Summary of End Products from Summit I and Their Current Status as of March 2, 1998

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The purpose of conducting summits on fuel cell codes and standards is to help coordinate various codes and standards activities and ensure that fuel cell technology has the opportunity to safely enter the marketplace with a minimum of institutional constraint from codes, standards, and regulations.

The purpose of this document is to highlight the major end products and action items from the first DOE Office of Building Equipment (OBE) Fuel Cell Summit on Codes and Standards held in April 1997 and briefly summarize what has happened over the past year that relates to them. In addition this document should serve to generate additional discussion on these and related items for Summit II.

1. Grid Interconnection

Description: Develop grid interconnection standards, reduce duplication of efforts, and compile existing standards. *Developments of such a standard will reduce or eliminate duplication in grid connect safety features. Efforts to compile what is avaffa6le and being done would help identify the "status quo " and could lead to identification of actions needed to bring these efforts together into one voluntary sector activity. IEEE 1001 could possibly fill the need for one standard on this issue. Remaining to be addressed is the adoption of any such standard and its application to stationary fuel cells and other distributed generation technologies*.

Status: IEEE formed an ad hoc committee to address the issue of dispersed generation. A recent report to the IEEE Standards Board by that committee suggested revitalization of a Standards Coordinating Committee (SCC) 23 within IEEE. It is believed that this action would increase the scope of the current IEEE working group efforts on fuel cells to address the issue for all distributed generation technologies. The independent ad hoc committee recommended to the IEEE fuel cell working group that they not limit their efforts to fuel cells but address all power producing devices, and suggested that IEEE Standard 100188 could be used as a starting point but would need revision. The SCC is supposed to act on this March 19, 1998 and, if approved, the current IEEE working group efforts would be expanded to cover all distributed generation technologies.

Related Activities: In mid-1997 EPRI initiated efforts to secure sponsors for a program to simplify and unify requirements for interconnection and integration of distributed electrical generators and storage devices within utility distribution systems. The first planned project is an assessment of current practice and requirements and to define needed guidelines (this addresses the action item above from Summit I to develop grid interconnection standards and reduce

duplication of effort). Other projects in the EPRI effort include system modeling and communication and control requirements. There was no discussion in the EPRI effort of securing adoption of any EPRI developed guidelines, although in discussions with EPRI staff (Conover and Herman) this was noted as something that would be needed.

The DOE Federal Energy Technology Center and IEEE Power Electronics Society also held a workshop on power conditioning and inverter technologies for distributed generation in July 1997. The workshop included discussions on cooperation, manufacturer and end-user perspectives, what is available from power conditioning and inverter manufacturers, and electrical equipment first cost, efficiency, reliability, and controls. The summary of the workshop noted a need for standards; stressing that a diverse group of professionals would be needed and questioning how that would be accomplished. The summary also stressed the need for technical committees; a standards coordinating committee for all involved in the subject, and the importance of international involvement. The current situation was categorized as having a strong utility side influence and an emerging power conditioning side influence.

In addition DOE/EPA/IEEE have sponsored a series of forums on fuel cell technology. The most recent was in Nashville TN on March 3, 1998. The purpose of these is to "take the message into the local industrial and commercial communities" and make information about the technology available. These include an overview of the technology, discussions from current fuel cell users, information on available technologies, and discussion of application issues as well as siting and licensing procedures.

Possible Discussion Points for Summit II: There appear to be a number of activities related to the issue of grid interconnection and power conditioning They would apply to fuel cells as well as other distributed generation technologies. Is there a need to coordinate these activities? Who should take that lead? Is the Summit approach a feasible way to do this?

How will utility restructuring affect this issue, if at all?

What efforts will be needed to secure adoption and use of a voluntary standard or guideline on this issue?

2. Performance Test Procedures

Description: Develop test procedures to determine the performance of stationary fuel cell power plants. *Standard test procedures will facilitate measurement of the fuel cell power plant performance from fuel input to power output. In addition, such a standard will define test conditions so performance of different equipment can be undertaken and the results compared on an*

equivalent basis. This could be helpful in securing financial support for fuel cell procurement based on a certain minimum level of performance.

Status: During 1997 the ASME PTC 50 committee has developed an Object (test procedures, methods, and definitions for performance characterization of "stand-alone" fuel cell power plant systems) and Scope (fuel cell power systems which contain a DC electrical module). These were presented to the PTC Boards and approved. ASME has registered them under the ANSI Standards Activities Tracking System - Project Initiation Notification System. A meeting of PTC 50 was held March 10 and 11, 1998 in Alexandria, VA.

