Fuel Cells Summit V Summary and Results

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FOREWORD

Fuel Cells Summit V is the fifth in a series of working meetings sponsored by the U.S. Department of Energy, Office of Power Technologies (the Summits originated in the Office of Building Technologies, State and Community Programs, but the responsibility for this program has since been transferred to OPT). The goal of the Summits is to support a receptive institutional and regulatory environment for fuel cell technologies. The Summit series provides a forum for representatives from industry, codes and standards organizations, governmental agencies (federal, state and local), and other interested parties to learn from each other about codes and standards affecting fuel cell implementation, and to cooperatively address the related needs identified for facilitating the technology's movement into the marketplace.

This summary report documents the presentations, discussions and results of the Summit. As the proceedings were not electronically recorded, the contents herein were produced from notes taken by various attendees and materials provided by presenters. To minimize risk of misinterpretation or misrepresentation, only a minimal attempt has been made to edit statements or discussion for purposes of clarity and continuity. However, the statements and text contained herein are not literal transcriptions and therefore cannot be treated as such. Undoubtedly some of the discussion and nuances of points made during the meeting have been lost in the translation. On the other hand, as this document has been compiled from multiple note takers and circulated for comment to Summit attendees, the authors believe it fairly captures the spirit and content of the meeting.

The authors wish to thank the various presenters for their individual contributions, as well as all of the attendees for their cooperative attitude and lively participation.

Any remaining inaccuracies in the text are the sole responsibility of the authors. The views expressed herein do not necessarily reflect the positions of the U.S. Department of Energy or any of its contractors.

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1. DAY ONE PRESENTATIONS AND DISCUSSIONS

1.A. Welcome and Introduction

Mr. Ronald Fiskum, Office of Power Technologies, U.S. Department of Energy
Dr. Mike Davis, Avista Corporation

Mr. Fiskum welcomed everyone to the Summit and noted the importance of building codes and standards in facilitating the deployment of fuel cells and other distributed generation technologies into the market. This meeting, the fifth Fuel Cells Summit, continues to be an important component of the Office of Power Technologies (OPT) fuel cells program. Mr. Fiskum next introduced Dr. Mike Davis, CEO of Avista Labs and former Assistant Secretary of the Office of Energy Efficiency and Renewable Energy.

Dr. Davis indicated that he has had the benefit of both public and private sector experience in the energy arena and discussed the need for patience in this effort. It will take a long time to successfully get fuel cells into the market, make a profit, and create a sustainable business. In addition to improving the technology itself, fuel cell developers must spend a lot of effort on codes, licensing, and education to achieve mass-market commercialization.

Fuel cells will benefit from earlier efforts to open markets for new power generation technology. There was a time when there were no independent power producers, and when it was impossible to bring a new technology to market and site it in a utility service territory. PURPA (Public Utilities Regulatory Policies Act of 1978) changed things. Solar energy developers also paved the way for opening transmission access.

Fuel cell systems consist of three main components -- fuel processing, the fuel cell itself, and power conditioning equipment. Of these three, power conditioning is the easiest aspect to deal with as the technology and the utility interfaces do not distinguish between generation sources. More work must be directed toward fuel cells and fuel processing

The central utility model works well in some respects; it offers guaranteed return, but limited profit and prices. Today, the “time to market” is a key issue affecting the central utility because it takes a long time to start earning on the very large investments. Also, there is much more environmental pressure now than in the past. But customer demands present the biggest change in the utility market. Utilities must be able to deliver goods and services to meet special needs. The digital economy demands clean power and reliable service. Fuel cells have traits that can meet these needs.

Dr. Davis stressed that it will be critical for the industry to set reasonable expectations and reduce the chance that expectations will get ahead of the industry’s ability to deliver. He hopes many fuel cell companies succeed, and that they work together to deal with critical issues that could inhibit success of the entire industry, such as safety. For instance, piping hydrogen around a building could present problems. Again, this calls for the need for standards, codes, licensing, and education. It is important to avoid the mistakes made by the solar industry in the past. (This point was particularly stressed by a

U.S. Senator on a recent visit to the Avista facilities.) However, it is also important that the standards are broad and flexible. Individual firms should not try to gain market advantage by attempting to set specific standards that only they can meet, as these will turn out to be detrimental to the industry as a whole.

Potentially, there is a huge global market for fuel cells -- both inside and outside the grid. But there is a long way to go before this market can be realized. The industry must find the most profitable applications. For example, in the solar industry, the size of the systems (in terms of overall watts necessary) declined over time until the solar module itself only contributed a fourth of the total system cost. In the fuel cells arena, companies will need to gain experience in the most profitable niche markets before they can tackle the larger residential and transportation applications.

Best components make the best systems. In an automobile, there are an impressive number of components and the integrator of these makes the most money, but integration is also very difficult. Everyone has a different idea about how to make a fuel cell. Avista has focused on developing certain components where they perceive a relative advantage. For instance, power electronics are very important. Fuel processors also need improvement and Avista is focusing on improving those.

When we think about the future and the issue of licensing a fuel cell for use in a house, many questions arise. For example – who obtains the permit? We need to think about the amount of time and education needed to clear the hurdles of building inspectors. When Dr. Davis owned his own mechanical contracting business in the Denver area, he had to maintain contracting licenses in over 20 different jurisdictions, adding time and cost. Although contractor licensing is a separate issue from building codes and standards, similar time delays and costs will result if the industry is not prepared for them. Codes and standards is not the most glamorous aspect of fuel cell development, but it is an extremely important one.

