



MISSION CRITICAL FACILITIES COUNCIL on New Technology Adoption

Background Information

The Uptime Institute hosted a Mission Critical Facilities Council on New Technology Adoption January 27-29, 2003, at The Bishops Lodge, Santa Fe, New Mexico. The purpose of the meeting was to bring together mission critical data center facility managers, leading consulting engineers, and The Uptime Institute (the *Institute*) to:

- Identify and discuss problems preventing adoption of new products or new technology that offers the potential of improved site infrastructure performance, reliability, or effectiveness
- Identify the different stakeholders involved in the adoption of new technology and overlapping areas of mutual interest
- Identify what alternatives might be created to reduce the risk and accelerate the appropriate speed of adoption for new products or technology, based on identified problems and potential benefits
- Use American Power Conversion Company's PowerStruXure as a case study to examine specific details for how products in the 3 Phase, 10-100 kW UPS (UPS with integral static switch and self-contained battery intended for installation within the computer room) classification might be evaluated and certified

Individuals in attendance were

Consulting Engineers

- Peter Gross, PE, CEO/CTO—EYP Mission Critical Facilities® Inc.
- William P. "Bill" Mazzetti, Jr., PE, Principal—Mazzetti & Associates Consultants & Engineers
- Richard Schlosser, PE, Electrical Engineer—TiePoint Engineering, PC
- Leo Soucy, Jr., PE—Facilities Engineering Associates
- Robert J. "Bob" Yester, PE, Design Principal—Swanson Rink Consulting Engineers
- W. Pitt Turner, IV, PE, Principal—ComputerSite Engineering

Data Center Manager and Owner Attendees

- Robert A. "Bob" Cashner, Senior Vice President (Corporate Real Estate)—Wachovia
- John Diamond, Director, Facilities Management (National Asset Services)—Cushman & Wakefield
- Paul Marcoux, Vice President (Corporate Real Estate Services)—State Street Corporation
- Robert L. "Bob" Talbot, Former Senior Vice President (Corporate Real Estate, National Engineering) —Fidelity Investments

The Uptime Institute Staff

- Kenneth G. "Ken" Brill, Executive Director—The Uptime Institute
- W. Pitt Turner, IV, PE, Facilitator, The Uptime Institute
- Paul A. Jorgensen, Co-facilitator and Program Manager—The Uptime Institute

- Joni Parman, Chief Operating Officer—The Uptime Institute
- Marilyn Coon, Communications Director—The Uptime Institute
- Candace Ruiz, Administrative Project Manager—The Uptime Institute

American Power Conversion (APC) Attendees

- Doug Rademacher, Director of Strategic Initiatives—APC (Monday sessions)
- John McNally, Director of Engineering—APC (Wednesday sessions)

Funding

Funding for the Mission Critical Facilities Council (Council) and the subsequent development of the Mission Critical Product Certification (MCPC) Program development has come from both the *Institute* and APC. The *Institute* has agreed to repay APC's seed investment over the first 15 product certifications as the Program becomes financially viable. Other manufacturer sponsors are being solicited for start-up support. While APC's financial support has been essential for bringing the Program to reality, APC's role in MCPC organization and decision-making has been limited. APC representatives attended only the portions of the Council meeting when the viewpoint of a manufacturer was appropriate. APC has been very attentive and respectful of the MCPC Program's need to be an independent body driven by end users and consulting engineers. Other financial sponsors will need to accept the same conditions of support.

Detailed Information

- The meeting agenda follows in the next section
- Meeting minutes follow the agenda



MISSION CRITICAL FACILITIES COUNCIL on New Technology Adoption

Who, Why, When, Where, What

Purpose	To bring together mission critical data center facility managers, leading consulting engineers, and the <i>Institute</i> to <ul style="list-style-type: none">• Identify and discuss problems preventing adoption of new products or new technology that offers the potential of improved site infrastructure performance, reliability, or effectiveness• Identify the different stakeholders involved in the adoption of new technology and overlapping areas of mutual interest• Based on identified problems and potential benefits, what alternatives might be created to reduce the risk and accelerate the appropriate speed of adoption for new products or technology?• Use American Power Conversion Company's (APC) PowerStruXure as a case study to examine specific details for how products in the 3 Phase, 10-100 kW UPS classification might be tested and certified (American Power Conversion is partially sponsoring this Council)
Dates	January 26-29, 2003
Hotel	The Bishop's Lodge Bishop's Lodge Road Santa Fe, NM 87504 (505) 989-8739 (Fax) (505) 983-6377 (Voice)
Meeting Location	The Bishop's Lodge

Agenda

<i>Sunday, Jan 26</i>	Council participants arrive at Bishops Lodge using airport shuttle (see subsequent section on travel and logistics). The <i>Institute</i> will make room reservations for each attendee with the room charges being paid by a master agreement
10:00 am	Those wishing to either go downhill or cross-country skiing should arrive Saturday or early Sunday. Skiing activities led by local <i>Institute</i> staff will depart from the hotel by 10 am and return by 4 pm with a possible stop at Ten Thousand Waves for a Hot Tub soak
6:00 pm	Participants join Ken Brill, Pitt Turner, Paul Jorgensen of the <i>Institute</i> for dinner. Meet in the hotel lobby for shuttle to local restaurant
<i>Monday, Jan 27</i>	
7:30 am	Continental Breakfast – Hotel
8:30 am	Introductions, expectations, and starting point for solving the Mission Critical Facilities New Technology Adoption Dilemma <ul style="list-style-type: none">• Participant introductions, expectations, and purpose for meeting• Background discussion on the new technology adoption process using the acclaimed business book <i>Crossing The Chasm</i> by Geoffrey

Moore. Paul Jorgensen will make a short presentation outlining the research in the book on the problems of introducing new products to mainstream customers

- Roundtable discussion on the difficulties of introducing new technology to mission critical facilities. Why do people stay with what they have despite knowing “better” products are available? How is the adoption process affected by the corporate culture of the client?
- Applying elements of the “Whole Product Concept” from the *Chasm* book to mission critical facilities equipment and services: industry acceptance, support materials, and service and support

