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FALL 09

20th ANNIVERSARY

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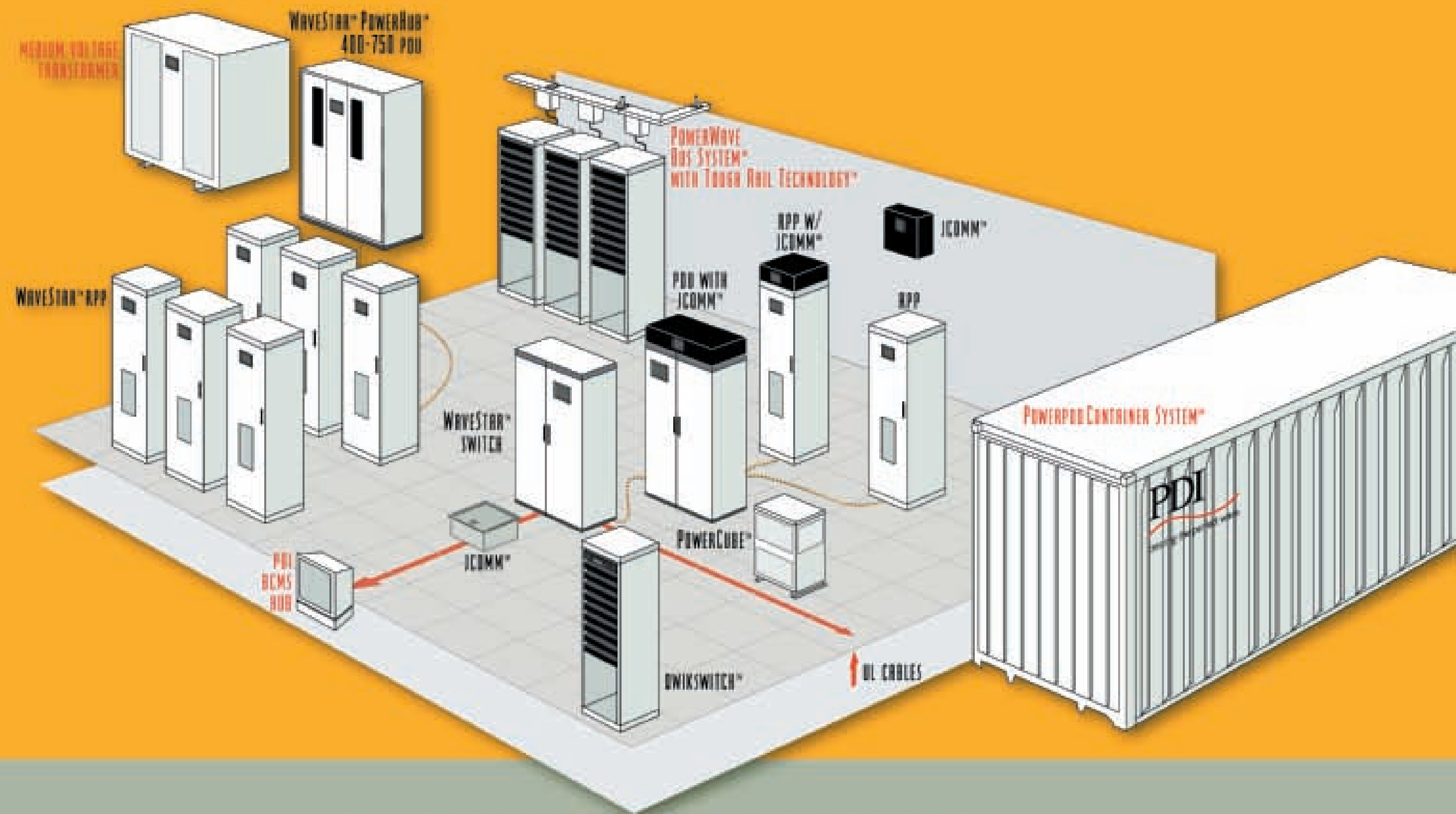

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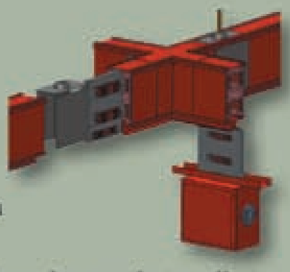

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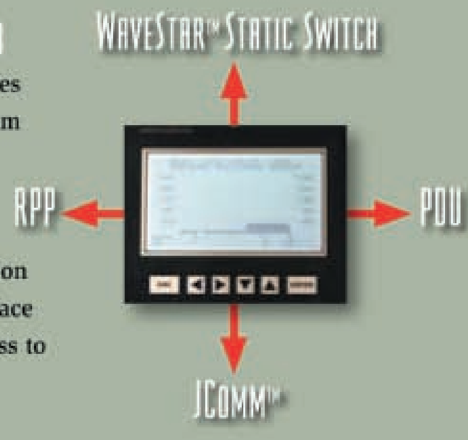

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CHAIRMAN'S LETTER

Fall 2009

Robert J. Cassiliano

I hope everyone enjoyed a wonderful Summer!

At this year's Fall Conference we will be celebrating the 20th Anniversary of the *7x24 Exchange*. The organization, a "Not–for–Profit," was founded as the Uninterruptible Uptime Users Group in November 1989 with a goal to promote dialog among industry professionals to address the many challenges facing owners and operators of mission critical enterprise infrastructures.