1.B. Status Report on the Fuel Cell Industry

Mr. Robert Rose, U.S. Fuel Cells Council

The U.S. Fuel Cells Council (USFCC) is a three-year-old organization open to any company or entity supporting the agenda of getting fuel cells into the market. Currently, there are 80 members. The USFCC works hard to make sure the industry advances a common agenda.

It is an industry that is just beginning, just on the cusp of becoming a commercial industry. In 2002, some members may start taking orders. In 2003, they could be offering commercial sales on commercial terms.

Recent activity includes:

- A lot of activity in buses – several dozen (perhaps as many as 100) new fuel cell buses have been put into service.

- A new buy-down program, a joint activity of DOE and the Defense Department will offer a fuel cell subsidy.

- Ballard Power Corp. will be making a $14M sale of fuel cells to Honda (1kW units.)

- Ze-Tek recorded some fuel cell sales and committed to building two production plants in the U.S. and one in Germany. (In order to get costs down, you need to develop the capability to produce in quantity.)

- Dupont reorganized and started a fuel cell group, including substantial hydrogen activity.

- The Bush administration is showing some support for fuel cells, e.g., Congressional support, possibility of tax credits, some federal R&D. There is also some interest on the part of States, maybe including fleets.

- The California Fuel Cell Partnership continues to grow.

- GM reports some good endurance testing results.

- Joint Ventures abound. The industry is internationalizing before fuel cells are even commercial (this is fairly unusual).

- Fuel cell companies are not depending on the government for supporting development. This is good.

- The first markets are likely to be high value markets; e.g., particular niches for specialized technologies with fairly high price tags.

Market Drivers for fuel cells include:

- Environmental benefits – fuel cells are highly efficient and have relatively low emissions.

- The general trend towards distributed generation in this country and the world.

- The modularity of fuel cells, which leads to a highly reliable energy source.

- Their output of "high value" energy. Poor power quality costs the nation between $150 and $450 million per year. "The most expensive kilowatt is the one you can't get." Fuel cells are reliable to "six nines," i.e., 99.9999% reliability.

On the automotive front --

- GM and Toyota have joined the California Fuel Cell Partnership. There have been quite a few vehicle demos – cars and buses (Mr. Rose showed many photos) and expect to have more than 70 by 2003.

- Fuel cells are being considered for specialty vehicles – fork lifts, bicycles, mining locomotives (mining vehicles are considered a high value market and the current technology isn't very good, requiring long extension cords).

- Remaining issues for automotive applications include fuel choice, cost, heat rejection, and performance issues like startup time and range. Major automotive application is still a longer-term proposition.

Stationary power side --

- The residential market is desperate for fuel cell attributes and we do not have enough product to supply demand.

- California situation is heightening interest. Fuel cells will be assured a place in CA.

- High tech growth requires high quality power.

Commercial buildings market --

- If fuel cells can come down the cost curve, there is a substantial market. The current market generally consists of users more concerned with power reliability than cost.

- There are lots of good ongoing demonstrations. The primary issues for fuel cells are cost, availability, competition from microturbines, and entrenched technologies.

Residential buildings --

- Those involved with codes and standards are very interested in fuel cells.

- There has been some recent patent activity in methane, propane, and natural gas fuels.

Portables --

- The Ballard/Coleman launch is a good development.
- The U.S. Fuel Cell Council is examining DOT fuel regulations.
- H Power made a sale of real fuel cells, 12,300 10kW units to the Energy Co-Opportunity, a consortium of rural electric cooperatives.
- Packaging is improving.

R&D --

- There is quite a bit of funding at Federal level and Congressional support (more than $175 million in FY2001).

1.C. Status Report on Institutional Issues and Responses to Them

Mr. David Conover, National Evaluation Service, Inc.

Mr. Conover's PowerPoint presentation is quite lengthy and detailed, containing many points and data not repeated here, The reader should consult Appendix A to view the main presentation and Appendix B for the background memo, "Status of Codes and Standards and Identification of Additional Needs to Support their Enhancement, Further Development, Deployment, and Use." Unlike similar presentations in past Summits, this presentation attempted to also address portable and vehicular applications and issues. This is difficult because codes and standards affecting portable, vehicular and stationary applications will be different and there is a number of other implementation issues that are unique to each application. What follows below are a few highlights.

Codes and Standards can support the implementation of fuel cells; they should not be seen as simply barriers to be overcome or roadblocks to successful deployment. The ideal situation is uniformity in the acceptance and application of fuel cell design, installation, operation, and use including a supportive service infrastructure. One key role that codes and standards play is to protect the market against unsafe products.

Different applications will call into play different codes and standards. For stationary applications, integration of the system with the building is a particular focus. For portable applications, acceptance for use in and around the built environment is key. For mobile applications, the means of refueling and refueling infrastructure takes prominence along with the location of the fuel cell vehicle and any unique on-board fuel supply in relation to buildings and structures.

The simple fact that a code or standard exists does not mean that it has been adopted in all jurisdictions. It will take a number of years after a code or standard is developed for it to be adopted and those responsible for its enforcement as well as those having to satisfy the code or standard to become fully aware of the requirements.

1.D. Presentation of Real World Experiences with Code Officials and Fuel Cell Installations

Timothy Hillman, Pacific Northwest National Laboratory

This study was conducted in the Tri-Cities area of Washington State, which includes five separate jurisdictions (3 cities and 2 counties). The survey included Building Officials, Fire Marshals, and Electrical Inspectors. The purpose was to assess the relative level of preparedness of local code officials for reviewing and approving stationary fuel cell installations.