11:30 am Break for phones and office business

Noon Lunch – hotel restaurant

1:15 pm Understanding the New Technology Adoption Dilemma

- What problems are we trying to solve for each stakeholder: the user, the consulting engineering community, the equipment or service vendors, and the mission critical industry
- Develop list of potential solutions
 - Understanding how this process fits into existing industry construction practices and product purchasing activities
 - Understand the thinking of equipment vendors. Potential impacts of product qualification on sales, research and development direction and expense, and bottom-line impact on profits
 - What are the business, legal, and regulatory issues involved with product qualification or certification?
 - How do similar product certification activities work in other industries and could they solve our problem? Review ANSI standards for Product Certification. Review standards programs used by UL, CSA, NITS, ARI, ASHRAE, The Green Buildings Council, and others.
 - Would an existing standards body be applicable to the mission critical facilities industry? If not, does this represent a possible role for the Institute and a vendor neutral panel of industry experts?
- Select topic for dinner discussion

4:00 pm Break for phones and office business

6:00 pm Meet in hotel lobby for shuttle to dinner. The suggested discussion topic for dinner is *Mission Critical Wisdom and Knowledge Transfer to the New Generation*

Tuesday, Jan 28

7:30 am Continental Breakfast – Hotel

8:30 am How might the product certification process work?

- Develop a list of mission critical product and services for which “Uptime Tested” or “Uptime Certified” might be useful

- What would the differences be between Tested and Certified?
- Review *Institute* thinking on a Uptime Tested process (see attachments 1 and 2 transmitted with the Council invitation)
- Is this a good approach, if so why, if not, what needs to be changed?
- How would the panel of industry experts be organized and managed?
- What would the panel do? What support services would be necessary? Would the panel do the actual product review and testing, or would they review the results of work done by a support services function?

11:30 am Break for phones and office business

Noon Lunch –Hotel Restaurant

1:30 pm Business Considerations. How can the certification process become professionally and economically viable?

- Benefits, drawback, and issues for different stakeholders
 - Is certification good for users?
 - Does certification threaten consulting engineering firm market differentiation or can it enhance it through participation on industry panels?
- Develop ideas for commercial arrangements between industry panel members, support services, the *Institute*, and equipment or service vendors
- What would the responsibilities of each be?
- Does it make sense to proceed? If so, what actions need to be taken before the next meeting?
- Select topic for dinner discussion

4:00 pm Break for phones and office business

6:00 pm Meet in hotel lobby for shuttle to dinner. The suggested discussion topic for dinner is *Advancing the State of the Art in Mission Critical Facilities* or other mutually agreed topic that stirs the collective juices of the group

Wednesday, Jan 29

7:30 am Continental Breakfast – Hotel

8:30 am Case Study: How would an “Uptime Tested” certification be granted for the 3 phase, UPS with an integral battery?

- Further refine the Institute’s previously suggested evaluation categories and develop the point weighting for this particular product classification
- Develop ideas for what criteria within each evaluation category should be used, how many points should be assigned to each criteria, and then an objective methodology for measuring whether the points have been earned
- Review Institute developed Certified Testing Plan for APC PowerStruXure UPS as a sample of what might be done for the functional testing category

- Would Liebert be interested in a similar certification process for large multi-module UPS systems to dispel any lingering doubts about their reliability problems caused by capacitor failures? Would the certification process be significantly different for large multimodule UPS product classification than for under 100 kW?

11:30 pm

Wrap-up, review original expectations, assignments for the next meeting

Noon

Adjourn

Travel and Logistics

Confirmation

Participants must confirm attendance with Candace Ruiz at least 15 days prior to the Council. Please notify us as soon as possible if circumstances prevent you from attending so the hotel registration may be cancelled

Santa Fe

United Airlines serves Santa Fe directly from Denver with small twin-engine 20 passenger planes. Other airlines go to Albuquerque. Santa Fe is located 65 miles North of Albuquerque up Interstate 25. Highway construction currently severely limits the normal access routes to Bishop's Lodge. A map will be provided. A more scenic route instead of I-25 to/from Albuquerque is to take Route 14, but the drive is about 30 minutes longer. People taking the shuttle to Santa Fe will be returned to the Albuquerque airport by Institute staff using Route 14.

Travel to Santa Fe

Shuttle service is available directly from the Albuquerque airport to Bishop's Lodge. Call Sandia Shuttle at 1-888-775-5696. Please call between 7 a.m. and 6 p.m., weekdays and 7 a.m.-5 p.m., weekends for reservations. Provide the shuttle company with your flight time and flight number. Let them know you are going to the Bishop's Lodge in Santa Fe. Roadrunner (to/from Santa Fe airport only) (505) 424-3367.

Expenses

Costs for airline, airport parking, hotel, and other reasonable expenses will be reimbursed by the *Institute* within 15 days after our receipt of your completed expense report. Our expense reimbursement form will be e-mailed to you upon registration. Participants who wish to pay for their own travel and lodging simply do not need to submit an expense report

Registration

Call Paul Jorgensen at (410) 990-0066 for programmatic information or Candace Ruiz at (505) 946-3464 for logistics



MISSION CRITICAL FACILITIES COUNCIL on New Technology Adoption

Minutes: Monday, January 27, 2003

Attendance & Objectives

To bring together mission critical data center facility managers, leading consulting engineers, and The Uptime Institute (the *Institute*) to

- Identify and discuss problems preventing adoption of new products or new technology that offers the potential of improved site infrastructure performance, reliability, or effectiveness
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Consulting Engineer Attendees

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Candace Ruiz, Administrative Project Manager—The Uptime Institute

Representative from American Power Conversion (APC)

Doug Rademacher, Director of Strategic Initiatives—APC

WELCOMING COMMENTS AND EXPECTATIONS

After welcome comments, Pitt Turner asked all participants to express their motivation for attending and supporting this new product innovation and adoption initiative. The following is a summary of the comments.