Related Activities: ASME has stated that it does not see the need for a formal relationship (e.g. co sponsorship) between IEEE and ASME, but rather that each committee (ASME PTC 50 and IEEE 1001, and others) should instead have liaison representation. When the IEEE Power Engineering Society (PES) Standards Board considered the request in early 1996 to begin development of standards for fuel cells, the IEEE Standards Board directed the PES to explore the formation of a joint standard activity with ASME, ASTM, and others. The present position of ASME is that others interested in their activities should participate in these (ASME) activities.

Potential development of a fuel cell terminology standard was raised by the Fuel Cell Power Systems, Technical Committee of AESD/ASME in early 1996. No action to develop such a standard has been undertaken by ASME to date, however, a document of common terms has been developed pursuant to Summit I and circulated a number of times for review and comment (see item 5 of this summary document).

Possible Federal legislation to provide financial incentives (tax breaks) for fuel cell power plants raises the issue of performance and the need for a standard upon which to evaluate and compare performance.

Possible Discussion Points for Summit II: Is some formal coordination, co-sponsorship, or other arrangement needed between the IEEE and ASME efforts on fuel cell standards? If so, how should it be designed and implemented? Would this be better addressed in a broader effort to coordinate all codes and standards initiatives related to fuel cells?

Is it possible for the ASME PTC 50 Scope to include up to the DC output of the fuel cell power plant and for the IEEE effort to cover the "electrical side" of the fuel cell from the point of DC output? If so (thereby eliminating duplication or overlap), what is the best way to ensure these two standards are compatible.

If there is overlap, what are the potential areas for IEEE and ASME overlap? 'If overlap, occurs what are the consequences and how will they impact the technology design, installation. and acceptance?

Who are the users of the ASME standard? Is completion of the standard necessary before commercialization of the technology can begin?

If some standard for performance measurement is needed today, what is available that could be referenced? Would ANSI Z21.83/CGA 12.10 fill that need?

3. Health and Life-Safety Codes

Description: Building construction regulations (codes, standards, etc.) will govern the design and installation of stationary fuel cell power plants through their adoption and enforcement by Federal, state, and local agencies. *The availability of code criteria for Federal, state, and local agencies to adopt and implement will facilitate and help drive the timely approval of stationary fuel cell power plant installations. Model codes and voluntary consensus standards developed within the voluntary sector provide an opportunity to ensure appropriate criteria are applied at each site because these agencies typically adopt these documents as opposed to writing their own. Updates and enhancements to the ICC model codes and NFPA standards are needed as well as educational materials on their application and use.*

Product standards will also be needed to ensure that a stationary fuel cell power plant and its components can be tested and evaluated by a recognized third party, further facilitating approval at the state and local level. Without a design and test standard, there is no uniform way to determine safety and acceptability at the local level. Moreover, each unit of local government will not be equipped to develop their own criteria when asked to approve an installation, nor will technology purveyors want to develop and submit an engineering report for each and every installation in order to secure approval

Guidelines and educational materials will also be needed to assist those wanting to use the technology or those responsible for its evaluation and approval.

The consolidated end product for activities related to health and life-safety codes and standards could be stated as follows: "to ensure that appropriate, coordinated, and succinct criteria exist in health and life safety codes and standards to Facilitate ready approval of stationary fuel cell power plant installations and that specifiers and regulatory officials have the necessary materials to facilitate their consideration of the technology".

Status: Relevant existing health and life-safety codes and standards include, but are not limited to, the following:

- ANSI Z2 1 .83/CGA 12.10 "Standard for Fuel Cell Power Plants" (and standards referenced therein).

- International Building, Mechanical, Plumbing, Fire Prevention, and Fuel Gas Codes (and standards and codes referenced therein).
- National Electrical Code (NFPA 70).
- National Fuel Gas Code (ANSI Z223.1/NFPA S4).
- NFPA 850 (electric venerating plants).

The ANSI Z21.83/CGA 12.10 standard is being used by third party agencies to approve stationary fuel cell power plants. It has been approved by the developing committee (ANSI Z2 1.83) and oversight committee (ANSI Z21) and went through an ANSI public review without any comment. As a joint US/Canadian standard, it was also submitted to the Canadian Standards Steering Committee and it received one negative comment, which is in the process of being resolved. The comment covers a few specific technical items as well as general items such as ensuring there are no conflicts with the National Fuel Gas and Operating Engineers Acts in Canada. Once the commentor is resolved, the standard will be submitted to ANSI for approval and will continue through the Canadian approval process. Approval and publication of the standards as an ANSI/CGA document is anticipated by this summer 1998. If the comment cannot be resolved, then the standard will have to be revised and an additional public review conducted.