One key point that the study identified was that code officials generally have no pre-existing knowledge of fuel cells. They do not have the resources to track technologies coming down the pike, so even though some may have heard of fuel cells they generally were not familiar with their operation or application.

The officials who participated in the study brought up three major issues: (1) fuel supply and storage systems, (2) utility interconnect, and (3) fire fighter intervention. The code officials seem to have no particular concerns regarding hydrogen, as long as components like automatic shut off valves, clearances around storage tanks, signage to indicate what is there, etc., are sufficient to ensure safe operation. For interconnection with the utility grid, local utilities will have different requirements and the code inspectors will need to know that the installation meets utility specifications. One issue is "islanding," which occurs when power is shut off to a portion of the grid but a fuel cell inside that portion is still live and continues to supply power to the wires. This is a particular concern for firefighters; they must be informed through signage or other means that a fuel cell is on the premises and therefore the electric wires may still be live.

Another important issue is that manufacturers will specify how a fuel cell is to be correctly installed in accordance with safety and other requirements. Will there be licensed installers besides manufacturers? Manufacturers will ease things by providing complete wiring schematics to their systems.

Code officials are not that concerned with the processes inside the fuel cell; they prefer to think of it as a black box, although it will be necessary to have the "box" tested and listed or some other means employed to verify that the "box" meets accepted and adopted safety criteria. Their main attention will be on the connections to this black box, i.e., fuel inputs and exhaust outputs, electric outputs, switching systems for energizing or de-energizing the circuit, etc.

For the code officials surveyed in this study, the favored means of getting information from the manufacturers to the code officials were conferences and field guides, then manufacturers' representatives and videos, followed by several other approaches. In general, computer-based information was seen as less desirable as many code officials still do not use computers to a large extent.

1.E. Lunch with Speaker

Dr. William Parks, Associate Deputy Assistant Secretary, Office of Power Technologies, U.S. Department of Energy

Dr. Parks of the Office of Power Technologies graciously took the spot of the original guest lunch speaker, as Dr. Robert Dixon was unable to attend. As Director of the Distributed Energy Resources Task Force, Dr. Parks presented on the directions of DOE activity in this area and how the Fuel Cells Summits fit into the larger DOE picture. His comments were not recorded for purposes of reporting here but his presentation slides are included in Appendix A.

1.F. Group Discussion

Ronald Jarnagin, Pacific Northwest National Laboratory, Facilitator

This session was designed to discuss the issues brought forward earlier in the day as well as to introduce any others that Summit participants thought should be put on the table. What follows is the mixture of comments, questions and ensuing discussion.

Lead-Off Question: *What are the main issues confronting deployment of fuel cells right now?*

Stationary fuel cells and separation of the reformer from the black box; the connectivity between these two black boxes is a main issue. Where is the fuel coming from?

There are three main components of the system that must be interconnected. Are there standards needed to address their interconnection? Is a reformer standard needed to allow for approval of this device as a separate component when outside an assembled fuel cell or matched set of components? If the assemblage of fuel cell components is not matched and tested by the manufacturer, the components would need to be tested and listed separately and code provisions made available to ensure their safe connection and installation. Where the manufacturer has an overall matched set of components that are to be installed as a single assembly, and has them approved that way, pursuant to Z21.83, which does address individual components as well as the assembly, then the entire assembly can be tested, listed and approved.

Also, if hydrogen is being produced by the unit and stored for later use, the building could be considered a hazardous production facility, changing its use group with respect to building codes and consequently imposing a number of other design and construction considerations. There is a need to determine whether this is an issue. CSA was approached some time ago to see if they could approve hydrogen storage facilities. It was suggested that since LNG is stored it can't be too different from hydrogen. Are there limits on inventory that put you in different classifications? => Yes, NFPA 50A and 850B cover liquid and gaseous hydrogen storage; however, there is no standard for the facilities or equipment that would "manufacture" hydrogen.

Who is addressing ten years down the road, when somebody makes a mistake and causes an accident? Who will be responsible? This question suggests that the entire industry needs to work together to address the identified issues, rather than allow a portion of the industry to move forward without considering necessary issues and causing a safety concern due to lack of attention to those issues.

Can we transport portable systems on aircraft? The USFCC is working on this, but it will require change in DOT and IATA regulations. Minimum time to resolution will be 9 months.

For stationary applications in multifamily buildings, the building may be considered a utility and have to be rezoned. This is determined by whether the building is selling the power to its tenants at a profit.

What about standards for earthquake or tornado (i.e., natural disaster) survivability? The stationary unit must shut down safely in the case of an emergency. This is something different than requiring the unit to operate through an emergency, supplying continuous power. (This issue was not discussed, as it would relate to portable and transportation systems and their fueling infrastructure.)

Are smaller fuel cells (appliances) to be treated differently than other systems? => Yes, there is currently a stopgap measure in place (Z21.83, soon to be renamed), but in terms of safety requirements there's not a lot of difference, mostly related to manuals and other things to help the homeowner. (The statement above could be controversial as "smaller" and "a lot" are not defined. A fuel cell is a fuel cell regardless of size. The only difference to date in the codes and standards world is that for units above 50 kW there is an installation standard, and for smaller units the manufacturers installation instructions are the only guide other than all units up to 1000 kW will have to meet Z21.83 or equivalent.)

What about repairs down the road? We're going to need standards for parts interchangeability, encompassing a) replacing the same part from the same manufacturer; b) replacing the same part but from a different manufacturer; and c) substituting a new replacement technology down the road.