The *7x24 Exchange* has grown from an initial membership of 16 to more than 500 member firms today. Our first meeting was conducted back in 1989 and was held in a small conference room in a brokerage house in NYC with 25 people in attendance. In recent years our semi-annual national conferences have approached 700 attendees. Even in these challenging economic times we've seen our conference attendance remain high, a testament to the value *7x24 Exchange* conferences provide to the mission critical industry.

The organization is recognized as the leading knowledge exchange in the Mission Critical Industry. At this year's Fall Conference being held at the JW Marriot Desert Ridge in Phoenix, AZ, November 15 – 18, 2009 we will be recognizing the individuals primarily responsible for achieving this prominent industry status. Included in this group are the founders who had the vision – Ken Brill, Dennis Cronin, Paul Fox, Frank Gialanella, John Jackson, Howard Levison, Alan Freedman – and long term board members who provided distinguished service, David Sjogren and John Oyhagaray.

Through the years the *7x24 Exchange* has been at the forefront of the core issues that have challenged the industry. Improving infrastructure resilience, dealing with rapidly increasing power and cooling densities, and highlighting operational best practices shared from our large end user base are topics that have all been covered in depth at past conferences. A number of major industry problems were addressed and resolved because of the attention they received at the *7x24 Exchange* conferences.

In recent years we've provided increased focus on cost containment, operational and energy efficiency and addressing the challenges that the industry is facing from an environment perspective. Industry thought leaders from our unique mix of end users, consultants, government representatives, industry standards organizations, and vendors all come together to provide our attendees with a broad view of the challenges that the industry faces and the solutions that best practice organizations are adopting. Armed with this knowledge, attendees are enabled to proactively communicate the solutions necessary to protect their company's information lifeline.

We are excited about the future of the organization as all indicators of success: Industry Status Membership, Conference Participation, End User Attendees, and Sponsorships are ever increasing.

I am privileged and honored to have been a part of such an important Industry Forum and look forward to seeing you at our Fall Conference in Phoenix, Arizona!

Sincerely,

Bob

The Founders of 7x24 Exchange International.
Howard Levison, Paul Fox, Dennis Cronin, Frank Gialanella,
Alan Freedman(deceased), Ken Brill, John Jackson.

Facility Optimization in the Era of Budgetary and Technology Challenges

Mike Hagan

With modern technology, change is the rule… not the exception.

Technology is always getting faster, smaller, and as a byproduct, hotter. For this reason, when it comes to facility optimization, data centers and other mission critical facilities (SCIFs, COOP sites, comm. centers, etc…) pose an ongoing challenge for organizations and individuals involved in the design, build, use and maintenance of these enterprise information infrastructures.

What's more, challenges associated with facility optimization are intensified for Federal government and DoD facilities that cannot risk a single iota of downtime during facility upgrades, relocation or consolidation.

For organizations in both the public and private sector, technology developments, energy usage and constrained budgets are placing greater importance on facility optimization. This paper outlines a series of critical steps for facility managers and operational staff to consider as they review each process for efficiency and facility optimization. By following these steps, organizations have the opportunity to lower costs and mitigate facility downtime.

LONG-TERM APPROACH: UNDERSTANDING YOUR ORGANIZATION AND IT GOALS

Organizations often develop initiatives for their mission-critical facilities in response to problems or limitations. However, creating a strong, long-term optimization plan up front is the first step to avoiding contingencies and ensuring scalability. The key to planning this stage successfully is bridging the gap between your IT manager and the design/build firm. To this end, the facility manager serves as the foundation of the planning process, ensuring that the IT department's needs are met by the design/build firm.

Start your planning with a Design Intent document that thoroughly illustrates the narrative of the project background. Ensure that your document includes thorough answers to the following questions:

- What were the specific circumstances that prompted the decision to design a new facility?
- What are the goals you look to achieve with the new facility?
- What are the performance and maintenance abilities of your staff?
- What is the expected lifespan and budget expectations for your mission-critical facility, today and in the future?
- What challenges did you face in the old facility, especially in relation to green initiatives?
- What are the IT department's plans for their technology upgrades in the next 5 years, and what are the best-case and worst-case scenarios for the business growth in relation to the IT department's needs?

Assessing Existing Facilities for the Long Term

Long-term planning applies to more than just new construction, but to existing facilities as well. Many organizations have put construction, relocation and consolidation plans on hold during this economic downturn, instead opting for a strong site assessment to evaluate existing facility capacity, availability, and potential for growth. Choose a site assessment partner with a clear understanding of the facility in relation to your organization's objectives and, ideally, one with a strong history of planning and managing technology facilities. Ask if the site assessment includes both power and cooling recommendations for long-term facility optimization. This partner can objectively evaluate how your mission-critical facility investment can yield the best results. Although no longer termed a Design Intent document, be sure that you can effectively answer the design intent questions to give the site assessor a complete understanding of your facility plans.

EQUIPMENT SELECTION, INTEGRATION & RIGHT-SIZING

Energy consumed by IT equipment is only half the problem. The electrical and mechanical infrastructure supporting the IT equipment is a major contributor to the energy bill. According to the Department of Energy, by 2012, the power costs for the critical equipment over its useful life will exceed the cost of the original capital investment. Maintaining the electrical and mechanical equipment is essential to ensure peak efficiency and replacing equipment in a timely manner will optimize your facility and the organization's bottom line.

