description
NFPA 853 continued		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; include other NFPA standards, ANSI Z21.83, and certain ASME pressure and process piping standards.
National Hydrogen Association 1800 M Street NW, Suite 300 Washington, DC 20036-5802 Karen Miller, Program Director (202) 223-5547 (202) 223-5537 Fax email: kmiller@ttcorp.com	The National Hydrogen Association, in cooperation with the U.S. Department of Energy Hydrogen Program, has the following seven working groups, in various stages of activity: 1) WG1: Connectors 2) WG2: a. Containers; b. Hydrides 3) WG3: Refueling Stations 4) WG4: C&S for using electrolysers and fuel cells at customer sites, including homes 5) WG5: C&S for safe self-service refueling of vehicles with H_2 6) WG6: Certification program for hydrogen vehicle fuel systems (SAE coordination) 7) WG7: C&S for maritime unique 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. WG3 (ISO/TC-197 WG5) is looking at the remaining technical questions, and determining a process or approach for resolving them and coordinating them with the other standards bodies. WG4 is charged with developing a standard for installation, safety, and use of electrolyser hydrogen generators in end-use applications, including residential, commercial, and industrial. WG5 is reviewing existing draft standards for refueling stations and connectors to identify any deficiencies for public use.

Table 2.1. (contd)

Title and Contact	Status	Description
NHA continued		WG6 is assisting the SAE in their efforts to specify design criteria (e.g., vehicle grounding, venting fuel lines, eliminating ignition sources, and other safety precautions) for refueling with gaseous hydrogen or liquid hydrogen. WG7 is identifying maritime-unique applications of hydrogen.
P1547, "Standards for Distributed Resources Interconnection with Electric Power Systems" IEEE Standards Coordinating Committee (SCC) 21 IEEE Standards Department 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855-1331 (800) 678-4333 (IEEE) (617) 770-3500 Fax Richard DeBlasio (chair SCC 21) National Renewable Energy Lab (303) 384-6490 dick_deblasio@teplink.nrel.gov T. Basso (secretary of P1547 Working Group) National Renewable Energy Laboratory – MS3411 1617 Cole Blvd. Golden, CO 80401-3393 (303) 384-6765 thomas_basso@nrel.gov	The IEEE SCC has several different projects underway and is responsible for standards associated with fuel cells, photovoltaics, dispersed generation, and energy storage. SCC 21 reports directly to the IEEE Standards Board. P1547 is a very active and fuel cell-relevant standard. Currently, a third draft of this standard is out for review and comment. Meetings of the P1547 subcommittees are scheduled about every two months. The standard is slated for completion in 2001.	P1547 provides 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 in 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 covers classification of the interconnection problem being considered so the appropriate provisions of the standard can be applied. Chapter 3 covers universal technical requirements associated with items such as voltage regulation, power quality, and abnormal operation. Chapter 4 provides criteria for common tests, degree of protection tests, and low and high voltage tests. Chapter 5 provides a summary of interconnection requirements.

Table 2.1. (contd)

Title and Contact	Status	Description
Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60068 Thad Bukowski (847) 272-8800 x 42948 Harry P. Jones harry.p.jones@us.ul.com Tim Zgonena (847) 272-8800 x 43051	Underwriters Laboratories, Inc., has several product safety standards available and under development that would have some bearing on fuel cell technology: • UL 2200 – "Stationary Engine Generator Assemblies" • UL 674 – "Electric Motors and Generators for Hazardous (Classified) Location" • UL 1778 – "Uninterruptible Power Supply Equipment" • UL 1741 – "Static Inverters and Charge Controllers" UL 1741 has been harmonized with IEEE 929, and is slated for harmonization with IEEE 1547 after IEEE 1547 has been published.	Stationary Engine Generator Assemblies, UL 2200: • Covers assemblies not exceeding 600 volts intended for installation and use in ordinary locations meeting NFPA standards 70, 37 (stationary combustion engines and gas turbines), 99 (health care facilities), and 110 (emergency power). • Not covered are generators for use in hazardous locations, which is covered by UL 674, and uninterruptible power supply equipment covered by UL 1778. Electric Motors and Generators for use in Division 1 Hazardous Locations, UL 674: • Electric motors and generators in hazardous locations are covered, as well as explosion-proof equipment. Use is limited to certain atmospheric conditions (minimum –70°C, oxygen concentration by volume of not over 21%, and one atmosphere barometric pressure). Uninterruptible Power Supply (UPS) Equipment, UL 1778: • Applies to AC or DC not over 600 volts intended for installations meeting NFPA 70. • The UPS allows primary or normal power to deliver AC power to the protected load through either the power conversion portion of the UPS or a bypass source. The UPS power conversion components consist of a rectifier and/or an inverter. • Some of the products used with a UPS and covered by the standard include remote battery supply cabinets, bypass switches, and remote panel switches. • A battery supply used with a UPS may consist of: a battery supply integral to the UPS, a battery supply in a remote cabinet, or a battery supply contained in a separate battery room.