The ICC International Mechanical Code has received a proposed change to adopt the ANSI Z21.83/CGA 17.10 standard by reference and to require that the technology be installed in accordance with the manufacturer's installation instructions. If the ANSI standard is not available (approved and published) by mid-April 1998 this change will be denied and can be reconsidered in the fall as described below. In addition, a change has been submitted to the draft International Building Code to delete the exception for certain equipment that is owned by public service agencies. This change would eliminate a situation that exists in the ICC codes that allows a utility to pursue installations without having to secure a building permit, while all other installations are subject to state and local codes. These changes will be discussed at public hearings in mid-April in Alexandria VA. The results of the hearing will be published and an opportunity will be available in mid-Summer to submit a "ne2ative ballot", which ensures a second hearing on the code change in the fall. Any change approved at the April hearing and not receiving a negative ballot or approved at the second hearing, as the result of a negative ballot will appear in the ICC codes.

The National Fire Protection Association (NFPA) TC 850 has established a task force to develop an installation standard for stationary fuel cell power plants. They are working on the development of draft text with the hope of securing approval from TC 850 to have the document enter the NFPA review process in 1999 so that it is capable of being published in 3000. The schedule calls for a first draft of the standard in April 1998 with subsequent review and revision within the task force and submittal to TC 850 in August 1998 with their consideration of the draft in September 1998.

No activity has been undertaken (other than by individual manufacturers) to develop checklists, guidance, educational materials, etc. to facilitate implementation of these technologies within existing code provisions (that do not currently recognize the technology). Such materials of a generic nature will be needed as these codes and standards are finalized and their adoption at the Federal, state, and local levels commensurate with more widespread technology deployment begins.

Possible Discussion Points for Summit II: The ANSI/CGA standard only applies to equipment not over 1000 kW and 600 Volts Will this standard be satisfactory for larger units or will new standards be needed for such units? What about modular components of larger power plants? What about "field engineered" power plants?

As smaller stationary fuel cell power plant technology is developed, will the ANSI/CGA standard apply? Will it need to be revised or will a new more "appliance" oriented standard be needed?

Will the standard or codes apply to vehicular systems that are "parked" and connected to buildings? Will standards being developed for vehicles be acceptable to the building code community should those vehicles be "parked" and connected to buildings?

What third party agencies are currently able to test and list stationary fuel cell power plants? Are they acceptable to state and local agencies in the U.S.? Are they acceptable to authoritative agencies in other countries?

Will U S. codes and standards find their way to the international level? Do they need to? How will that be accomplished?

What are the impacts on the technology if public service agencies have to secure building permits and meet building construction regulations as opposed to being exempt and essentially self-certifying? How will utility restructuring affect the issue of exemptions for public service agencies?

Do public service agencies self-certify and how does the insurance industry position on the technology vary if a public service agency is involved in the installation?

What criteria will state and local code officials use to evaluate the acceptability of an installation?

Are there any different responses to the above questions based on fuel source to the power plant? Would, for instance, the use of pure hydrogen directly (as opposed to producing it within the power plant) raise additional issues and necessitate a review of other codes and standards?

4. Unattended Operation

Description: Building and other regulations require on-site supervision for certain types of equipment. *Based on the existence of requirements for boiler operators, building engineers, and other on-site operational personnel, it is likely that existing criteria, although not written specifically for stationary fuel cell power plants, will be applied to the technology. If an argument cannot be made as to why the technology does not require supervision while other current technologies do, regulators could extend the current requirements to fuel cell power plants.*

Status: No known coordinated or consolidated efforts have been undertaken to address this issue as it would apply to stationary fuel cell power plants. A larger review of the issue in relation to distributed generation technology in general would be applicable. Size (input and output) of the equipment will be a contributing factor. Certainly, small (5 kW) "appliance" type fuel cells would not be subject to such requirements. Conversely, multi-megawatt facilities may be required to have operators because of insurance, fire code, or other interests. The process that is occurring within the power plant (temperatures, pressures, and other operational conditions) will determine the degree to which operators may be considered an issue. Another consideration is the impact automated controls and monitoring and control systems may have on the need for supervision.

Possible Discussion Points for Summit II: What requirements exist for any equipment supervision and to what equipment do they comply? Are they national in scope or do they just have a limited application at the local level?

What is the scope of the existing requirements in terms of input, output, size, fuel source, internal processes, etc.?

Is the development of guidelines in this area warranted? Should a case be developed for when and where non-supervision is justified?

If operators are required, how will they be trained; certified, licensed, etc.? Will this apply to other distributed generation (DG) technologies, suggesting some broader treatment of this issue by the entire DG community?

How will utility restructuring affect this issue? If utilities no longer operate generation plants then who will address this issue? On a broader level, will they be subject to state and local codes if they are then not under the control of a "public service agency"?

5. Terminology

Description: One common set of terms and definitions is needed to improve uniformity and consistency in dealing with the technology. Definitions are also

needed to ensure that purchasers and sellers of the technology and its output have an understanding of reliability, availability, downtime, and other performance measures. *Over the past year, DOE has sponsored the development of a terminology document This document initially compiled terms and definitions from numerous sources in addition to the listing provided to ASME when DOE made the request that ASME initiate development of a terminology document.*

Status: Two drafts have been prepared and include comments received from interested and affected parties. The draft is currently available for further revision and/or use by standards developers.