Paul Marcoux: Expects to gather knowledge that he can bring home to better understand relationships between the facilities and data center groups. Currently there is a wide chasm between these groups, and he wants to bridge the chasm. Would like to address national and international issues. Large institutions have a global presence.

Peter Gross: Excited because this [new technology adoption] has been a problem in industry for a long time. His position involves him in new technology; he looks at everything new and tries to develop new technologies. Frustration arises because clients don't trust new technology. They are very conservative and very reluctant to take risks, which makes it difficult to introduce new equipment. Peter would like to see a process that would speed up the introduction of new products, make the process easier, and reduce the risk of being first.

Leo Soucy: Leo faces a similar problem to Peter's. His group examines new technologies, but cannot sell or market them because the owner has to make the ultimate buying decision. He would like to be able to substantiate the decision to recommend a new technology.

Bob Talbot: Bob relayed a recent experience where he had three engineering people examine "Layer Zero" and prepare a comprehensive report. Each came back with a "buy" recommendation. However when it came to making the purchase decision, these same engineers were reluctant because Layer Zero was a new technology. Bob asked his engineers whether or not their buying decision would have been affected if the Layer Zero static switches had had the *Institute* stamp of approval, and they all agreed that they would have been more confident with the purchase.

Richard Schlosser: Richard would like to try new equipment, but would prefer to have the bugs worked out before he tries them on the projects in which he is involved. He is excited about the Council process and how it will evolve.

Bob Cashner: Bob buys millions in new technology equipment. He would prefer better intelligence for new equipment like Consumer Reports. He looks forward to having fun and interacting with participants. He always leaves conferences such as this with more than he came with.

John Diamond: John focuses on mission critical issues including better practices, better technologies, and the long-term concern for engineering companies to anticipate and avoid human error. His expectations are to benchmark with other industry leaders. He would like to see the development of a certification process with classifications similar to what is currently standard in the ocean shipping industry. Experience in the shipping industry correlates directly to the source of failures in data centers. John is looking for products that don't require people touching them or that can be hot-swappable so that there is less chance of human error. People and site certification are real industry issues

Doug Rademacher: Doug's role involves strategic initiatives and bringing a new product to market. His interest is from the vendor perspective, i.e., how to get people to use a new mousetrap in their home. He wants to bring innovation to the marketplace. His role in the meeting is to bring the vendor perspective.

Bob Yester: Bob is conservative; he would prefer to see a product track record. He has used new technologies in the past, but problems have cropped up “to bite you.” He commented, “Things that are improvements on past technology always have a better chance. Static transfer switches are a good example. It would be beneficial to the industry to find a way to speed up the process of introducing new technology.”

Bill Mazzetti: “As a consulting engineer, high reliability and high availability are important to my mission. I would like to break the paradox we’re stuck in. We all have a reticence to use new products because of a lot of zeros in the serial number.” Several partners within his company sit on the certification boards such as IEEE, and the processes are brutal. The data center industry does not have standards because it is not a broad-based commercial business. Instead there are a lot of tools in the marketplace as far as risk tolerance but these are not being addressed in a general manner. IEEE and UL programs are not adequate and also do not address the manufacturing processes required to reliably build and support this equipment over its lifetime.

Pitt Turner: Pitt framed the sponsorship for the Council and mentioned that APC is providing funding to assist with development of an industry-wide program for equipment certification of new evolving technologies.

Ken Brill: Ken welcomed the attendees and offered his vision for the mission critical industry and the role of The Uptime Institute (the *Institute*). He described personal events that made him more aware of the relationship of “accident theory” to data center uptime. These are highlights from his comments.

We know why failures occur and we choose not to do what we should, mostly because of money. I am increasingly convinced that there is a psychology of uptime. There are psychological attitudes that underpin success. You learn by causing an outage. I had to learn by falling off a ladder and [through retrospection] learning the eight things I did wrong.

In the long term, I am planning to start The Uptime University. [High risk and high value aren’t exclusive to data centers.] Hospitals, for example, wherever human failure has high consequences. In Afghanistan, our troops fired on our own people. While there was a single final event that caused us to shoot at our own people, I strongly suspect there were many interesting and interdependent events that led up to it. I think [the psychology of uptime] has societal value. That is my overarching vision.

We’re all being pressed to reduce energy consumption. I think there are significant savings, particularly in cooling, that will actually improve reliability.

The *Institute* has been working with APC because they have many new products to introduce into the marketplace and wanted certification. We got the idea to bring people together to discuss and brainstorm the problems of new technology adoption with full disclosure as to APC’s self interest. This has to be done as objective, honest, and unbiased. It has to be above reproach. Then if we chose to go forward with certification, we have to involve other people.

Roundtable Discussion on Difficulties of Introducing New Technologies

Several concerns about the mission critical industry in general were raised during the ensuing conversation. Where will the next generation of uptime professionals come from? The younger generation seems impatient, so perhaps there should be a certification process or residency requirements. It’s either arrogance or humility depending on whether or not the person has experienced an outage. Pitt pointed out that commissioning was supposed to give operators the opportunity to get experience at a Greenfield site, but Bob Yester pointed out that owners wouldn’t employ the operators until after the new facility is commissioned.

Peter Gross identified a paradox in the industry: on the IT side, there is a technology turnover approximately every 18 months. On the facilities side, this can be as much as 30 years. Peter added that there is no incentive to change related to performance because on the facilities side “We are measured on whether we are up or not. One or zero. On the IT side there are many ways to measure, on site infrastructure it just has to be up.”

Paul Marcoux brought up the fact that IT purchases depreciate at a different rate than facilities purchases. Paul has instituted a program to depreciate facilities equipment, where possible at an accelerated rate. “Rapid depreciation is in the best interest of the company and allows for consideration of new technologies.”