Electrical

When discussing electrical efficiency, PUE calculation is always a topic of conversation in the mission-critical world. Lowering your existing facility's PUE calculation, although not a perfect solution, will save money and reduce your carbon footprint in the long-term.

As energy resources become scarcer and more expensive, electrical efficiency becomes a more important factor in the specification and selection of large UPS systems. According to APC, two factors contribute to UPS inefficiency: inherent losses of the UPS modules themselves, and system design and implementation (i.e. right-sizing, redundancy). To check the accuracy of a UPS system efficiency number listed on a data sheet, APC recommends creating a UPS efficiency curve.

Surprisingly, IT infrastructure often fails to take full advantage of the power of IT. Many of the functions performed by various mechanical and electrical systems and technicians can be automated with advanced tools. Power management tools can power down servers or place systems in sleep mode during off-peak times. Similarly, processing activities of non-critical nature can be scheduled for off-peak hours. Sensors and remote monitoring systems can provide a real-time, 24/7 view into environmental and mechanical factors such as power use, temperature, humidity, generator status, and UPS levels. These vital statistics on the health of your mission-critical infrastructure are a gold mine of information for basing further efficiency improvements.

Computer-Aided Facility Management (CAFM) is a powerful tool for ensuring that infrastructure systems operate at peak efficiency. CAFM solutions contain detailed data on every cable, component, connection and configuration both within the facility and throughout the infrastructure chain. Detailed, drill-down 3D representations of each piece of equipment help to quickly identify potential problems and opportunities for efficiency gains.

Computerized Maintenance Management Systems (CMMS) also offer significant opportunities for increased efficiency. These systems automatically schedule preventive maintenance and provide valuable historical information on work orders, equipment and sites. The information is available in summary or at the detail level, accessed on screen or in report form, and annotated with free-form note. By ensuring all preventative maintenance is performed as designed, you can achieve optimum performance and extended product lifecycles.

the building envelope as a whole.

While unnecessary openings lead to unwanted bypass airflow, clutter results in restricted airflow. Within cabinets and beneath raised floors lies a twisted maze of cables that collects heat while restricting and redirecting airflow. Minimizing the distance, obstructions, and barriers between the computer room air conditioning (CRAC) is crucial to maximizing airflow and cooling system efficiency. Sorting this mess out is not the most glamorous of IT jobs, but it will provide increased energy efficiency, and will also lead to quicker troubleshooting down the road.

An efficiency curve is created by first measuring the power supplied to the UPS (input) and the power the UPS supplies to the load (output). These measurements are taken at various loads usually at 25%, 50%, 75%, and 100%. A measurement is also taken at 0% load to find out how much power the UPS itself draws (no-load loss). From these measurements the losses are calculated by subtracting the input power from the output power. These losses are then plotted on a graph and a trend line is fitted to these points. The trend line provides a formula from which all the other points can be plotted for every load percentage. With all of the power losses calculated, the efficiency curve is then created by plotting the ratio of output to input power with respect to load level.

http://www.apcmedia.com/salestools/VAVR-6LJV7V_R1_EN.pdf

Mechanical

Designing and managing airflow can also significantly affect energy usage. Cooling alone accounts for 40% of mission-critical facility energy consumption.

Implementing hot and cold aisles is the most notable best practice. Equipment with like airflow patterns are placed together and aligned so that the conditioned air and the exhaust air travel in the same direction. Consolidating high heat-density equipment facilitates more efficient heat rejection and minimizes the recirculation of hot air.

Moreover, effective air management strategies can extend equipment life, minimize downtime and increase productivity per square foot; this is, however, only the beginning.

Infrastructure experts have specialized tools to help fine-tune cooling strategies. Variable-speed fans can adjust cooling dynamically. Advanced visualization tools such as infrared tomography and computational fluid dynamics modeling can reveal significant opportunities to improve airflow efficiency. Experts can also adjust environmental temperature and humidity set points to maximize energy efficiency without compromising mission-critical operations.

Bypass airflow can be significantly lowered through the use of blanking panels and capturing cable cut-outs. Hunt down any opening that lets cold air out or hot air in. From doors and windows to below the floor and above the ceiling, keeping your cool begins within the cabinet and expands to the data center or mission-critical facility cavity itself, and continues to

Finally, setting appropriate environmental thresholds can affect efficiency and reliability. Previously established thresholds for temperature and humidity may no longer be appropriate for the facility's current requirements. Ensuring that set-points are correct, airflow is as-designed, and that sensors are calibrated and balanced based on the configuration is vital to maximum infrastructure performance.

A Note on Mechanical and Electrical Vendors

Selecting the right equipment and vendors for electrical and mechanical infrastructure helps not only to ensure successful completion of the project, but also the success of the facility over time. It is crucial to ensure that the equipment vendor meets the engineering specifications and has the ability to support the equipment long-term. This includes delivery times, installation support, start-up services and the availability of spare parts and authorized maintenance personnel. Although this is frequently a given for electrical and mechanical vendors, new green-specific vendors have come upon the scene in recent years. Do not be quick to utilize a product based on its green promises alone. Ask around and ensure any new vendors meet the same long-term support requirements that your existing vendors have based their reputation upon. Conversely, your existing vendors' green products may just be a marketing response to the industry trends, and may not be the technical answer you require.