Table 2.1. (contd)

Title and Contact	Status	Description
UL continued		Static Inverters and Charge Controllers, UL Subject 1741: • Inverters used with photovoltaic systems are covered, as well as inverters with charge controllers that convert AC power from a generator or electric utility to DC power for charging batteries. • Inverters, AC modules, and charge controllers that are covered are rated to up to 600 volts and intended for installation in accordance with NFPA 70. • Inverters include standalone units and utility interactive inverters for use in parallel with an electric utility to supply common loads. The AC modules are intended to be installed on dedicated branch circuits in parallel for use with an electric utility. The charge controller may be separate or incorporated with the inverter.
National Evaluation Service 5203 Leesburg Pike Suite 708 Falls Church, VA 22041 Dave Conover 703-931-2187 dconover@nateval.org www.nateval.org	The National Evaluation Service (NES) is continuing development of the evaluation protocol.	The NES is developing an evaluation protocol by which stationary fuel cell power plants can be evaluated and a National Evaluation Report (NER) issued on a subject technology. An NER verifies and supports compliance with adopted codes and standards, and is used by state and local code officials to enforce building regulations.

3.0 Code Officials

Code officials are responsible for addressing the life, health, and safety issues of every individual that enters, works, or resides in a building. Typically, their job involves site plan reviews, as well as on-site inspections to ensure compliance with the adopted codes of that jurisdiction.

This section briefly describes the hierarchy for code compliance, the requirements for becoming a code official, and the educational resources available to code officials in the state of Washington. In this report, the term code official includes building officials, code enforcement officials, and code inspectors.

3.1 Code Compliance

In most states, a hierarchy exists to create code compliance for every jurisdiction within that state. In the state of Washington, codes are adopted at the state level and are enforced at the local level. Each jurisdiction may make slight modifications to the adopted code, but it must first get approval from the state. Currently, the state of Washington has adopted the ICBO model codes, with applicable amendments at the local level.

3.2 Certification Requirements

A code official must be certified by the model code organizations responsible for developing the codes enforced by the official's jurisdiction. To become certified, code officials must pass an exam showing a certain level of proficiency in areas of building construction (e.g., electrical, mechanical, envelope). In addition, code officials' must be recertified in these areas after a given period of time. (The appropriate model code organization for a jurisdiction can provide more information about specific certification processes.) Code official certification in the state of Washington follows guidelines from ICBO.

3.3 Educational Requirements

Code officials regularly attend training activities, such as seminars, conventions, and technical courses, which are organized by national and state programs. These training activities allow code officials to stay up to date on new information, to be certified and recertified, and to network among peers.

Code officials in the state of Washington attend both national and state conventions. Once or twice a year, regional ICBO Chapters offer a four-day workshop to bring local code officials and inspectors up to date on recent code changes and to refresh their knowledge of existing code requirements. The

Washington Association of Building Officials (WABO) is one group that organizes two workshops per year for code officials. In addition to these two conferences, several other associations and organizations provide information and support to local code officials:

- International Conference of Building Officials (ICBO)
- International Association of Plumbing and Mechanical Officials (IAMPO)
- American Association of Code Enforcement (AACE)
- International Fire Code Institute (IFCI)
- International Association of Electrical Inspectors (IAEI)
- Building Officials and Code Administrators International, Inc. (BOCA).

Code officials also receive information through several publications:

- *Official*, *Standards*, and *Code Official* **-** all three publications published by the International Association of Plumbing and Mechanical Officials, Walnut, California.
- *Building Code Standards* **-** published by the International Conference of Building Officials, Whittier, California.

The following organizations publish newsletters related to code compliance:

- WABO
- IAPMO
- ICBO
- Underwriters Laboratories, Inc. (UL)
- IAEI
- Washington Association of Code Enforcement (WACE).

4.0 The Tri-Cities Building Code Environment

The metropolitan area known as the Tri-Cities is located in south-central Washington and is composed of the cities of Richland, Pasco, and Kennewick. The Tri-Cities has five code-enforcing jurisdictions–the three cities and two counties (Benton and Franklin). Kennewick is the largest city with a population of 50,390, while Richland and Pasco have a population of 36,860 and 26,090, respectively. Combined with nearby communities, the population of the greater Tri-Cities area is in excess of 150,000.

4.1 Code Officials in the Tri-Cities

Each city and county has its own organization responsible for enforcing codes. Appendix B provides a list of the code officials in the Tri-Cities who participated in our evaluation.

4.2 Permitting Process

The process for requesting a permit is similar throughout the United States. However, differences exist in the process for requesting and attaining a permit in each jurisdiction. These differences must be considered when addressing fuel cell and other DER technology installations across the country.

The following steps are required for a typical permitting process:

- The party interested in using the technology requests a permit by submitting plans and specifications covering the installation of the technology to the agency or agencies having jurisdiction.

- The plans and specifications are approved based on specific conformance to codes and standards provisions or, where they do not provide specific requirements for the technology, are approved based on equivalency with the intent of adopted codes and standards.

- The technology is installed and inspected for compliance with the approved plans and specifications, and the conditions of the permit covering the installation.

- The party must comply with any order by the inspector requiring corrections.

- The project receives final approval.