This stimulated a discussion on whether or not the risks were compelling enough to warrant changing out existing equipment, trying new technology, and increasing capital expenditures. John Diamond pointed out the positive aspects of supporting technology changes that removed the human-error factor from facility operation. Ideas for changing the status quo included looking at other business models where new technology rapidly gained acceptance.

The Technology Adoption Life Cycle

Paul Jorgensen of the *Institute* made a short presentation that outlined a theory on the technology adoption life cycle presented in *Crossing the Chasm* by Geoffrey Moore. During this presentation, one important characteristic of the technology adoption process was highlighted—product performance characteristics being most important during the earliest stage of the life cycle. As the product moves through toward the early and late majority, the characteristics of the product become less important than the characteristics of the company. The presentation also touched on the subjects of “the Whole Product” and the difference between “continuous innovation” and “discontinuous innovation.” Various attendees commented on their own personal characteristics and comfort zone in the technology adoption life cycle.

Barriers to Product Adoption in the Corporate World

It is not one-stop shopping within a corporation because there can be 125 sites, each with its own IT person whose learning curve is unique. The leadership in the company can be ignorant of technology. Many will purchase what they are familiar with rather than risk a new technology. Purchasing departments add another layer of difficulty. Paul Marcoux mentioned that he has been able to improve on the above issue with service agreements. His engineering group has master specifications that are maintained to high standards so that anyone can buy what they need as long as the product meets the group’s specifications. They keep the specifications updated through a “lunch and learn” program with vendors.

Bob Cashner said, “We see people make decisions that have no right making them because they don’t have the education for it; portfolio managers are making them.” Bill Mazzetti added, “You pitch an approach with several options and it gets to the top. Then someone at the senior level plays golf with a totally new vendor that they now want you to consider.”

Understanding the New Technology Adoption Dilemma

Talking points related to certification were as follows:

- Certified test reports: what will be the report procedures, what will be included in the observations? Will there be a rating system, a point system, pass or fail? Will there be provisions for correcting defects?
- What are the differences between standards and specifications? (Pitt: “Standards are like code standards for buildings; specs are specifications for your product.”)
- Should product testing take into consideration the product’s interaction with other data center equipment and the data center environment (what about differing geographical issues in different parts of the country—elevation, degree days, ambient relative humidity)?

- Would the certification be static (one time only) or dynamic (recertification required periodically)?
- Certification should be functionality and performance-oriented rather than being proscriptive of a specific solution.
- Keeping records and documenting follow-up actions should be part of certification.

The group reviewed some key problems that the Council could address. These include:

- Leading the mission-critical industry in new technology adoption
- Involving manufacturers in the technology adoption process
- Encouraging innovation
- Overcoming risk and liability issues for adopting new technologies

Next on the agenda was a discourse on the issues that were key points to be solved in the minds of users, manufacturers, and consulting engineers. What follows is a summary of the points from that discussion.

Issues to Solve for Users

- Reduce risk of being an early adopter
- Develop tests that reflect real world performance
- Demonstrate behavior with variable load
- Provide clarity of expectations
- Unbiased, clear, easy to understand product/system information
 - Fact-based, attributable
 - Same data from every manufacturer
- Due diligence certification

Issues to Solve for Manufacturers

- More traction, sooner
- Acceptance in the marketplace
- Clarity on hurdles the new technology must address
 - Understanding marketplace rules
 - What show-stoppers the new technology must address
 - How to earn our stripes as a new company
 - Understand issues up front, not as we go
- Clarity of user expectations (define expectations)
- Consistency of message both from and to manufacturers
- How to communicate tradeoffs in design or manufacturing be communicated
- Objective and meaningful criteria
- Differentiate value-add services (warranty, delivery dates, services, etc.)
- Respond to emerging issues/trends
- Consistency of service and whole products

Issues to Solve for Consulting Engineers

- Due diligence
- Standard of care—raise the bar
- Reduce risk with group, peers (consensus)
- Reduce liability

Ken summarized the Council's efforts in identifying all of the elements that must be considered. "We're cutting a new path through the underbrush. This will be a first best path and there will be opportunities in the future to improve what we did."

Presentation of the Proposed Methodology

Paul Jorgensen presented materials on how certification programs from other organizations function. The group discussed programs used by Underwriters Laboratory (UL), Canadian Standards Association (CSA), and Air-Conditioning and Refrigeration Institute (ARI), as well as consumer methods such as Consumer Reports and PC Magazine. The differences were identified in terms of the scope of testing, if the testing processes were developed internally or externally.

A discussion evolved that addressed the concepts of qualitative measurements and other qualities such as cost of ownership and how, or if, this characteristic should be included in the standards and how this would be measured. Both PC Magazine and Consumer Reports blend specific criteria and qualitative judgments into their reviews.

Paul Jorgensen distributed portions of a specification called Leadership for Energy and Environmental Design (LEED) that was developed by the Green Building Council to establish a performance-based standard for sustainable building design. It was explained that this is an example of a methodology that has attracted considerable acceptance in the marketplace. It was also proposed as a model for a qualitative certification program for mission critical facilities. The discussion continued on the issues of how to apply a qualitative method to very complex equipment such as is used in this industry.

Pitt Turner suggested that the group attempt to apply the proposed methods described to a typical piece of equipment used in the industry. After this exercise, it became clear that considerable thought is required to carefully develop a performance-based specification, as opposed to a proscriptive specification. During this discussion, the group moved between these two approaches with each technical issue. It also became clear that many of the whole product issues from *Crossing the Chasm* might have a common language across many different product types.

Bob Castner noted, "We talked about hinged doors, [but we should have said] people should not be electrocuted." John Diamond said, "It is kind of scaring me [that] we spent the time defining limits for the products." Pitt Turner reminded the group of the positives, "Root cause reporting on failures, recording failures, voluntary disclosure of problems. I will take away that we are in fundamental agreement that there is something that can be done about speeding new technology adoption."

The meeting adjourned at 5:00 p.m.