Possible Discussion Points for Summit II: How should a terminology document be updated and maintained in a way that provides for a singular focal point on the issue, allows input from and use by other standards developers, and does not preclude each standards developer from defining terms within their own individual documents?

6. Cost/Benefit Guidelines

Description: Guidance will be needed in preparing cost/benefit analyses so that buyers, sellers, and users of the technology can communicate on the same basis when addressing this issue.

Status: To our knowledge nothing has been done to address this issue from a fuel cell standpoint or from the standpoint of distributed generation technologies in general.

Possible Discussion Points for Summit II: What individual efforts have been undertaken on this issue?

Is there an advantage to developing some guidelines for all distributed generation technologies that would facilitate comparison of different technologies within a class of generation technologies (e.g. fuel cell I in comparison to fuel cell 2) as well as comparing those in different classes (e.g. fuel cells in comparison togas turbines)?

Who is best positioned to develop those guidelines?

7. Coordination at the International Level on Codes and Standards

Description: Development and implementation of U.S. codes and standards will facilitate commercialization and use of stationary fuel cell power plants within the U.S. If other countries do not have compatible criteria then the U.S could become "an island unto itself". Without similar criteria or reciprocity amongst countries,

U.S. produced technology will have to be modified for use in other countries. *An ad hoc group on fuel cell power plants was established in June 1996 within the International Electrotechnical Commission (IEC). Their charge is to define a strategy for the IEC on fuel cell standardization, stay current on technical developments, represent the IEC at all international meetings where fuel cells are addressed, and comment on documents produced by other standards organizations. To date we are not aware of any IEC comments to the ANSI/CGA standard nor interest in the NFPA activity. This suggests that the ad hoc group on fuel cell power plants may not yet be fully implementing their charge. Certainly as U.S. activities in the codes and standards area proceed there should be some coordination with the international community, possibly through this ad hoc group.*

Status: Kevin Knudsen of Rocketdyne represents the U.S. on the IEC ad hoc group on fuel cell power plants. This group does not report through any U.S. Technical Advisory Group (TAG) but rather reports directly to the management at the IEC. Charles Zegers at ANSI did not know the status of the ad hoc group activities but was going to check on them while in Europe during March 1998. Mr. Knudsen reports that there has been little communication to date within the IEC ad hoc group. To date we are not aware of any involvement by the ad hoc group in any of the onaoin<~ U.S. codes and standards initiatives.

Possible Discussion Points for Summit II: Is the current process for U.S. - international coordination on standards for fuel cell power plants working? If not what needs to be changed?

What is happening at the international level regarding standards and codes for fuel cell power plants? Who from the U.S. is following and/or coordinating U.S. input to those activities?

How might activities of the hydrogen industry, and others, at the international level affect the acceptability of fuel cell power plants?

8. Education on Fuel Cells

Description: Information on stationary fuel cell power plant design, installation, operation, benefits, etc. is needed to inform potential users, operators, code officials, insurers, specifiers, etc. It is recognized that technology manufacturers will develop some of this information, but there are a number of educational pieces that can be developed by the collective fuel cell industry.

Status: A listing of web pages on fuel cell power plants has been prepared and circulated. In addition we requested information from the industry and Summit I participants on existing educational materials and programs on the technology. Information received was compiled and circulated in 1997. More recently DOE OBE has initiated the development of a 4-page executive summary on the

technology as well as a more robust Technology Alert describing stationary fuel cell power plants and their benefits and experiences to date.

Possible Discussion Points for Summit II: What is being done by individual manufacturers and the collective industry (through organizations such as Fuel Cells 2000, U.S. Fuel Cell Council, and Small-Scale Fuel Cell Group) on this issue?

What activities should be coordinated? Who should coordinate them and how?

Can the "fuel cell interests" agree on the messages they want, audiences they want to reach, and media to communicate the message and develop a joint educational and outreach program to help facilitate technology commercialization?

Who should implement education and outreach efforts and to whom should they be directed? Do they need to be coordinated with codes and standards initiatives so they bolster efforts to secure technology approval?

9. Other Related Issues

Description: The above activities and interests "spill over" into other technology areas. These include distributed generation technologies in general; vehicular systems; and production and use of hydrogen. Issues such as streamlining the standards development and approval process can also be raised as well as emissions testing. Siting and zoning are also generic issues.

Possible Discussion Points for Summit II: What are these other related issues? Who is working on them? How can they be effectively integrated with these efforts? Do they hold the potential to drive or preempt activities related to stationary fuel cell Dower plants?