4.3 Zoning Ordinances

In most areas of the country (and in the Tri-Cities), local zoning ordinances strongly influence the permitting requirements for a fuel cell installation. Local zoning ordinances dictate specific guidelines for classification of land use and requirements placed upon them (some degree of variability exists in local ordinances that is expected to increase on the national level). The most apparent influence of these ordinances on fuel cell installations relates to the location of fuel storage tanks within the premises of the structure and within the property lines setback.

4.4 Installation Requirements

Several issues related to fuel cells may attract the attention of code officials, including fuel supply and storage, electrical interconnection to the power grid, ventilation, and fire protection and intervention. Figure 4.1 shows the most common installation requirements for a fuel cell in a commercial building.

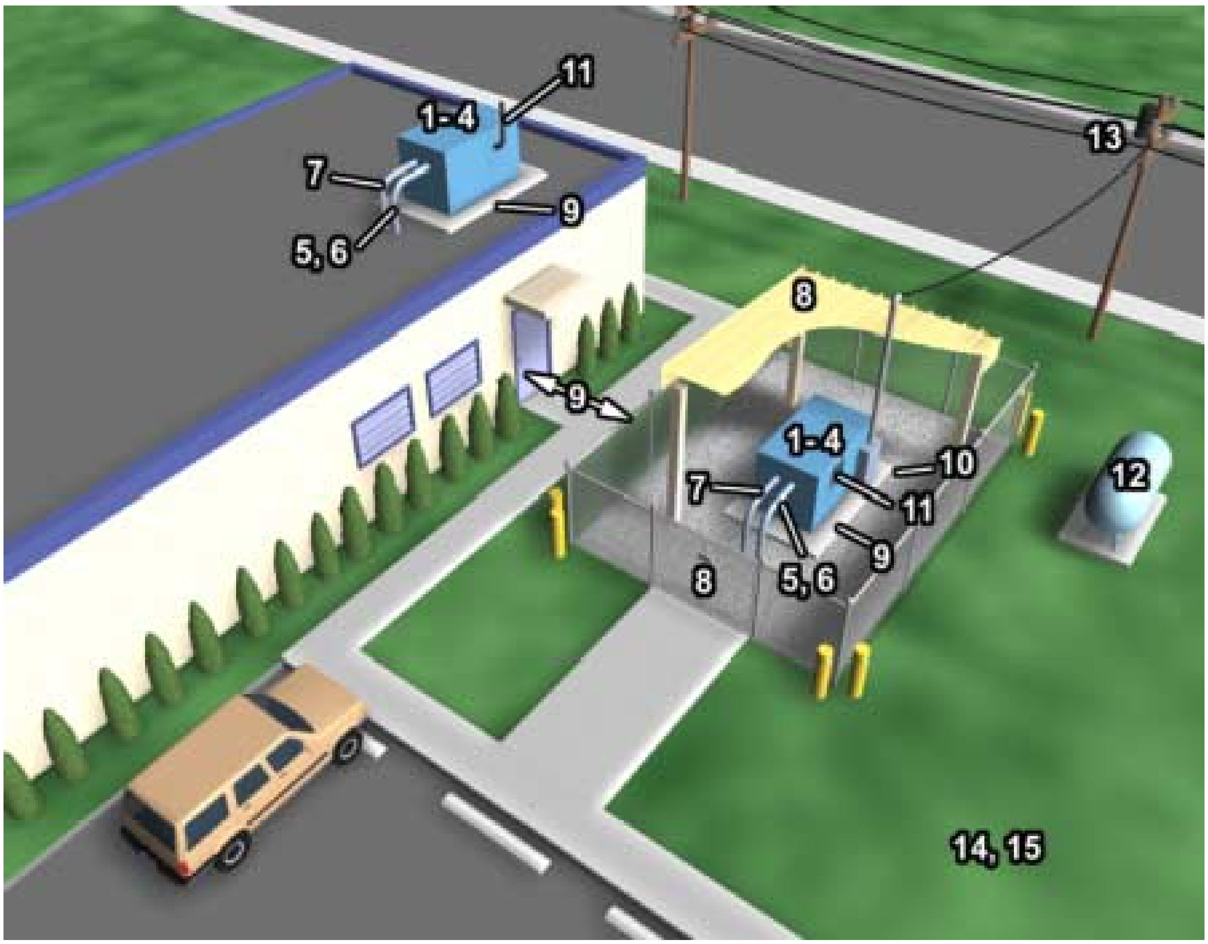

Figure 4.1. Typical Installation Requirements for a Fuel Cell in a Commercial Building