MISSION CRITICAL FACILITIES COUNCIL on New Technology Adoption

Minutes: Tuesday, January 28, 2003

Attending Tuesday morning were Ken Brill, Bob Cashner, Marilyn Coon, John Diamond, Peter Gross, Paul Jorgensen, Paul Marcoux, Bill Mazzetti, Joni Parman, Richard Schlosser, Leo Soucy, Bob Talbot, Pitt Turner, and Bob Yester.

Insights from Monday

The morning began with a reflection on the insights gained from Monday's sessions. Peter Gross noted, "We don't have the sales volume to validate new equipment in this industry." Ken Brill emphasized this was where the Council could step in and compensate for existing industry problems. This segued into the first agenda item on how the product certification process might work.

Certification Process

The discussion centered on the need for certification to focus on outcomes that will raise the bar across the board for the mission critical facilities industry. The group also acknowledged that the Council needed to be realistic about its goals and should concentrate on what is feasible. The need for people and site certification was discussed, and put on hold for the time being. As Ken Brill put it, "We are going to eat the elephant one bite at a time. We'll focus first on products"

The user's perspective, not the vendor/manufacturer, should drive the criteria. The Leadership in Energy and Environmental Design (LEED) certification model was reviewed and accepted as a good starting point for developing a certification process. LEEDs was seen as non-threatening, logical, based on sound engineering and economic principals, voluntary, leads people to do the right thing, has minimum levels that must be met, plus elective levels, and is driven by and accepted by the marketplace.

Bob Talbot and Richard Schlosser raised the issue of whether or not the results of product certification would be valid six to twelve months down the road, which is another issue the certification process will have to address. Paul Jorgensen indicated a concern that certification needs to be an ongoing dynamic process instead of a one time evaluation. Subtle changes can make an acceptable product unacceptable. Other issues raised included repeatability of test results, levels of certification, where tests would be performed, self-validation/certification, and long-term liability.

Paul Jorgensen was concerned that existing Master Service Agreements and CSI Master Specifications might be a barrier to the deployment of certified products because the certified product will have met the higher bar of mission critical performance, which is likely to greatly exceed minimum product requirements. The industry's need for intelligent buyers and informed consulting engineers was discussed.

"Credibility is the key; how the concept is presented. If we can successfully deliver our message to owners who will then drive this, once the owner tells his engineer to include a certification requirement in the procurement spec, then every vendor will go for certification."—Peter Gross

Discussion on the Organization of the Mission Critical Facilities Council

The members gave careful consideration to the organization of the Council. Richard Schlosser suggested soliciting input from other consulting engineers and manufacturers perhaps through a survey or questionnaire. Peter Gross indicated the need for a mission statement and a document with goals, objectives, and process that could be distributed publicly for comment. Ken Brill shared his personal vision that the *Institute* staff, led by Paul Jorgensen would synthesize the work done at the Council. The participants would contribute their technical

expertise, name, and ideas. Each member would receive compensation for his time in dollar payment and/or recognition.

There was unanimous acknowledgment that the Council needed other certification customers in addition to APC (which co-sponsored the first Council meeting). Ideas included having users fund certification testing for their own use or manufacturers could fund testing. Realistically, manufacturers will be the primary funding source.

Draft Mission Statement

Paul Jorgensen drafted this mission statement based on conversations among the Council members.

Accelerate the adoption of new technology and the enhancement of existing technology for mission critical facilities through an objective forum of user and consultant industry leaders creating intent and outcome-based guidelines.

Roles and Responsibilities

The Council reviewed who might participate in voting on issues and other support aspects for the suggested product certification process and the operation of the Council. As of the January meeting, the roles are as follows:

- Core consulting engineers and users on the Council have a voting role and a technical role on each product classification. Their staff time will be reimbursed (these are technical people who may be asked to write technical scripts or provide testing supervision).
- The *Institute* has a voting role; will select who serves on various product classification committees; will coordinate meetings; will serve as the point of contact and “customer face”; will provide the administrative staff, marketing, and sales; will administer funding and serve as paymaster; handle legal issues and insurance; and will check into liability issues.
- Manufacturers would supply funding for certifying their products, testing facilities, comment, and feedback.
- Other manufacturers would provide opinions and input.
- Other consulting engineers would provide comments and feedback.
- Other users would provide comments and feedback.
- Paul Jorgensen will research others who might be missing from this core group.

The morning wrapped up with a conversation on how the member companies of the Council would work together, whether or not a corporation should be formed and if it should be non-profit, the idea of certifying engineering firms to perform the certification process, the ways in which revenue could be generated, the need for experts in specific areas, and how the Council would know when its knowledge base had been exceeded.

TUESDAY AFTERNOON

Initial Equipment to Prioritize

The group voted on which pieces of equipment would be the top priority for the certification process. Uninterruptible power systems (UPS), static transfer switches (STS), and stored energy (batteries: VRLA-AGM, VLA) were selected and ordered from a list that also included switchgear software, air handling units (CRAC or CRAH), chillers, engine generators, fuel cells, ultra-violet lamps, filter systems, harmonic filters, security systems (life-safety, fire alarm/fire suppression), rack heat load ratings and integral-rack cooling systems, EPO, building management systems, automatic transfer switches, transient voltage surge suppression, battery

alternatives (flywheels), chilled water storage, rack-mounted point of use transfer switches, and circuit breaker/trip units.

Bob Yester commented, “I think our primary charge is new products,” reminding the group of the emphasis on new technology adoption. Peter Gross noted that the equipment would be used for mission critical purposes. “We know what the mission critical facility needs. We impose restrictions and requirements related to mission critical requirements. Whether it is a fuel cell or a hydrogen generator, the requirements will be about the same as to how to respond to transient conditions. We cannot be everything to everybody.” Pitt Turner added, “The intent is ‘this’ will have concurrent maintainability—not how the STS will be configured.” Paul Jorgensen said “We should focus on the meat of achieving uptime through performance standards that raise the bar and add real value, not specifying the color or style of product enclosures.”