Complex systems rely on the operation of multiple systems and platforms and optimization relies upon the equipment working together in as an integrated and efficient whole. It is essential to focus on the overall connectivity and interaction of multiple systems. Integrators provide the owner with a single point-of-contact, reducing the project's completion time, and ensuring that all of the systems are properly installed and interconnected.

Right-Sizing

While often counter-intuitive, too much capacity can be a bad thing. As illustrated above, excess server capacity creates losses in both power consumption and the related cooling requirement. However, the need for rightsizing extends beyond IT and continues throughout the entire infrastructure chain.

It is a traditional approach of facility planners to over-engineer support systems to help ensure redundancy, but this approach can drain the operating budgets. In addition, the temptation to over-engineer one link in the chain can result in too much strain on the next. Behind the scenes, systems such as excess UPS capacity can place unnecessary demand on HVAC systems, driving up energy costs and consumption. Power distribution units operating below their full load capacities generate significant heat and require otherwise unnecessary cooling requirements.

The Green Grid estimates that many data centers have twice the needed capacity designed into their physical infrastructure systems. This results in recurring fixed losses in power and cooling that exceed the actual IT load. According to the Green Grid, right-sizing the physical infrastructure to actual loads can have the biggest impact of power consumption, offering up to a 50% reduction in electricity costs.

ENSURING UTMOST OPTIMIZATION IN YOUR MONITORING, MAINTENANCE & BENCHMARKING

Purchasing new, more energy efficient hardware offers immediate returns and relatively instant gratification. Proper maintenance, however, is often more important (though less glamorous) to efficiency. After all, "brand new" is short-lived, but meticulous maintenance delivers consistent, long-term energy efficiency and 24/7/365 reliability.

Solutions like monitoring offer an insight into understand the system's capabilities. Establish the various alarms, trends and notifications to provide not only alarm notification, but also important historical data that can be used to measure efficiency.

You will need to decide how to staff your facility. Whether you use internal our outsourced staff it is important that the depth of knowledge meets the requirements of your mission-critical facilities. It is also important to have a comprehensive training program for the operation and maintenance staff. Training should start with the equipment manufacturer/installer. Start-ups and commissioning offer ideal opportunities for training operation and maintenance staff. Once the site is operational, schedule regular training to keep operational and maintenance staff current.

The development and verification of procedures for site operation, maintenance and recovery are vital to maximizing uptime while maintaining efficiency measures. Methods of Procedure (MOPs) should be very thorough and specific, written to the switch level detail, and tested during the project's commissioning phase.

Establish and strictly enforce a structured maintenance program. Critical facility operators often work valiantly to maintain their physical infrastructure systems only to see their efforts undermined. At the highest levels of an organization, profit and loss pressures often result in short-term budget decisions, without a full understanding of the long-term implications of maintenance failures. High-profile "state-of-the-art" technology receives the attention of the press and upper-level management, while less glamorous maintenance goes overlooked.

Keep in mind the quantity and length of maintenance windows required to properly maintain the facility. The system will need the appropriate redundancy and bypasses in order to operate while maintenance is performed. An annual maintenance matrix should accompany the equipment list to ensure adequate redundancy allowances and complete integrated efficiency. Systems without the appropriate maintenance allowances may require the use of temporary equipment or the installation of additional systems for continuous uptime.

Maintenance should go beyond remedial and preventative maintenance to include predictive maintenance. Using equipment trends and conducting a thorough failure analysis after each incident will help predict and prevent future problems and issues with facility optimization. All maintenance documentation should be detailed and should provide methods for predicting and anticipating potential trouble spots and weaknesses. Details are the building blocks of a comprehensive predictive maintenance program.

Energy Benchmarking

Effectively controlling energy usage and costs cannot occur in a vacuum. Benchmarking mission critical facility energy usage against comparable industry peers and best practices plays a key role in optimizing the facility from an infrastructure efficiency perspective. The Department of Energy recommends energy benchmarking measurements for mission-critical facilities, and government regulations may require it in the future. Once an organization determines primary motivations and objectives for energy efficiency, a number of steps can be taken to begin and sustain energy benchmarking:

- Collect data on the data center infrastructure systems (power, cooling, and lighting)
- Measure the total IT loads
- Measure the total power input to the data center
- Calculate infrastructure efficiency using the total IT load and total power measurements
- Compare (benchmark) the resulting efficiency to the efficiency of other data centers of similar design

SUMMARY

The numbers speak for themselves. Of course, the cost of downtime is preeminent (lost revenue, productivity and potentially customers). Beyond that, virtually every link in the electrical/mechanical infrastructure suffers efficiency losses without proper long-term planning and systematic maintenance. For example, for every year a HVAC system goes without maintenance, efficiency drops by as much as 2%. At today's energy costs, a site assessment and comprehensive maintenance plan can quickly pay for itself.

Success, however, relies on management developing a maintenance philosophy. This philosophy must align with the organization's overall performance goals and must be enforced and managed throughout every aspect of the maintenance organization.

Mike Hagon is a Executive Vice President at the Lee Technologies. He can be reached at mhagan@leetechnologies.com.