Requirements for Figure 4.1

1. Component - Relevant standards from ANSI, ASME, IEEE, UL.
2. NFPA 853, Chapters 4-6 - Automatic and control shutdown for fuel, ventilation, and fire protection systems.
3. NFPA 853, Chapter 4 - Unattended fuel cell units shall have shutoff valve installed ahead of any flexible connector to other controls.
4. Oil lubrication system consists of a sealed system; does not require manufacturer's installation instructions.
5. NFPA 853, Chapter 5 - All fuel piping outside the fuel cell power plant shall be marked or identified in accordance with ANSI A13.1. The design, location, and installation of piping valves and fittings from the outlet of the point of delivery from the supply to the inlets of the equipment shutoff valves for the case of 1) natural gas (in accordance with NFPA 54), 2) liquefied petroleum gas (in accordance with NFPA 58), 3) hydrogen (in accordance with ASME/ANSI B31.3), 4) biogas (in accordance with NFPA 54), and 5) liquid fuels (in accordance with NFPA 30). Piping protection is outlined in MSS SP-69, Pipe Hangers & Supports – Selection and Application.
6. ASME Boiler and Pressure Vessel Code, where fuel cell power plants employ pressure vessels or power piping.
7. NFPA 70, Article 691- All wiring and batteries must be protected from arcing and shorting. Fire protection installation process of electrical equipment and components in accordance with NFPA 853, Section 6.1.4.
8. NFPA 853, Section 3.3.1 – A fuel cell installation should meet the following conditions: 1) The room shall be separated from the remainder of the building by floor, wall, and ceiling construction that has at least a 1-hour fire resistance rating in accordance with NFPA 251, 2) electrical, piping penetrations, and joints associated with the room shall be sealed with approved materials that have a fire resistance rating of 1-hour, and openings between the room and other occupied spaces shall be protected by fire doors (installed in accordance with NFPA 80) and fire dampers (installed in accordance with NFPA 80), and 3) each room shall be provided with egress (in accordance with NFPA 101). Unit and auxiliary equipment must be protected from natural elements (wind, sun, precipitation, detritus) and vehicular impact.
9. NFPA 853, Sections 3.1, 3.2, & 3.4 - (outdoor location) Unit must be anchored properly and placed on a firm foundation. Unit must be above the base flood elevation and sited in a manner that permits service, maintenance, and emergency access. Unit must be located away from hazardous materials and building openings. Foundation to be made of noncombustible materials. Air intakes to a fuel cell power plant shall be located so that other exhausts, gases, or contaminants do not adversely affect the plant.
10. NFPA 853, Sections 3.1 & 3.3 - (indoor) Same foundation requirements as outdoor installations, as each apply. Must be located away from hazardous materials and building openings.
11. NFPA 853, Section 3.2.3 and Chapter 5 - The exhaust outlet(s) from process areas that contain fuel-bearing components of a fuel cell power plant shall be located at least 15 ft (4.6 m) from HVAC air intakes, windows, doors, and other openings into buildings. For design of ventilation and exhaust system,
   All fuel cell power plants shall be provided with a source of ventilation, exhaust, and makeup air in accordance with this chapter (exception: fuel cell power plants installed outdoors and listed prepackaged or pre-engineered and match modular fuel cell power plants that have a sealed, direct ventilation, and exhaust system installed in accordance with manufacturer's installation instructions.
   The ventilation exhaust system shall be design to provide a negative or neutral pressure in the room.
   For ventilation system, separate mechanical ventilation is required, a control interlock shall be provided to shutdown the unit upon loss of ventilation. For exhaust system, the exhaust rate from the room shall not be less than 1 cfm/ft^2 of floor area and not less than 150 cfm of total floor area.
12. NFPA 853, Chapter 4 and Section 6.1.1.1, "Fuel Supplies and Storage Arrangements" - This section applies to natural gas (also refer to NFPA 54), liquefied petroleum gas (also refer to NFPA 58), hydrogen (also refer to NFPA 50A and 50B), biogas (also refer to NFPA 54), and liquid fuels (also refer to NFPA 30). The Flammable and Combustible Liquids Code, API (American Petroleum Institute) 620, "Design and Construction of Large Welded Low-Pressure Storage Tanks," may also apply. Sites with fuel storage tanks shall have fire hydrants provided in accordance with NFPA 30 and NFPA 24. Hydrant shall have a water supply of at least 250 gpm for 2 hours.
13. Grid Interconnection for fuel cells in accordance with standard currently under development by IEEE SC 21, (Standard P1547), and NFPA 70, Article 691.
14. Local zoning ordinances (e.g., definition of hazardous materials and relation to residential zones, distance to property line and rights-of-way, access by local fire and safety authorities) may need to be consulted in some areas.
15. Fire Protection - Local building inspectors will require a fire risk evaluation be performed for each installation with respect to design, layout, and operating conditions of the unit. From that analysis, the inspector may require any or several of a variety of fire protection systems (portable versus fixed systems, foam or gaseous extinguishers, automatic sprinklers or dry chemical fire suppression systems).

Note: Refer to ANSI Z21.83 for information regarding construction, performance, and testing of fuel cell power plants.

5.0 Assessment of Code Officials in Tri-Cities

To help develop an effective agenda for a national education program on fuel cells for code officials, we assessed the needs of building code officials and code inspectors in the Tri-Cities, Washington, to effectively and efficiently permit fuel cell systems.

During this assessment, each participant completed a questionnaire and participated in a group interview. (See Appendix B for a list of code officials who participated in the assessment.) The questionnaire was designed to assess participants' current knowledge of fuel cells. The interview included a brief introductory presentation on fuel cells, a fuel cell demonstration, and a discussion on potential issues. The group interview helped identify the participants' major issues if required to inspect a fuel cell installation in local jurisdictions, and determine the most effective training tools to educate participants on fuel cells and assist them in code compliance.