A discussion followed about batteries and the performance elements that are evaluated when making purchasing decisions. These elements include installation resources, function, life-cycle costs, operations and maintenance, software, manufacturer’s support, faults/failure, and systems statistics and diagnostics.

At this time, Ken Brill introduced the idea that part of the certification process should include validation of the claims made in the marketing material related to the products being tested. “Whatever they publish, good or bad, we have to verify it.” Also, concerning a UPS, he stated that if the manufacturer did not state that it was hot-swappable, the Council would not test it unless hot-swap capability was deemed to be a requirement for that particular product classification.

Preliminary Work on Intent Section of Certification Specification

Paul Jorgensen proposed that the Council use the LEEDs building certification model as an example and take an actual mission critical product, and develop an intent statement, a prerequisite, and a list of specific requirements. This resulted in the following:

3.0 Intent	
3.1	Prerequisite: Validate manufacturer’s product performance claims/specifications (they can change the spec sheet or redesign the product)
3.2	Meet accepted standards for Ripple Harmonics Fault condition @100% load high impedance fault Minimum requirements Overload tests Bypass tests Transient tests Module fault Failure mode

The 3.0 Intent generated several comments related to the product needing recertification whenever the equipment was redesigned or the manufacturing process was changed; having the test report reflect that the original specification sheet was found to have incorrect information

if this was found to be true; deciding whether or not the original report should be made public; “safety is in full disclosure”; checking what other certifying bodies do related to ground rules on publishing reports; fee structures for various steps of certification; protection of product patents during the certification process; making certain that the certification process is at a high level, e.g., if you have three different UPSs, they must all be tested to the same criteria.

Pitt Turner summarized the 3.0 Intent by saying that the products evaluated for certification would need to 1) meet the manufacturer’s claims/specifications, 2) meet the minimum performance requirements for the mission critical industry, and 3) receive brownie points if they exceed items 1 and 2. Paul Jorgensen added that efficiency would be a key factor. Bob Talbot stressed, “I want uptime,” as his key factor.

Ken Brill suggested that the equipment be subjected to “all the things that a maintenance person would do to it in five years.” He recommended developing a high-level failure analysis diagram for each piece of equipment to be evaluated so that the certification process can determine if the product is likely to perform as promised.

Tracking Equipment Failures

Paul Jorgensen mentioned the idea of an ongoing forum or website where a user could check to see if a piece of equipment had been reported as having a systemic problem. Richard Schlosser thought this should be anonymous. Ken Brill suggested that there be a moderator for the forum. John Diamond said, “I still run into data center managers who say nothing happened here.” Paul Jorgensen further described that the forum would have anonymity such that the users would not be identified. This idea will be evaluated further.

Ken Brill mentioned how Consumer Reports annually gathers data on home appliances and automobiles. He suggested a large scale mailing each year to many data centers to collect a scorecard on equipment performance. Bob Cashner related his recent experience of a new UPS from the factory received six weeks ago that had a defective capacitor in it, which the manufacturer had previously sent out industry notifications not to use.

The meeting adjourned at 4:45 p.m.

Attending Wednesday were Ken Brill, Bob Cashner, Marilyn Coon, John Diamond, Paul Jorgensen, Paul Marcoux, Bill Mazzetti, John McNally, Joni Parman, Richard Schlosser, Leo Soucy, Bob Talbot, and Pitt Turner.

The group reconvened minus Peter Gross and Bob Yester who left Tuesday afternoon. John McNally, APC Director of Engineering, Availability Enhancement Group, joined the meeting.

Barriers to Innovation and Evolution

A letter regarding barriers to product innovation and evolution prepared by Neil Rasmussen, Chief Technical Officer of APC was read (the letter is appended to these meeting minutes). The Council agreed that certification performance standards need to be outcome-based and not proscriptive of how equipment must be designed. Standards must be free to evolve and change. New solutions and topologies need to be encouraged.

Proposed Certification Categories and Review of APC PowerStruXure

Paul Jorgensen presented proposed certification categories for evaluating products. First on the agenda for the morning was the UPS/battery element of the APC PowerStruXure architecture. The Council worked through several sections of the proposed certification categories focusing on PowerStruXure. In what follows, the category description narrative is followed in each section by the discussion points concerning PowerStruXure, if any were noted by the group. Comments are shown in italics.

- 1.0 Installation Resources. Review installation manuals, documentation and recommended procedures for feasibility, NEC compliance, and other installation-related issues. Review a sample of existing field installations. Consult electrical contractors who have installed the system to receive feedback on installation-related concerns.
- 2.0 Codes, Standards, and Specifications. Evaluate the design specifications against recognized standards and industry practices that include ANSI, IEC, IEEE, NFPA, and typical construction specifications. This work is not to be considered a replacement for independent testing by CSA or UL.
 - 2.1 *The top-mounted wireway for PowerStruXure needs to be reevaluated if certification is done on this product. Bill Mazzetti noted a difficulty when PowerStruXure was installed at a client's data center, as the wireway did not meet UL requirements.*
- 3.0 Functionality. Detailed testing of the product's electrical and mechanical characteristics to identify shortcomings in engineering, maintenance, or operational that may not be initially obvious. Testing will include simulation of typically expected failure modes, expected maintenance functions, and changes in operating configuration that can be reasonably expected to occur during five years of use. The results from these simulated tests must demonstrate the equipment responds in the manner expected or promised by the manufacturer's specifications or literature. The *Institute's* panel of experts will use its intimate knowledge of the type of equipment being tested to identify the particular testing program that will be run by the *Institute's* professional staff. The operational and performance testing program will take into account previous failures recorded in the *Institute's* Abnormal Incident database. Important characteristics such as electrical efficiency, capacity, operation with non-linear loads will be verified under controlled test conditions. This testing will be in addition to IEC 62040-3, UL 1999, and other industry safety standards.
 - 3.1 *Completely concurrently maintainable and operable*
 - 3.2 *Regulated output: frequency, voltage, rate of change, input versus output*
 - 3.3 *Ride through capability*