Back to School:

Data center assessments are a very simple job that rely more on the engineering basics taught in classrooms than they do the design specifications learned on the job. A data center assessment is a job that is performed by a team of electrical, mechanical, and fire protection engineers. It is a walkthrough (site visit) of an existing facility, in which the engineer will 'assess' the data center. It is followed by a report issued to the client / data center manager. These assessments look at the power consumed by the data center, power density, and other values that might not be apparent with just a cursory glance, in addition to facility size, amount of electrical units, number of servers. That data is included with the report / assessment. A data center assessment serves as an overview of the data center, providing a wealth of information about the data center in both numbers and words to the client / manager, allowing them to make informed decisions about the center. This validates the owner's project requirements for day 1 and day N.

These assessments are necessary. What was designed in 2001 is not going to be appropriate in 2009. Designing a new state of the art data center is going to be highly expensive, so the alternative is to increase the optimization of the current data centers. The first step to doing this is to understand the current capabilities of the data center and what the project requirements are for the data center. The assessments serve a number of purposes for the client. First, they provide the client with an overview of their data center(s), allowing them to see things such as the cost of cooling the data center or the PUE ratio for the center. Second, the assessment allows them to determine if their data center(s) have any code compliance issues. These issues are deeply significant and need immediate attention. Thirdly, the assessments find and identify any single points of failure. These are important to present to the client because single points of failure need to be fixed in order to ensure maximum uptime for the data center. A data center assessment is a great way to determine if a data center needs to be re-commissioned or undergo renovation.

The easiest way to perform data center assessment starts with the formulation of a checklist. This list is the simplest way to organize the data collected from the assessment. Figure A shows a sample checklist that could be used to assess a data center. This checklist is very basic, and would need to be expanded in the actual report, but the core items from the assessment can be found on this sheet. This sheet is a cover to the actual report, showing the important data.

Another important document for a data center assessment is a single point of failure matrix. Single points of failure are incredibly important to data center managers because they are items that need to be fixed

Data Center Overview - (Completed for each site): Date Completed

Tier
Electrical: __________
Mechanical: __________

Redundancy
Generators: __________
UPS: __________

Facility Size
Amount used for servers: __________ sft
Amount used for cooling infrastructure: __________ sft

Power Input
Amount used by servers: __________ w
Amount used by cooling infrastructure: __________ w
Amount 'lost': __________ w
Power Density: __________ w/sft

BAS System: Yes ☐ No ☐

PUE Ratio: __________

Electrical Units – (For detail, see following equipment list)
PDU – Quantity: ___
EPO – Quantity: ___
RPP – Quantity: ___
UPS – Quantity: ___
ATS – Quantity: ___
MTS – Quantity: ___
Panel Boards – Quantity: ___
Distribution Panels – Quantity: ___
Switchboards – Quantity: ___

Mechanical Units – (For detail, see following equipment list)
CRAH – Quantity: ___
AHU – Quantity: ___
CRAC – Quantity: ___
Chillers – Quantity: ___
PACU – Quantity: ___
Exhaust Fan – Quantity: ___
Ventilation Fan – Quantity: ___
Refrigerant Monitoring System – Quantity: ___

Fire Protection –
Wet Sprinkler System ☐
Fire Alarms ☐
VESDA ☐
Preaction System ☐
Smoke Detectors ☐
Leak Detection ☐

Figure A

Data Center Assessments

Mahmood Akhter

in order to insure maximum uptime. A single point of failure is an item of the data center that has no redundancy or back-up. For example, if a data center had just one feed to the CRAC units, that would be a single point of failure because if the one feed to the CRAC units fails (a short, power outage, etc), the CRAC units would fail because there is no redundant feed. An issue like this would be a major issue for the data center because CRAC units provide the cooling for the servers. A simple server is capable of generating 1500 BTU an hour, and in a room with a hundred of these servers, the heat would climb rapidly without any cooling. To put it in perspective, 1 BTU is the amount of energy required to raised 1 pound of water 1° Fahrenheit. A room generating 100,000 BTU would quickly heat up the air, damaging the equipment. Figure C shows a sample document that would be use to document the single points of failure and provide possible solutions to fix the single point(s) of failure.

The next issue to address is that of code compliance, and best practice. These issues can be area specific, as different cities / municipalities have different building codes, but codes such as the National Electric Fire Protection Code, project sustainability (LEED), and best practices apply regardless of location. Failure to the municipality code or National Fire Protection Code can result in an increased liability, the risk of large lawsuits in the event of a building emergency, and also risks a building shutdown if the code issues are discovered by a building inspector and aren't fixed within the specified time range. Building shutdowns for data centers are incredibly costly. Figure B shows the cost of downtime for data centers serving specific industries. It is therefore in the best interests of the data center owners and managers to keep the data center up and running for the most time possible, and thus there is a need to both eliminate single points of failure (to the best degree possible) and to meet applicable codes.

After the actual assessment has been completed the next step is to issue an overall report. This report contains 2 main documents. The first is the checklist / assessment documents that were completed at the site visit or shortly thereafter. These documents include the single point of failure matrix and a matrix listing code compliance issues, as well as copies of the engineers' notes for the site visit. The second document included in the report is a review compiled after the assessment was completed which summarizes the findings. This review should summarize the findings of the assessment. The review will focus on the big picture rather than the little details. The focus is not the single point of failure of code compliance issues, but rather the 'numbers' from the assessment. This will include efficiency, both of the data center as a whole and for the individual pieces of equipment inside of the data center, power input, PUE/DCiE ratios, etc. The following three diagrams are examples of the types of graphs that can be used to show the 'numbers' gathered from the data center assessment and how they can be presented in the review. Data center assessments are the most cost effective way to increase data center performance and efficiency and maximize uptime.