5.1 Questionnaire

The questionnaire was sent to seven individuals–the building officials for the cities of Richland, Pasco, and Kennewick; the two building officials for Benton and Franklin counties; the city of Kennewick Fire Marshall; and the supervising electrical inspector, who covers all five jurisdictions as it applies to electrical inspections. (See Appendix A for a copy of the questionnaire.)

5.2 Group Interview

Our group interview was designed to educate participants about fuel cells and to work with them in an open forum format to identify the major issues they would face when permitting a fuel cell installation in their jurisdiction. We chose to use this format, or a group interview, over individual interviews for two reasons. First, the questionnaires indicated that every code official had very little to no knowledge of fuel cells. Second, the code officials emphasized that their input would be more comprehensive and complete if they could respond openly to each other's comments in an open forum format.

All code officials attended the group interview except for the supervising electrical inspector for the Tri-Cities. In addition to the code officials, the Chief Electrical Engineer for the city of Richland and a representative from IdaTech (fuel cell developer located in Bend, Oregon) attended the interview.

We identified several items during the facilitated group interview:

1. the concerns of local code officials in reference to a fuel cell installation

2. the major issues local code officials would face if required to inspect a fuel cell installation

3. what code officials would need to make the plan review process as easy as possible

4. the most effective training methods and tools for educating code officials on fuel cells and assisting them in code compliance.

5.3 Major Issues

Several issues or concerns were identified during the group interview. Table 5.1 lists and describes these issues and concerns, and provides related codes and standards or a potential action to resolve each issue or concern. The three most critical and potentially hindering issues identified in the interview were fuel supply and storage systems, utility interconnect, and fire fighter intervention.

5.3.1 Fuel Supply and Storage Systems

For fuel supply and storage systems, the following were noted as items that need to be addressed (note that storing liquid hydrogen on the premises did not raise any more issues beyond those that need to be addressed with storage of any other fuel on site):

- proximity of fuel storage tank to walls, doors, window openings, and public right-of-ways
- venting of storage containers
- secondary containment of fuel
- automatic shut-off valves at the storage container
- sight glass on the storage container
- appropriate signage.

5.3.2 Utility Interconnect

Grid interconnection with local electric utility companies is a critical issue involving the installation of onsite power sources such as stationary fuel cells. The IEEE Standards Coordinating Committee (SCC) 21 is developing P1547, "Standards for Distributed Resources Interconnection with Electric Power System." This standard will provide a uniform standard for interconnecting distributed resources with electric power systems, and requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.

The Washington Department of Labor and Industries requires that local regulations for grid interconnections be based on the following codes:

- *National Electrical Code* (NFPA 1999) - This code presents an installation procedure for one or more electric power production sources operating in parallel with a primary source(s) of electricity. Power sources include any system that produces electricity like utility sources, as well as on-premises sources like rotating generators, solar photovoltaic systems, and fuel cells. Basic safety requirements are addressed, specifically related to parallel operation with application to power sources.

- *Washington Administrative Code* (Washington Department of Labor and Industries 2001) - This code is related to electrical inspection and permitting for the Department of Labor and Industries. Section 23001, "Service Requirements," states that the serving utility shall be consulted regarding the service entrance location and meter equipment before installing the electric power source service and equipment. It specifies firewall separation standards defined by the *Uniform Building Code* (ICBO 1997a), as well as firewall separation standards based on the *National Electrical Code* (NFPA 1999).

5.3.3 Fire Fighter Intervention

The major concern with fire fighter intervention is entering a building that is still powered by a fuel cell after the power is cut off from the electric power grid. To effectively address this issue, appropriate signs and/or labels should be in easy-to-see locations to make fire fighters aware of the presence of a fuel cell within the premises, the type of fuel used, the exact location of the unit, the location of emergency shut-off valves for fuel supply lines, and the direct power supply to fuel cell plant.

Table 5.1. Code Officials' Issues and Concerns Relating to Fuel Cells

Issue	Description of Issue	Related Code or Standard[(a)] or Possible Action
Uniform Building Code (ICBO 1997a)		
Fuel and Fuel Storage	What fuel is used and where is it stored?	NFPA 853, ASME Boiler and Pressure Vessel Codes, ISO/TC-197
Ventilation	How much ventilation is required?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10
Structural Protection	Will an installation require any particular structural protection?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10
Fire Protection	What, if any, are the necessary enclosures (1-h/2-h firewall)?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10
Chemicals	What chemicals are being used? Are potentially dangerous reactions taking place?	Information to be provided by the manufacturer
Clearances	What are the necessary clearances, especially pertaining to proximity of combustibles?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Weight of Fuel Cell Unit	What is the weight of a unit relating to building structural concerns?	Information to be provided by the manufacturer
Indoor vs. Outdoor	The code officials were aware that different codes will apply based on the location of an installation.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10
Safe Environments	It should be specified if certain environments exist where a unit should not be installed.	Information to be provided by the manufacturer

Table 5.1. (contd)