Replacement or repair of a piece of equipment is not going to be exempt from mechanical codes and it will have to be shown that the repair is not significantly modifying the operation of the system, as this would typically void the manufacturer's warranty and bring other problems, and make the modifier liable for them. In effect, the repaired fuel cell will have to show that it continues to meet code after the repair or retrofit, hence the need for tested and listed replacement parts such as a fuel cell stack. This will also require education and factory training of the repair force. NFPA 853 talks about who can perform servicing, what training is required to be certified, etc.

Is there anything covering breach of the separator, which could cause potentially explosive conditions? Also, what about air bleed into the system as a means of

controlling CO concentrations? => Yes, NFPA 853 covers these issues. Additionally, Z21.83 requires shutdown in a passive and inert state. This is usually done with nitrogen but other ways are possible.

ANSI Z21.83 addresses open flames; what about catalytic technologies that do not employ combustion? That section is currently being modified to accommodate non-combustion. NFPA 853 may talk about this; where they don't have an open flame, Z21.83 covers.

What about reverse power controls on interconnection? These controls monitor voltage and scale the system back to prevent back feeding the grid. Right now everyone seems to be developing their own system for this purpose. Is a standard needed so that utilities can pre-approve? => There are standards for utility companies for reverse power relays; however, no one is aware of any inverters that have this capability. Generally, it is done through a dual backup system

Is there an issue with odorants in the gas or lack thereof in hydrogen? What you do with the extract, sulfur or whatever from the deodorizer? Is there a code that addresses the use of de-odorized gas? => The leakage rate is limited and there are ventilation requirements in Z21.83, but this is an indirect standard in that it does not specifically address odorants. A separate ventilation system is needed to vent any escaping hydrogen to the outside of the building; natural ventilation is not acceptable. Maybe don't need two fans, though. One well-designed fan might work

One of the training needs identified in the Tri-Cities study was a checklist for design and commissioning. Is this needed? NFPA 853 does address some of this.

Are small residential units going to be covered under NFPA 853, which right now only covers stationary fuel cells over 50 kW in capacity? Eventually.

Any safety codes covering fabrication of sulfur traps? ANSI Z21.83 and NFPA 853

Would it be worthwhile for someone to sift through NFPA 853 and Z21.83 and extract salient features for consumption by this more general audience?

1.G. Expert Panel Discussion

For the sake of clarity, applications (i.e., Stationary, Portable, and Mobile) were handled consecutively in the discussion.

<u>Stationary Applications</u>

Mr. Todd Strothers (TS), CSA: I recommend everyone get a copy of Z21.83 and NFPA 853 and understand all of it before you get to the production stage to make sure you will be in compliance; you can have a pre-assessment done by CSA or UL.

Mr. Guy Tomberlin (GT), City of Fairfax: These are "appliances" in the eyes of the code official. The location on the premises, identifying the components, then getting qualified, certified installers are a good idea but not in the code right now. To take this through a site plan, a lot of this has already been developed, the guidelines we have to go by are pretty much contained in Z21.83; having qualified installers will certainly ease things. The more qualifying documentation you offer to the code official the better off you are going to be.

<u>Comment:</u> *You are also going to need NFPA 853 as well, which tells you how to install.*

GT: A lot of things haven't been adopted by individual states (e.g. there may be a number of standards and other documents that are under development or have been published) but remember it may take time before they are adopted by state and local government into their rules and regulations.

<u>Comment:</u> *There aren't references to the model codes in many instances.*

GT: This is only pertaining to units > 50kW. Still, there is a need to get NFPA 853 adopted into the model codes.

Mr. Timothy Bernadowski (TB), Dominion Virginia Power: A lot of work is still in draft form and we need to make sure the work keeps moving because no state is going to reference anything that is still in draft form. Just because model codes exist, that doesn't necessarily help. You need adoption and implementation of them as well. We need to recognize that we are dealing with two bodies – one that implements the codes and another, like the state utility commission that regulates utility grid issues.

We also need some sort of acceptance testing for installed systems by the utility on grid and interconnect issues, overall for initial installation as well as for later modification. We need standardized testing methodologies to make sure the installed system does what it is supposed to do.

There are other peripheral issues such as zoning and environmental requirements. For example, in Virginia there is a difference between emergency power and normal power installations. If it is a normal installation, there has to be leakage detection for the underground fuel supply tank associated with the installation.

Fuel cells are not unique. Or, at least selling them that way marks them for special attention by approving officials. He recommends calling the fuel cell an onsite generator.

Mr. Chris Fennell (CF), National Association of Home Builders Research Center: What is the impact on the actual construction site? Homebuilders don't sell fuel cells, they sell homes. At what point is the fuel cell installed? Does it require a specialist to complete the installation? How is installation going to affect the overall construction process? You may really only have one opportunity for getting fuel cells into the residential construction market, if the process isn't handled properly the first time you

may cause a lot of damage to fuel cells' reputation that will take years to repair (e.g. if the initial installations have problems in approval and/or subsequent operation and servicing).

Mr. Harry Jones (HJ), Underwriters Laboratories: In reference to the "black box" – it would be nice to have standardized connections to waste water, electricity, etc., to minimize any special approvals required. If mistakes occur and installations aren't well carried out, local code language may be the result. Primarily, you want to simplify the construction and installation process as much as possible.

Monitor the standards making process. There are many ways to address risk, but there are some ways that might put undue pressure on the manufacturers. Manufacturers must recognize that they have to keep code committees informed so that the committees don't write something that is out of date with the technology. Keep them informed!