Industry	*Avg. cost of downtime ($/hr.)*
Brokerage:	$6,400,000
Energy:	$2,800,000
Telecom:	$2,000,000
Financial:	$1,500,000
Retail:	$1,000,000
Chemicals:	$704,000
Health Care:	$636,000
Media:	$340,000
Source: Network Computing Magazine, March 5, 2001, and Computer Economics of Carlsbad, CA	

Figure B

Single Points of Failure

Issue #	Description	Nature of Work/ Issue(s)	ESD Recommendation to Fix
1	Utility	• Reduced Capacity	• Contact Utility • Verify Capacity • Improve Load to accommodate future growth
2	Utility	• Redundant Feed	• Contact Utility • Arrange for redundant feed from different sub-station
3	Generator	• Provide Standby Power	• Install 1 500-KVA generator to supply critical loads
4	UPS	• Redundant Feed	• Provide redundant feed to UPS to static bypass
5	CRAC Units	• Redundant Feed	• Provide redundant feed to CRAC units to ensure cooling

Figure C

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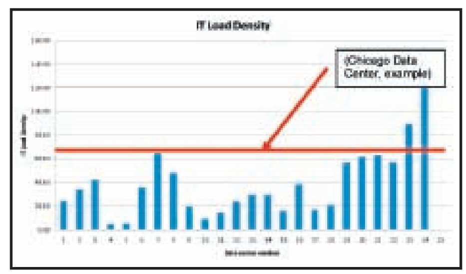


Figure D1

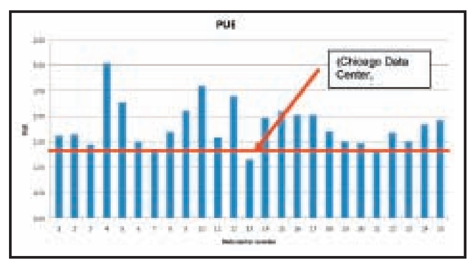


Figure D2

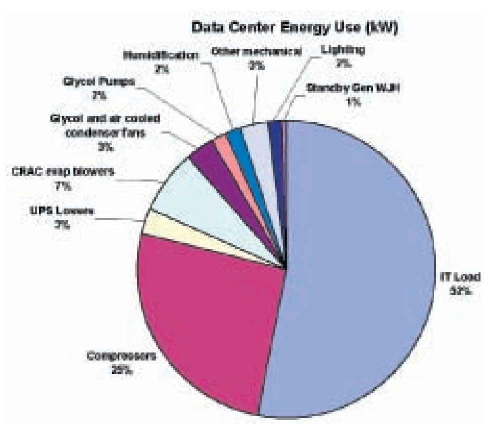


Figure D3

Economized Data Center Cooling – Defining Methods & Implementation Practices

Daniel Kennedy

EXECUTIVE SUMMARY

Data center owners and operators are in constant pursuit of methods to further reduce their energy costs and negative impact on the environment. For many years, economizing methods have been used in conjunction with cooling systems found in both commercial and industrial settings to cut energy consumption. More recently, the application of these technologies to the data center environment has also been widely practiced, although primarily in large data center spaces. This paper explores the methods of economized cooling that can be used in the small-to-medium size data centers that are more prevalent in the industry today than their larger counterparts. A brief overview of system implementation is also included.

COMMON ECONOMIZED COOLING SYSTEMS

In regards to the data center environment, economized cooling systems are basically just simple heat exchangers and typically take two forms. They are usually referred to in terms of the medium they use to remove energy (heat) from the data center. These common mediums, water and air, give rise to the terms “water-side economizing” and “air-side economizing.”

The primary difference between these economizing methods, as alluded to above, is that to remove the heat energy from a data center a water-side economizing system utilizes water and an air-side system utilizes air from the outdoor space.

WATER-SIDE ECONOMIZING SYSTEMS

Water-side economizing systems cool the chilled water used in the data center by using the outside environment. The water is cooled to appropriate levels simply by passing through the outside air without actively expending energy (refrigeration) to chill the water.

An understanding of typical chilled water systems is important to fully comprehend the method often used to cool data centers without economizing systems. See figure 1 below to see the operating cycle of a typical small scale chilled water system utilizing an air cooled chiller and a typical computer room air handler.

The packaged chiller removes heat energy from the water through the use of a refrigeration cycle, rejecting it to the environment on the condensing side of the refrigeration cycle. The chilled water is passed into the data center where it picks up energy from the air in the data center generated by the IT load and passes back to the chiller where the cycle is repeated.

The simplest water-side economizers take over the function of the chiller when the temperature in the ambient environment allows. See figure 2 for a simple block diagram of this system.

In the configuration above, a simple radiator equipped with fans, often referred to as a “dry cooler,” is installed in parallel with the chiller. When the ambient temperature drops to the point where the chilled water can have all energy removed from it using only economized cooling, the system is switched from the chiller to the dry cooler, allowing it to reject heat directly to the outside environment.