- 3.4 *Impulse withstand*
- 3.5 *Bypass synchronization*
- 3.6 *Accessibility/location of key breakers/infrared lines of sight/access to loads*
- 3.7 *Footprint/size comparison for same kW*
- 3.8 *Single tool maintenance (one side of a bolt is captive) (there are fuzzy lines here so this might go under maintenance)*
- 3.9 *Adding/removing module/plug-in*
- 3.10 *Complexity of testing*
- 3.11 *Expansion modules—backward compatibility (for reasonable cost)*
- 3.12 *Self-testing/self-diagnostic/recording function—optional?*
- 3.13 *EPO*
- 3.14 *Battery charging methodology*
 - 3.14.1 *Replacing battery—plug in*
 - 3.14.2 *Monitory battery*
 - 3.14.3 *Topology/equal chain on parallel strings*
 - 3.14.4 *Capacity options/scalability*
 - 3.14.5 *Recharge rate control*
 - 3.14.6 *Interlocks*
 - 3.14.7 *Perform discharge test (at DC or AC output?)*
 - 3.14.8 *Life of battery cycling: number of discharges, depth discharge duration*
 - 3.14.9 *Connection point at backplane*
 - 3.14.10 *Response to shorts, open, overheating, thermal runaway: remove later (containing local issue, fixing later)*
 - 3.14.11 *Hydrogen detection, ventilation/dispersal*
 - 3.14.12 *Avoid runaway logic*
 - 3.14.13 *Battery monitoring—safety level/charge balance*
 - 3.14.14 *Life expectancy notification*
 - 3.14.15 *Battery options*

(The group discussed the fact that there is not currently a standard for a catastrophic battery failure on the raised floor, i.e., sulfuric acid vapor. There is no requirement for preventing release of byproducts. There should be a big benefit for those manufacturers who add this to their equipment to contain this problem.)

- 3.15 *UPS System Static Switch*
 - 3.15.1 *Feedback*
 - 3.15.2 *Interlocks*
 - 3.15.3 *Continuous/intermittent duty rating*
 - 3.15.4 *Overload rating*
 - 3.15.5 *Withstand rating*
 - 3.15.6 *Diagnostics*
 - 3.15.7 *Test*
 - 3.15.8 *Failure mode alarms*
- 4.0 **Cost of Ownership, Adaptability to Growth or Redeployment.** Addresses the total cost of ownership including initial first cost and life-cycle cost on a cost per delivered kW or ton, cost per square foot, and energy efficiency at partial and full load as well as return on investment at different rate of return for different growth models. Operating costs are incorporated into the life-cycle cost modeling including energy, regular maintenance, parts replacement and repair costs (specifically battery replacement if gel cell batteries are employed), and recommended spare parts. This category also looks at scalability and adaptability to changes in customer capacity requirements.
 - 4.1 *Efficiencies at different load points*

- 4.2 *Life-cycle cost of installed capacity*
- 4.3 *Maintenance cost structure*
- 4.4 *Life expectancy*
- 4.5 *Expansion costs*
- 4.6 *First cost: entrance cost, startup cost*
- 4.7 *Scalability*

(Paul Jorgensen suggested creating a formula for life-cycle cost that the manufacturer could complete, i.e., a “fill in the blank.” He also said cost of ownership needs to be made simple for the owner or their eyes will gloss over: energy costs, maintenance costs, and replacement costs.)

- 5.0 Operation and Maintenance. Review routine operation, operator functions, routine maintenance, and system modification while the equipment is in service. Also included are control convenience, labeling, and other human factors characteristics, which will prevent failures resulting from the human interaction and response. Human factors problems have been associated with a significant percentage of all data center outages identified by the Site Uptime Network's® Abnormal Incident Reports.

- 5.1 *Identify maintenance tasks: onsite versus field service*
- 5.2 *Eliminate or easy maintenance*
- 5.3 *Maintenance access*
- 5.4 *Operate to failure*
- 5.5 *Access to field change orders*
- 5.6 *Risks during maintenance: where is critical load?*
- 5.7 *How are updates delivered? Downloadable via web?*
- 5.8 *Customer alert process*
- 5.9 *Can maintenance be done following procedures?*

- 6.0 Local and Remote Management Software. Reviews the functionality of software including capability to interface with different building management systems

- 6.1 *Power quality option*
- 6.2 *Full disclosure: customer can get what factory gets*
- 6.3 *Gateways*
- 6.4 *Open protocol*
- 6.5 *Firewall/secure/switchable*
- 6.6 *Compartmentalized or packaged so you can get local without remote*
- 6.7 *Can you get upgraded without taking system down (upgradeable on-line)*
- 6.8 *Interface*
- 6.9 *What happens when display dies—swappability—load stability?*
- 6.10 *Customized reporting detail*
- 6.11 *Time stamp, time sync 0.001 second local time stamp—no latent time delay (we need to drive a standard and anything better gets brownie points), 0.01 prerequisite standard*

- 7.0 Manufacturing and Life-cycle Quality. Review the manufacturing facility and associated manufacturing procedures, test processes and quality control procedures. Review processes for notifying older customers of problems and product improvements.

- 7.1 *Root cause analysis of field failure*
- 7.2 *Updates/notifications*
- 7.3 *Viability*
- 7.4 *OEM parts availability*
- 7.5 *Supplier quality control/outsourced product control*

8.0 Reliability and Failure Mode Analysis. Evaluate the design from a reliability perspective. Particular emphasis will be placed on single-points-of-failure and how the risks of these points can be minimized. A comparative analysis of the product's tolerance to change and tolerance to maintenance will be performed.