Issue	Description of Issue	Related Code or Standard[(a)] or Possible Action
Generated Waste	Need to be aware of all by-products and waste produced.	Information to be provided by the manufacturer
Batteries	Will the batteries require specific ventilation or a possible metering device to detect hazardous gases?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Interface with Emergency Equipment	How does the unit react to water and possibly a fire extinguisher?	Should be safe, or properly noted by manufacturer
Uniform Fire Code (ICBO 1997b)		
Emergency Remote Shut-Off	Is it necessary to have a remote shut-off for both the fuel cell and its fuel?	NFPA 853, manufacturer installation specifications
Signage	Needs an appropriate placard describing the fuel used.	To be provided by the manufacturer
Electro/Mechanical Shunt	Does the unit have the necessary electro/mechanical shunts?	Included in life/health/safety codes
Installation in Garages	Potential exposure issues and chemical reaction related problems in a garage.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Explosion	Can the unit explode?	Information to be provided by the manufacturer
Storage Tank	Clearance and proximity issues, as well as possible ventilation for leaking gases.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Site Plan	Necessary distances from house, property line, or building.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, local zoning ordinances
Fire Fighter Intervention	Is it necessary to have prior knowledge of a fuel cell located in a burning building?	Signage by electrical panel and at the connection to the power grid should notify fire fighters
Necessary Detectors	Possible heat detectors, as well as additional fire and smoke detectors.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Uniform Mechanical Code and *Uniform Plumbing Code* (ICBO 1997a, 1997b)		
Ventilation	How much ventilation is required?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Generated Waste	What are in the by-products? Can waste go down the drain? Can waste be vented to DWV system?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Drainage	Check with proper authorities (e.g., Health Department, EPA[(b)]) for permission to send drainage into the sewer system or septic tank.	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications

Table 5.1. (contd)

Issue	Description of Issue	Related Code or Standard[a] or Possible Action
Effect on Existing Piping	Will a fuel cell unit or its generated waste adversely affect the existing piping system?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10, manufacturer installation specifications
Fuel Storage	What is the allowable storage amount of fuel?	NFPA 853, ANSI Z 21.83-1998/CSA 12.10
Toxins	Are any toxins used or produced that need to be monitored?	Information to be provided by the manufacturer
Disposal/Recycling	What are the proper methods of disposing of or recycling fuel cell components?	Information to be provided by the manufacturer
National Electrical Code (NFPA 1999)		
Utility Interconnect	What are the issues related to interconnecting to the local power grid?	IEEE SCC 21, NFPA 70 Article 691
Static Electricity	What are possible issues with generated static electricity, particularly with pace makers?	NFPA 70 Article 691, manufacturer installation specifications
Switchgear	Should the switchgear be automatic or manual?	NFPA 70 Article 691, manufacturer installation specifications
Radio Frequency Signals	Will there be an issue with RF signals produced by the unit?	Proper FCC code compliance listing provided by manufacturer
Grounding	Should there be additional grounding?	NFPA 70 Article 691, manufacturer installation specifications
Ground Fault Circuit Interrupter (GFCI)	Will there be a need for a GFCI?	NFPA 70 Article 691, manufacturer installation specifications

(a) Refer to Section 7.0 for reference information on codes and standards.
(b) Environmental Protection Agency.

Because most current building codes and standards do not address fuel cells, permitting these systems is a slow process. Therefore, to help expedite the permitting process, the participants recommended that building professionals include the following information on plans:

- a site plan with the location of the fuel cell
- manufacturer installation requirements, with the manufactures' standards approved by a quality assurance agency like UL
- the licensure that will be required to install a fuel cell system

- a complete wiring schematic showing all connection points
- all necessary clearances.

The participants also recommended that manufacturers consider over design (i.e., using larger pipes or greater clearances than required) to reconcile possible inconsistencies between jurisdictional requirements. In this case, the savings in installation costs will offset the higher manufacturing costs of a slightly over-designed product. Although these needs are typically met, the time and money saved by clearly addressing each of them could greatly increase the return on investment.

5.4 Training Tools

Several training tools are available to educate code officials on fuel cells. During our evaluation, we proposed 11 potential training tools to the participants. Each participant listed the top five choices. Figure 5.1 shows the 11 training tools and the number of votes given for each. The most popular training tools for code officials were conferences and field guides/checklists. The second highest rated tools included having a manufacturer's representative as part of a workshop and providing an educational video.

Note that although this evaluation identifies issues relating to fuel cell installations, it may not be representative of the country as a whole because the participants were from the Tri-Cities, Washington. These three cities are smaller and more rural than metropolitan areas that may extensively employ such DER technologies. A similar effort should be conducted in a larger metropolitan area to provide more comprehensive results on the national level.