The economizing systems referred to thus far use air as the principle method to reject heat, either on the chiller side or on the dry cooler side. The most popular of the remaining economizing methods is an

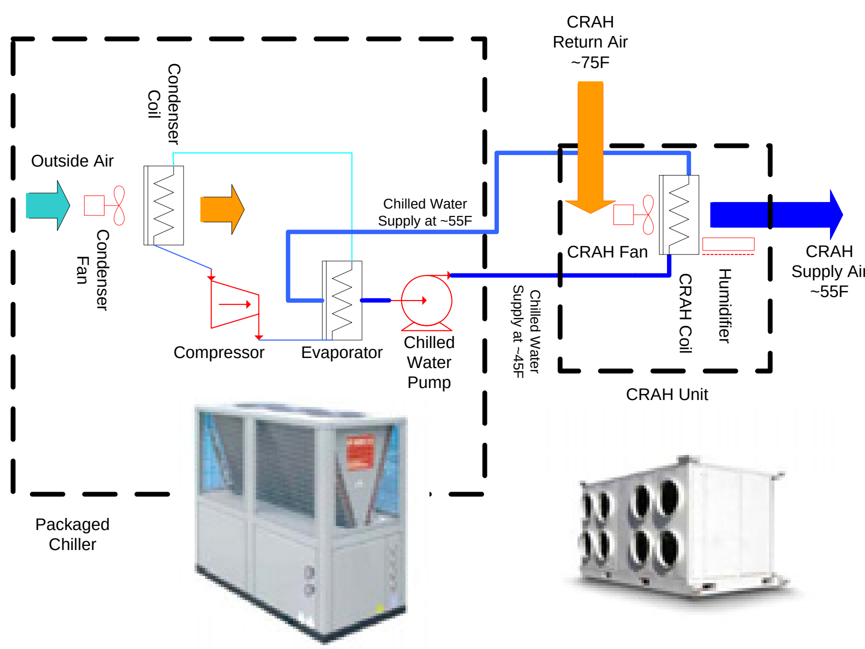


Figure 1: Typical Chilled Water System Block Diagram

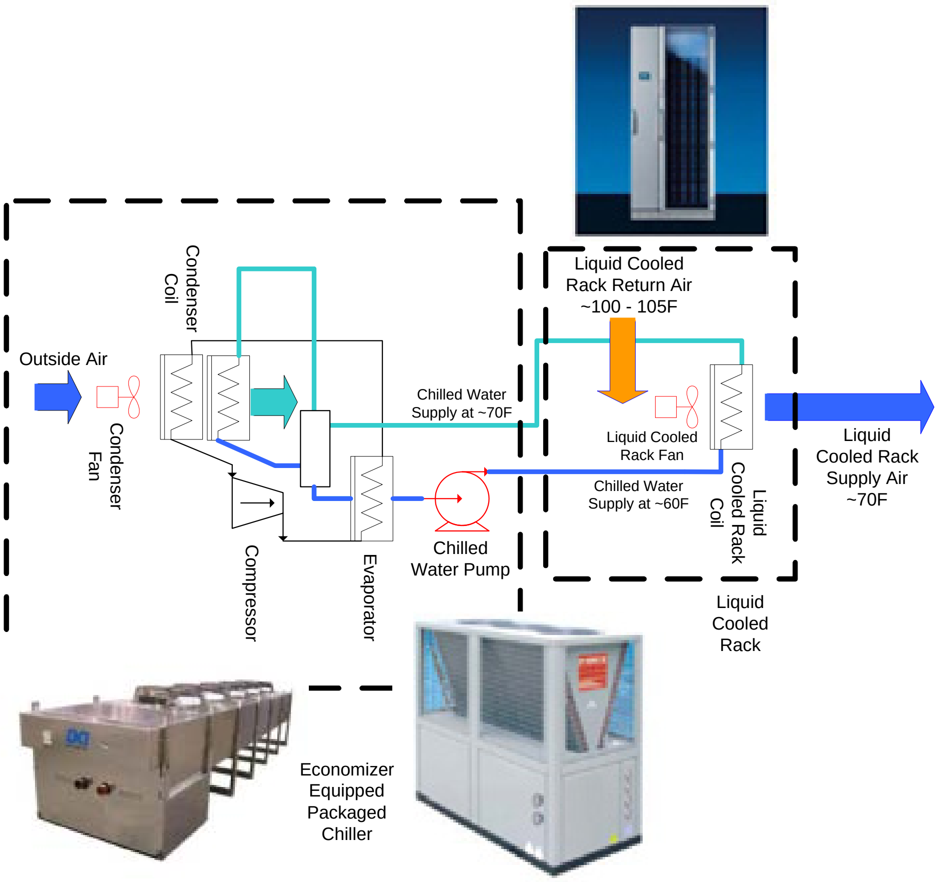


Figure 2: Simple dry cooler utilized to provide water-side economizing

"evaporative-type" system.

Evaporative systems work similarly to dry cooling systems, but allow for a wider window of functionality because they are less dependent upon environmental conditions. These systems use the evaporative process to cool a water loop that is used in conjunction with the standard chiller systems like those shown in figures 1 and 2 by inundating the circulating water with warmer water to create evaporation. In a typical layout, the remainder of the standard chiller system would be found to the right of the components shown in figure 3.

Other methods of water-side economizing are a bit more extreme. Some systems utilize direct energy exchange via a geothermal approach. These systems can often produce chilled water temperatures above what is typically used in data center cooling applications (systems that can utilize this water temperature directly are covered in other Rittal Corporation white papers).