Manufacturers putting temporary equipment out in the field should make sure that the authority having jurisdiction will approve equipment beyond these prototypes.

The manufacturers should assign responsibility to someone to track feedback from the field, problems encountered, etc., to head off issues further down the road.

Mr. Alan Mace (AM), Idatech: A manufacturer can't always afford to get products listed when you know the products will be changing soon, because the effort will be wasted (e.g., testing and listing can be expensive propositions that are not necessarily cost effective on a technology that changes rapidly in the early stages of development). So you need to work with the local code officials or else we're hampering the industry. We've actually gotten a "bye" on many of our installations; that is, they don't require strict adherence to all kinds of standards for installations that are specifically considered temporary. The code officials are more concerned with the fuel rather than the black box. Fire marshals are really the primary disciplines that take a look at our installations. A Eugene, Oregon fire marshal required an additional $30,000 in safety related devices and siting considerations for the installation of a methanol tank associated with the fuel cell. There's also a lot of disparities between urban and rural code officials and what is the best means to reach them (many don't even have computers).

CF: Residential fuel cell sizing – the PATH project – Partnership for Advancing Technology in Housing - is assisting with a fuel cell installation and much of that work might be of interest to the people here. It's designed to provide information to the construction industry as to the kinds of hoops they'll have to jump through in order to install these.

Would a builder and a homeowner be content to consider the fuel cell a black box, not knowing what was inside, similar to the code officials? Maybe we should use the same method as was recently done with the code officials to solicit their opinions.

GT: Frequently there are concessions to the manufacturer – if you can prove you've met the "spirit and intent" of the overriding code, inspectors will often approve the installation. Also, nationally recognized listing agency approval is what we look for. We're book/tech kinds of people and like to have documentation. Establish "level of equivalency" where the code does not yet exist.

Use community opinion to overcome some of the barriers. If there's concern on the part of the public, the inspector might look at things a little differently.

Question: Can something be done regarding the qualifications of the installers? Codes don't mention this.

CF: Who is the installer? A plumber, electrician, other? There has to be enough availability of that talent so as not to be a restriction.

TB: As far as interconnection requirements, we require signoff by a licensed electrician and approval according to manufacturer's instructions.

GT: We'd like to get this incorporated into the code (installer certification).

Comment: We're fearful that the code will drive the construction standard.

GT: The code official's primary job is public health and safety; if you have demonstrated compliance with intent, they should approve it.

Comment: Licensed and bonded installers are sort of the responsibility of the manufacturer. It shouldn't be a code issue.

AM: The European directive system is effective (the "CE mark"). It defines safety and allows the manufacturer a lot of leeway in meeting requirements, e.g., low-voltage, emc.

TS: These are tricky to get a handle on what you want to do, however. What tests, how long, how much? Also, some countries might have standards on top of these – additional requirements. There are some political differences between EU countries. With the U.S. system, it's more prescriptive but more clear cut.

AM: We think the issue of CE marking is coming to the U.S., driven by requirements to meet the European market.

Question: What do each of you see as the biggest obstacle to fuel cell deployment?

HJ: Marketing people deciding what they want to build and then getting it certified.

GT: Not really any barriers, as long as you install correctly.

TS: Don't think there are obstacles from the Test Lab perspectives for stationary units. It's more the issue of cost; perhaps incorporating the true cost of fuels into all technologies will make fuel cells more competitive.

TB: I don't think there are any drop-dead barriers.

CF: 1) The winner is going to be the company who makes the process as transparent as possible; 2) builders will build what buyers will buy, there needs to be a market.

AM: Time – trying to refine the technology to meet all the requirements on it.

Question: To list a new product, what's the cycle time?

TS: 1-6 months, depending on the manufacturer's schedule and whether the product passes all of the tests. You could break the system up into parts and have them certified separately. Also, talk to component manufacturers and ensure that the components they supply to the fuel cell have been certified; if you're using other parts that aren't certified, this will delay your certification.

Question: How pressing is the need for annual test ratings and labeling for consumers (e.g., such as done by NIST for heat pumps)? Should we consider an ASHRAE standard for seasonal ratings?

Portable Applications

TS: Portable units would not be certified under Z21.83, but CSA is currently writing a standard and hopes to have it ready this year (by September, it's in draft form right now).

Comment: Transport of the fuel supply and storage of the fuel supply once it reaches its destination needs to be addressed with DOT and whoever else.

GT: ICC developed a definition of portable. But taking a portable unit and affixing it to a fixed fuel supply (e.g., a natural gas pipe), does this change its status as portable? It's currently a gray area. Mainly it is an issue for ventilation.

HJ: Household use may trigger Consumer Product Safety Commission issues, at least to monitor how they're being used. Fire code is probably the only code that will affect portables.

Question: The definition seems restrictive, are you planning to modify the definition to include vehicles plugging into the grid?

GT: No, we're really looking at appliances; vehicular application is completely different.

HJ: There are indoor use issues that will be associated with units intended for indoor use.

Transportation Applications

Mr. Tony Androsky (TA), Society for Automotive Engineers: The Society for Automotive Engineers (SAE) covers much more than automotive applications and actually writes more standards for aerospace applications than for automotive. SAE also covers locomotive, heavy trucks, forklifts, and others.