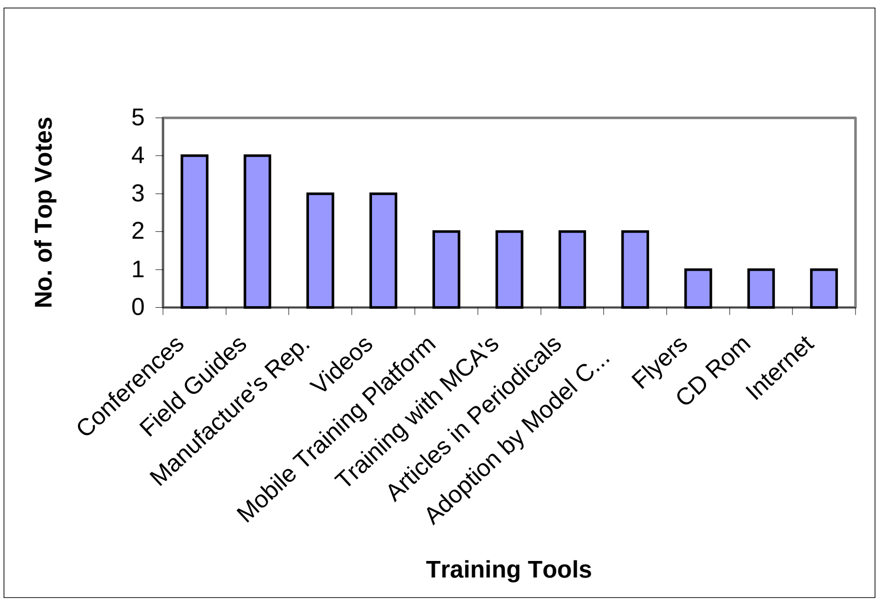

Figure 5.1. Participant's Rating of Training Tools

6.0 Conclusions and Recommendations

During the group interview, the participants identified several issues related to permitting a fuel cell installation (see Table 4.1). The three most urgent and potentially hindering issues that must be addressed are

- fuel supply and storage, as it relates to the type of fuel being used and storage location

- utility interconnect, as it relates to requirements for connecting and supplying electricity back to the local power grid

- fire fighter intervention when responding to a fire with a fuel cell installed in or around the building.

Our assessment indicates that code officials will need a great deal of education to become "up to speed" on fuel cells and their relevant codes and standards. None of the code officials participating in this study had previous knowledge of fuel cells or of relevant codes and standards. Thus, developing and implementing a national education program is vital to ensure fuel cell penetration in the commercial market.

Based on our findings, incorporating a half-day workshop (see Appendix C for a sample agenda) into regularly scheduled conferences would be the most effective and efficient way to reach and educate code officials throughout the United States. Not only do code officials attend conferences across the country, but the participants of our evaluation also rated these conferences the highest and most beneficial training tool. In addition, reference materials, such as a field guide and an educational video, should be available at these workshops so that code officials can take the information back to their respective jurisdictions.

To develop and implement the most effective national education program, we also recommend that:

- similar evaluations be conducted in larger metropolitan areas to provide more comprehensive results at the national level

- appropriate agenda items be developed by assessing
  - the type of information the particular group needs to receive
  - the most effective way to get that information to the participants.

We recommend that the next step in this process be focused on developing the most effective plan for implementing a comprehensive national education program. To properly design such a program, we must identify what type of information these building professionals should receive and how to most effectively and efficiently deliver the information to them. Attending code officials' conferences seems to be the easiest way to reach the greatest number of individuals. However, we now need to identify how the material should be presented and how reference materials like a field guide and a video should be designed.

7.0 References

International Conference of Building Officials (ICBOa). 1997. *Uniform Building Code.* Whittier, California.

International Conference of Building Officials (ICBOb). 1997. *Uniform Fire Code.* Whittier, California.

International Conference of Building Officials (ICBOc). 1997. *Uniform Mechanical Code.* Whittier, California.

International Conference of Building Officials (ICBOd). 1997. *Uniform Plumbing Code.* Whittier, California.

National Fire Protection Association (NFPA). 1999. *National Electrical Code*, NEC 705, "Inter-connected Electric Power Production Sources." Quincy, Massachusetts.

Washington Department of Labor and Industries. 2001. *Washington Administrative Code*, Chapter 296-46A WAC, "Safety Standards, Installing Electric Wires and Equipment – Administrative Rules." Olympia, Washington.

Appendix A

Fuel Cell Systems Code Official Questionnaire

Appendix A

Fuel Cell Systems Code Official Questionnaire

Section I—Personal Background

1. What is your area of responsibility in building inspection? (electrical, mechanical, subsystems, energy efficiency, fire, plumbing, etc.)

2. How long have you been in this position?

3. What codes or standards do you most frequently consult? (If a standard, please give full name and number. If a code, please give code number and relevant articles.)

4. If you have a question, how do you research the answer? (who do you ask, what references do you use, is there a state code agency that can help, etc.)

5. Who do you report your findings to?

6. Is there a hierarchy within the state of Washington for code compliance, determining which codes will be used in a given jurisdiction, etc? ______If yes, please explain briefly.

7. How long does a permit requestor have to comply with an order given by you?

Section II—Code Official Education

1. What are the requirements to become a code inspector?

2. Are there any state or national programs that code officials regularly attend? (please list)

3. Are there any on-going education requirements for code inspectors? (a specific number of hours of training annually or training sessions, specific courses).

   If yes, who conducts these trainings?