8.1 *Level of desk analysis by factory in design*

8.2 *Single point of failure partnering to evaluate process and outcome—feedback loop for problems*

8.3 *Test bay, labs, PF load, out of phase transfers, full load*

While the focus of the discussion was primarily on the UPS portion of the APC PowerStruXure, the group also discussed other aspects of normally separate products that APC includes as part of PowerStruXure. These include power distribution units (PDU), point of use transfer switches, intelligent outlet strips, and emergency power off.

Power Distribution Units

- CU versus AL bus
- Meter accuracy
- Bolt terminations for bus
- Breaker stabs versus screwed lugs
- Ability to drive screw straight in
- Certified circuit breaker testing
- EPO function

Static Transfer Switch/Point Of Use Transfer Switch

The final piece of equipment that was discussed was the Static Transfer Switch/Point of Use Switch (20amp/30amp one pole/two pole). Due to the shortness of time, the group focused on item 3.0 Functionality and 8.0 Failure Mode with the following ideas being captured.

3.0 Functionality

3.1 Transfer within ITI curve: sense, process, transfer

3.2 Not transfer on a downstream FAULT

3.3 Control power is from source going "to" not "from"

3.4 Selectability: manual, latch, auto reset depending on customer choice

3.5 Indication of source

3.6 Local/remote status

3.7 Local/ remote selectability

3.8 Ability to inhibit auto or manual transfer

3.9 Preferred source selection

3.10 Alternate feed acceptable source

3.11 Communication/monitor/command

3.12 Address phase (\emptyset) angle tolerance

(Ken Brill asked what happens when we clarify the issue? Richard Schlosser said there would be customers that say "it doesn't matter to us," but Richard has customers that find it very important. Leo Soucy has customers in broadcasting who use a different type of equipment.)

3.13 Power supplies

3.14 Ratings

3.15 Neutral code issues (grounding issues)

- 3.16 Load monitoring
- 8.0 Failure mode
 - 8.1 1 or several power supplies, relay, etc.
 - 8.2 Overload, withstand
 - 8.3 Cycle count
 - 8.4 Survive a transient/transient-response capacity
 - 8.5 Consequences of control failure—diagnostics

Next Steps

The Council moved to a discussion on how to proceed. It was decided that the activities of the Council would be kept confidential (no public announcements) until more details were finalized about the structure and activities of the group. The *Institute* was tasked to look into legal issues and liability insurance for both the *Institute* and Council participants. The *Institute* also agreed to research the additional resources required to address failure analysis, human factors, and whole product life-cycle quality issues. Each member of the group would track their time dedicated to Council issues. The *Institute* planned to take approximately a month to synthesize all of the input from the three days of meetings and then schedule a conference call with the group to discuss structure. Minutes were scheduled to be delivered in a month's time.

The group wrapped up the meeting by expressing their thoughts about the proceedings. The meeting adjourned at 10:30 a.m.

Text of Letter (re-typed from fax version) from Neil Rasmussen, Senior VP, CTO—American Power Conversion

January 27, 2003

Dear New Technology Adoption Council Attendees,

APC is very pleased to support the effort by this group to consider process and standards for assessing new technologies related to the physical infrastructure of critical networks.

This is an area of genuine interest and concern for APC, because it is highly likely that APC will invest more in new technology and products for this application than any other company in the next few years.

We would like to make a few suggestions regarding your important work.

There is a risk in our business of believing that the basic problems have been solved, and that we simply need to document and standardize the status quo. It is said that in 1899 the head of the US patent office recommended that the office be shut down because “everything important has been invented”. At APC, we believe that the area of Network-Critical Physical Infrastructure will undergo unprecedented change in the upcoming years. Therefore, it is essential that standards are open to the concept of evolution.

We believe that global, high volume production is a requirement to deliver the quality, cost benefit, and most importantly, the shared learning that will improve system availability. To this end we urge that efforts to standardize nomenclature, testing, etc. be global. Customers are more “globalized” than ever before and are interested in global infrastructure design. Even today, unnecessarily contradictory standards across geographic boundaries add cost, prevent commonality, and even result in different design practices. APC strongly believes that global standards and assessment practices will improve the quality of products and customer satisfaction. Increased number of similar systems located in diverse environments is the best way to accelerate learning. In our view, rapid learning is one of the most powerful ways to reduce human error, defects, and improve availability.

We believe that two of the most fruitful areas for standard development include standardized testing protocols and standardized human interface factors. Standardized testing protocols allow customers to make rational comparisons between products; we believe this is a large problem in our industry today. Standardized nomenclature for describing the human interaction with various systems, phasing, functions, and labeling of power and cooling distribution are important to allow deployment of equipment in heterogeneous environments.

APC does not believe establishing performance criteria (levels of required performance) is necessarily beneficial. Such criteria can limit innovation significantly, and can be unresponsive to technology shifts. Just three examples of the many technology shifts currently happening are the increase in power factor in the data center, the increasing use of loads with dynamically varying power consumption, and the overwhelming shift to galvanically isolated communication like Ethernet and Fiber. Performance standards that fail to comprehend these shifts could burden systems unnecessarily with cost and complexity. Furthermore, in the absence of efficient and rapid learning in our business we run the risk of developing performance criteria based on mythology; even the most professional attempts to characterize the environment such as the IEEE Emerald Book draw conclusions from anecdote and as a result still contain some mythology.

Any activity to develop standards for assessment of products is at risk of being manipulated by vendors. While consideration of vendor comments and concerns is important, vendor control of

standards can lead to a stifling of innovation. In one recent case in Europe, a standards committee controlled by a few vendors attempted to define the term UPS to be restricted to only a certain list of known circuit topologies in a deliberate attempt to gain competitive advantage over emerging technologies. It is very important for standards to remain open to innovation, and for the standard setting process not to become a weapon for vendors to use against each other. The temptation for vendors to attempt to manipulate standard setting is very, very great. The best standard work is performed when the customer's long-term interest controls the process.

I hope your discussions are fruitful. If we can be of any service to your effort, feel free to contact me at any time. My cell phone is 978-697-0120.

Sincerely,

Neil Rasmussen, Sr. VP, CTO, APC