Vehicles are an international product and there is a need to ensure that all of the components and systems work together, no matter where they come from. We're initially looking at bus use safety and performance standards and need to address these right away. Another large potential application is in airport vehicles; currently the Dallas/Ft. Worth Airport cannot provide the amount of energy needed to charge these vehicles for the level of service being demanded of them.

The core of our engineering community is currently focused on internal combustion engine technology; we need to change that somehow. The bottom line here will be the cost/kW compared to what the internal combustion engine can do.

Refueling infrastructures are going to be a major issue. Right now, the more proactive automobile manufacturers are considering the option of converting their dealerships into refueling stations for hydrogen vehicles, just to ensure there is somewhere to refuel these vehicles.

There are a number of post-crash safety issues that need to be addressed so that volunteer fire forces, emergency medical technicians and others know how to tell what vehicle has what inside of it and how to deal with it. These people aren't always professional emergency responders and may be confronted with very complex fuel systems. SAE is in collaboration with IAC and ISO, and with groups like the NHA to deal with these issues.

There's going to have to be a lot of cutting edge information going to the design engineers, inspectors and service technicians; somehow they're going to have to be certified on these vehicles. If they don't buy in to the new systems, there will be a lot of broken stuff out there.

Question: What are the issues the insurance industry brings up?

TA: Don't really know but we have been approached by the Transatlantic Consortium about refueling of buses.

Question: Is infrastructure or fuel reformation capability driving the fuel choice currently being researched by the manufacturers?

TA: Both of these are drivers. Direct methanol fuel is being considered by some manufacturers. Energy distribution network has been brought up a lot. The California Air Quality Control board is considering CNG, putting in fuel supply.

Question: How about hybrid systems – Solid Oxide with microturbine? NFPA 37 standard covers turbines, but there isn't a microturbine standard (according to Mr. Conover). NFPA 37 was written for gas turbines of a much larger capacity but currently they could be considered within the scope of that standard.

Question: What about parking garages?

TA: Underground garages, aboveground, everything needs to be looked at. Resulting codes are probably going to be specific to every fuel type. It is hard to retrofit residential garages to add more ventilation and existing ventilation systems, and construction of public garages may not be satisfactory to accommodate potential hydrogen events.

Question: What about driving a fuel cell vehicle into a tunnel?

TA: That's a DOT issue.

Question: Are there going to be emissions inspection stations similar to what we have for current vehicles?

TA: Presumably there will be some sort of safety inspection.

Other infrastructure issues:

- Hydrogen production
- Service stations

Hydrogen generators – regulations are drafted, not published.

2. DAY TWO IDENTIFICATION OF ACTIONS

Much of the discussion during the first day was captured on flip charts, and where needs for cooperative action could be discerned, were identified as such. These newly articulated needs were next added to a table of needs previously assembled by Mr. Conover in preparation for the Summit (the resulting table is included in Appendix 3.B.)

Summit attendees broke into four working groups the entire morning of the second day to identify actions that could be undertaken to address as many of these needs for which ideas could be generated. The different working groups were defined by topical area, including Stationary/Residential, Stationary/Commercial, Portable, and Mobile applications. Following lunch, a spokesperson for each group presented the resulting set of actions identified during the morning.

Following is a summary table of the actions identified by each group, along with the parties responsible for participating in each action where they were identified. Full presentations and notes from the breakout sessions are included in Appendix 3.E.

Actions Table from Fuel Cells Summit V, May 31, 2001

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
Stationary/ Residential	No known standards exist for hydrogen piping. What type of material should be used for piping hydrogen at the pressures that are required by the fuel cell?	Check with Dave Conover to see if there is any applicable code or standard in place. If not, pursue development of one.	Not identified
	Piping connections need to be designed such that they would meet existing standards	Manufacturers should consider aiding the permitting process for an inspector in the field	NA
	Education agenda items are being developed for code officials, should we also be compiling points similar to the one above to be shared with manufacturers?	The list of issues identified at the Summit could be forwarded to the different manufacturers for feedback on some of the concerns and solicit additional comments/concerns from them.	Not identified
	Manufacturers will be installing initial units, but what will happen years down the road when thousands units are being sold/resold on the market? Will there be licensed installers, or will many be installed by relatively unskilled labor?	Should there be a federally mandated program to require that installers be certified by a state or federal agency? How much of this responsibility should we place on the manufacturers?	Not identified

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Will there be certified mechanics to work on these units in the field? Who will be responsible for the maintenance and upkeep of the unit? The homeowner? Will new home owners know what to do with an existing unit? What if the technology doesn't pan out? What steps will be taken to appropriately dispose of/recycle the unit, components, fuel?	Need to maintain contact with manufacturers to ensure that they properly consider and address the long term issues	Not identified
	Education issues exist on many levels, and not just with code officials. A lot needs to be done with the general public creating awareness and a general understanding of the technology. Increasing public awareness will aid market penetration of the new technology.	Anne-Marie Borbely has already begun an education campaign for code officials about fuel cells and other DER technologies. Manufacturers can help with input and in generating materials for this ongoing activity.	Anne-Marie Borbely
Stationary – Commercial	*What is the impact of the fuel cell on the construction process? Specialty contractors?*	Modifications to rooftop cranes to allow for extra weight of FC units relative to current RTUs. The incremental cost of these changes at the time of construction would be minimal. Flue/ventilation requirements could be quite different for fuel cells.	Not identified