4. What periodicals do you subscribe to for information in your field as a code inspector?

5. Do any associations related to codes and standards, inspectors, etc., have newsletters? _______. If yes, please list them:

6. Do any associations related to codes and standards, inspectors, etc., have annual conventions? _______. If yes, please list them:

7. Are there any other sources of information available to you as a code inspector? (online sources, state agency information or hotlines, etc.)._________. If yes, please list them:

Section III—Inspection of a Fuel Cell Installation

The following questions will help us understand the current knowledge base of code officials and inspectors with respect to fuel cell installations. If you do not know the answer to a question, please mark "n/a" **– it is very important that you note this** so we can be sure to provide that information to officials in the future. If you refer to any source for an answer, would you please also note that source for the same reason.

1. Please explain, briefly, the fundamental differences between the following fuel cell technologies -

    a. PEM (polymer electrolyte membrane):

    b. Phosphoric Acid:

    c. Molten Carbonate:

    d. Solid Oxide:

2. Please list all codes or standards that you are currently aware of that reference fuel cells or fuel cell systems, or the installation of fuel cell systems:

3. To inspect the fuel system (i.e., propane, natural gas, methanol or hydrogen production, distribution, and storage tanks) for a fuel cell installation, which codes or standards would you refer to?

4. To inspect the fire safety of a fuel cell installation, which codes or standards would you refer to?

5. Does the ASME Boiler and Pressure Vessel Code apply to fuel cell systems?

6. Is there a standard you would use to test and certify the safety and performance of a stationary fuel cell system?

7. Is there a third-party testing organization recognized to test and certify fuel cell power plants?_____. If yes, please give the name:

8. What are the utility interconnection requirements for connecting a fuel cell system to the local electricity distribution feeder?

9. Can a stationary fuel cell power plant be considered as meeting the building code requirement of providing a standby emergency power source for certain buildings?

Section IV—Recommendations

We are developing education training workshops and other education materials for code officials and fuel cell installations. Please rate each of the suggestions below on a scale of 1 to 10 for importance–with 1 being least important to you as a code official and 10 being most important. Please briefly describe why you gave the rating you did.

1. Bring products or systems to the code officials for hands-on training?
   Rate: ________

2. Bring manufacturers' representatives for Q&A?
   Rate: ________

3. Bring third-party experts for Q&A?
   Rate: ________

4. Develop a building code handbook for fuel cells and other DER technologies?

5. Develop a CD-ROM?
   Rate: ________

6. Develop a web site for updated information on codes and standards and fuel cell systems.

7. Distribute information on upcoming seminar and convention schedules related to the fuel cell technology?

8. Additional ideas or recommendations?

Appendix B

List of Participants

Appendix B

List of Participants

Contact information and responsibilities for code officials who participated in this study.

Dene Koons (not present for group discussion)
Electrical Field Supervisor
Washington Department of Labor and Industries
500 N. Morain St., Suite 1110
Kennewick, WA 99336-2683
(509) 735-0130

Responsibilities: Supervising field electrical inspections

Joe Terpenning
Fire Inspector
Kennewick Fire Department
600 S. Auburn
Kennewick, WA 99336
(509) 585-4231

Responsibilities: Fire code inspections

Rick Hopkins
Building Inspector Supervisor
City of Richland
505 Swift Blvd.
Richland, WA 99352
(509) 942-7568

Responsibilities: Building official, Administration of Bldg. Department, enforce all adopted model codes (building, plumbing, mechanical, and energy code)

Mitch Nickolds
Inspection Services Manager
City of Pasco
525 N. 3rd
Pasco, WA 99301
(509) 735-0109

Responsibilities: Building official, Administration of Bldg. Department, enforce all adopted model codes (building, plumbing, mechanical, and energy code)

Steve Brown
Building Official
Benton County Building Department
5600 West Canal Pl.
Kennewick, WA 99336
(509) 735-3500

Responsibilities: Building official, Administration of Bldg. Department, enforce all adopted model codes (building, plumbing, mechanical, and energy code)

Daryl Brown
Building Official
Franklin County Building Department
1016 N. 4th
Pasco, WA 99301
(509) 545-3523

Responsibilities: Building official, Administration of Bldg. Department, enforce all adopted model codes (building, plumbing, mechanical, and energy code)

Rick Wright
Building Official
City of Kennewick
210 W. 6th Ave
Kennewick, WA 99336
(509) 585-4277

Responsibilities: Building official, Administration of Bldg. Department, enforce all adopted model codes (building, plumbing, mechanical, and energy code)

Appendix C

Sample Half-Day Agenda for Fuel Cell Workshop

Appendix C

Sample Half-Day Agenda for Fuel Cell Workshop

Agenda	**Fuel Cell Workshop** **Location: TBD**
Type of meeting:	Workshop
Facilitator:	TBD
Attendees:	TBD
Please bring:	TBD
Time (minutes)	**Agenda topics**
5	Introductions
10	Why We Are Here
45	Introduction to Fuel Cell Technology
30	Codes and Standards Related to Installation of Fuel Cells
15	Break
60	Codes and Standards Related to Installation of Fuel Cells
20	Wrap-Up/Questions
60	Manufacturer Representatives with Possible Demonstrations (Possibly set up booths for hands-on interaction with code officials after workshop.)