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	During the product development cycle the prototype may not be listable since the product is in flux – need opportunities to install prototypes without being listed	The semiconductor industry has experience with hydrogen-consuming equipment and their use in buildings. This equipment typically has a short life cycle.	Valerie Harris (City Public Service, San Antonio TX) will provide further information concerning other industries methods for managing this issue.
	There is a need for a consistent listing requirement between North America, EU, and Asia.	Track the progress of IEC TC 105 that is trying to address this issue. ANSI Z21.83 is being considered for safety requirements and NFPA 853 is being considered for installation requirements. USFCC has a C&S working group and disseminates information concerning the progress of C&S. Information is available to members on the USFCC website (http://www.usfcc.com/).	Andy Skok U.S. Fuel Cells Council
	Presentations and videos for code officials on the technology and how to inspect and approve installations	Need outreach not only to code officials and customers but also utility commissions, environmental commissions, legislators, customers, schools. Communication methods can also include training seminars, workshops, training CDs, test site visits and demos, newsletters.	Not identified

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Attend and present at meetings of model code organizations (ICC, IAEI, BOCA, SBCCI, ICBO, NFPA)	Get contact information for each of the organizations.	Terrence Moore, DEM, Fairfax, VA. Conover is writing an article for IAEI magazine and one has been written in the NFPA Journal on fuel cells. Conover will also present information on fuel cells at educational sessions he is giving in 2001 at BOCA/ICBO and SBCCI annual meetings.
	Develop standards for verifying or testing as-installed performance, which may be required for interconnection to the utility. The requirements for verifying as-installed performance can vary depending on the capacity of the unit, interconnection voltage, line PQ etc. Having some sort of as-installed test standard that recognizes these needs could avoid unnecessary testing or simplify testing of as-installed equipment	Expand the scope of the item to include items beyond interconnection. Many of the issues are addressed by existing standards. Develop a recommended practice for commissioning associated with or included in ASME PTC50 or NFPA 853.	TBD
	Standard operational data communication protocol across technologies, manufacturers, countries.	No specific action at this time	Honeywell
	Hybrid systems	Should be done through ANSI Z21.83 and IEC TC 105	Not identified
		Develop/create a “political” process/forum/advocacy group to facilitate the “technical solutions” to meet power, energy, and infrastructure needs	Andy Skok will work on a proposal

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
Portable	Basis for designation of a fuel cell as stationary, portable, or vehicular - definition needed for battery substitutes.(remove cord and plug connection) May not be the case in scenarios.	A fuel cell generator of electricity, which is not fixed in place. A portable fuel cell appliance utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.	Drafted at Summit by Breakout Session attendees
		Expand definition scope to include non-cord connected products i.e. laptop, flashlight	Harry Jones, JG to address with the ICC Ad Hoc Hydrogen Comm. in Golden, CO 06/04-5
		18.1 Occupancy (Code) 18.2 Container (Standard)	Beth Hock to verify
		Add “non-reversible” to definition ?	Not identified
		What about: - Micro fuel cells - Fire Codes – Stockpiling fuel - Quick disconnect to fuel tank ? OK but not to utility fuel line	Not identified

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Indoor use (Confined Spaces) - work is being done by CSA 3.01 to address oxygen depletion, hydrogen emissions - limit power output/fuel supply of FC to intrinsic levels - toxicity - other indoor emissions issues i.e. MEOH, Propane etc.) Impact - Confined Space (Boat, house, RV's, aircraft) what standard will apply (ask T. Strothers) - Fuel storage technology (NaBH4, NH3…) - H2 Gaseous fuel Detection – Will H2 be odorized ? detection.	- Identify CSA limits - FC Council determine issues other than home/garage, commercial bldgs (Requires research) Make sure product standards insure full range of confined space issues including O2 depletion, H2 emissions, multiple appliance use.	Todd Strothers Fuel Cell Council Portable Group Not identified
	Education/Consumer Awareness - Literature, product search - USFCC Working Group (Web Site) - Educating Manufacturers - Educating Regulators - Educating Consumers	Status report at FC 6	Not identified
	Interchangeability of Components - Disposal/Recycling (Options and opportunities) - MF lifetime ownership - Product life cycle - Study hazards - Certification of replacement components (e.g., stack)	Expand the scope of the CSA to include other FC technologies	Not identified

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Testing Protocols (Standards for operating range – performance	- Verify whether ASME PTC 50 covers portable Do we need performance standards ?	ask D. Conover/B. Wichert Conover response: My understanding is that ASME PTC 50 covers all fuel cells and associated components from fuel input to electric, heat and other outputs. Ask the USFCC WG regarding portable
	Transport of fuel supply - DOT - Fuel type	Update from portable WG for FC Summit 6 (RMES report)	
	Marking and labeling (misuse of appliance) – beyond standard (CSA) requirements. Product liability. Misuse of appliance.	Review and participate in the development of CSA 3.01. Encourage CSA to action and identify gaps. Review CSA standard at FC Summit 6	
	Reversible fuel cell appliances		

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
Mobile/ Vehicular	Basis for designation of a fuel cell as stationary, portable, or vehicular	*IEC TC-105 Working Group #1 should handle this. Dave Conover will communicate with Kelvin Hecht and Steve Kazubski of the US TAG to ensure these three terms are addressed:* Stationary Fuel Cell Portable Fuel Cell Vehicular / Mobile Fuel Cell	Dave Conover, to be accomplished ASAP. Conover 6/23/01 update: E-mail on this topic sent to Kelvin and Steve; item resolution assumed to be underway.
	Safety related to hydrogen production	SAE has a Fuel Cell Standards Working Group on Safety, covering all aspects of vehicular safety for fuel cell vehicles, led by Glenn Scheffler.	SAE, Jane Hock
		On-Board Reformer design criteria is addressed by SSAE J2579 under the SAE Working Group. Jane Hock will convey this concern to the SAE Fuel Cell Standards Working Group at the next meeting on June 12.	SAE, Jane Hock

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
		Vehicle crash response is covered by SAE J2578 under the SAE Safety Working Group. Jane Hock will follow up.	SAE, Jane Hock
	Identification of necessary safety concerns for each type of fuel cell and how to address them	List out safety issues associated with each fuel and storage scenario and I.D. who is working on each one of them. SAE has developed a list of safety issues, available on their web site. NHA and ISO TC-197 are also working on these issues. SAE has liaison agreements with NHA and ISO TC-197. ICC is also working on some of these issues. Dave Howell will work with PNGV to explore the task to compile a list of all these safety scenarios and keep it up to date.	Dave Howell

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Ventilation needs for all parking garages *How combustible liquids and flammable gases can co-exist in the same interior spaces or be stored on the same site?*	Being researched by ICC for Fuel Cell Safety Standards Work by Dr. Swain in Florida applies to residential garages. Additional work on public/commercial garages and tunnels may be necessary. DOT and NHTSA may need to be involved. Jane Hock will convey this concern to the SAE Fuel Cell Standards Working Group at the next SAE meeting on June 12, 2001.	Jane Hock
	Standardization of data	The following proposed SAE standards address these issues: Fuel Cell System Performance Testing Fuel Processor Subsystem System Performance Testing Fuel Cell Stack Subsystem Performance Testing ASME PTC-50 also addresses fuel cell system efficiency performance. Jane Hock will bring this to the attention of SAE. Bob Wichert will bring this to the attention of ASME.	SAE, Jane Hock ASME, Bob Wichert

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Basis for the acceptability of fuel cell vehicle storage, fueling, and use within the current building infrastructure	ICC ad hoc hydrogen working group is addressing this issue.	ICC ad hoc hydrogen working group
	Need to address reforming on board or off site and issues associated with each	See hydrogen production above	
	Operational guidelines for consumers and distributors	Education/Training	SAE/Industry/OEM/Component Manufacturers
	How to address hydrogen safety	Covered previously	
	Servicing and maintenance protocols are being explored by SAE in cooperation with the Service Technicians Society (STS)	Covered by SAE	Covered by SAE
	Need to integrate fuel cell technology into airline support applications	Covered by SAE	SAE, Jane Hock
	Need to integrate fuel cell technology into portable power applications.	Fuel Cell Manufacturers should work with various temporary power markets	Manufacturers
	Need to identify regulatory barriers to fuel cell utilization	Fuel Cell Manufacturers should work on this issue.	Manufacturers
	Need to compete against gearhead mentality regarding IC engine competition	Fuel Cell Manufacturers should educate appropriate audiences.	Manufacturers
	Need energy efficiency message to drive application of fuel cells	Develop education package	DOE, Fuel Cell Manufacturers, NGOs, Associations, EPA
	EMTs need help dealing with increased issues associated with use of fuel cells and related fuels	Covered by SAE action item above	SAE
	Service technicians need to be educated, in place and certified	Add qualified service technicians to operational guidelines above	Manufacturers, SAE, Jane Hock

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Aircraft in process inspectors need to be trained in fuel cell technology	Add qualified service technicians to operational guidelines above	Manufacturers, SAE
	Auto Inspectors / mobile platform inspectors	Add qualified service technicians to operational guidelines above	Manufacturers, SAE
	What do commercial insurance carriers need?	Being accomplished by SAE in cooperation with insurance liability industry	SAE Working Group, Jane Hock
	SAE has started a dialogue with the Performance Review Institute (PRI) for potential mobile unit certification	No action required	
	Producing and storage of hydrogen on site may change the building categorization to a hazardous production facility facility-need to review use group iss	ICC is studying this issue ASAP	ICC ad hoc hydrogen working group
	SAE has relationship with transit standards consortium for standards for bus applications	Continue relationship	SAE, Transit Standards Forum
	Federal transit authority – bus standards on safety, but also performance	Continue this work	FTA
	Refueling stations may be a big issue (OEMS considering getting involved in distribution of fuel)	Inform ICC of the possibility of dealerships becoming fueling stations for hydrogen or otherwise	ICC, Guy Tomberlin
	SAE is doing a lot in codes and standards	Continue this effort	SAE
	Need hydrogen infrastructure	This is a market issue. DOE OPT (Carol Hammel) is assessing what needs to be done and developing a plan for what the infrastructure should be.	DOE (Carol Hammel), manufacturers, etc

Application	Issue Description	Suggested Actions to Address	Responsible Party(ies)
	Need to address parking garages?	See ICC item above	
	What about tunnels? (DOT and NITSA need to address this)	See ICC item above	
	Will state vehicle inspectors need to inspect fuel cell related components?	See educational item above	
	What about passive ventilation of enclosed spaces for hydrogen safety?	See ICC item above	
	NFPA Building Codes	Review NFPA Building, Mechanical, Electrical, Plumbing, and other new NFPA building codes to ensure proper coverage of fuel cells, consistent with work done for ICC Building Codes.	Manufacturers
	National Building Code of Canada, Administered by the National Research Council of Canada	Review National Building Code of Canada to ensure proper coverage of fuel cells, consistent with work done for ICC Building Codes.	Manufacturers
	Utility Company or Federal refueling stations may not be required to follow building codes	Utility companies and Federal facilities will have to review their requirements	Utility companies and Federal facilities.