There are also systems that reject their heat into large bodies of water such as lakes, or even oceans, for direct transfer. These systems often produce water warmer than that typically used in conventional cooling approaches, but as in the case of geothermal systems, newly advancing cooling solutions are equipped to take advantage of these economizing methods.

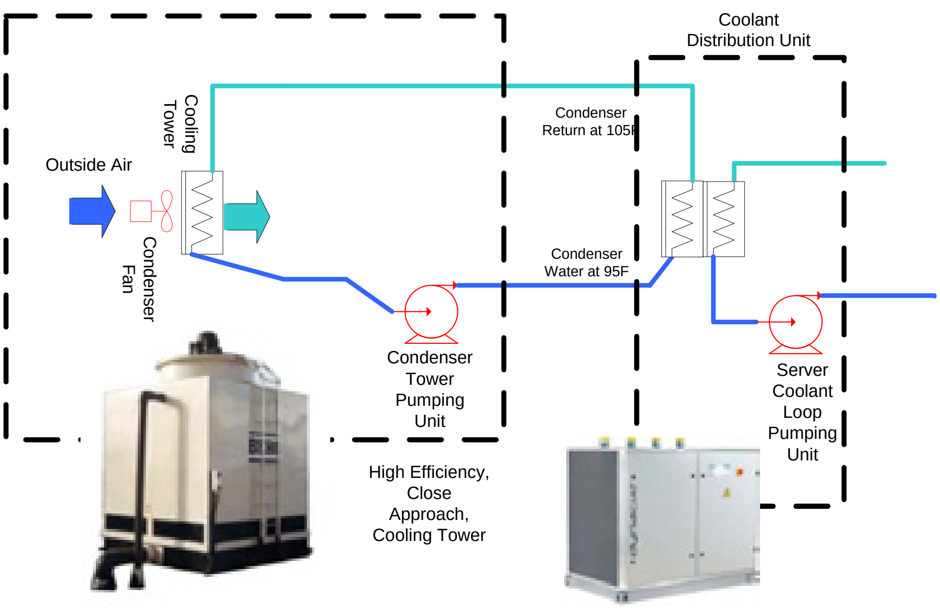


Figure 3: Evaporative Cooling Systems

AIR-SIDE ECONOMIZING SYSTEMS

Air-side economizing systems have been utilized for many years in building air conditioning (HVAC) applications, but these systems are quickly gaining favor in today's data center environments as well.

These systems typically pull outside air into the data center space, may or may not condition this air, pass it to the equipment to be cooled and then reject the heated air back to the outside environment. This approach is the most direct economization method currently in widespread use. Figure 4 is an example of the process that is generally employed.

As shown in the diagram, it is customary for a "primary cooling" system to be in place to handle the heat load when the outdoor ambient air is outside of the required data center specifications. The conditioning of or use of the outside air is dependent upon the user's requirements.

ECONOMIZING CONSIDERATIONS AND BENEFITS

Water-side

The water-side economizing approach minimizes the interaction of the outside environment with internal data center air, while also working in conjunction with often pre-existent data center cooling infrastructures. The system's functionality is directly related to the required water temperature needed for the cooling system utilized in the data center and the ambient environment used for heat rejection. See figure 5 for a comparison showing the number of hours of operation for an economizing system utilizing a standard dry-type cooler at a 45°F supplied chilled

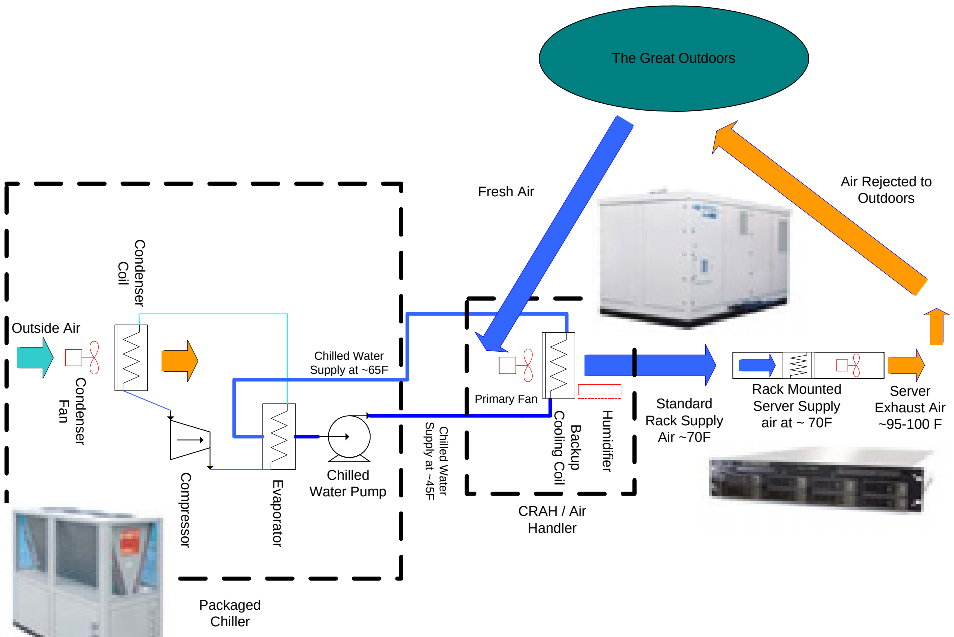


Figure 4: Air-side Economization

water temperature vs. 60°F supplied chilled water temperature. Figure 5 also compares the impact of using close-coupled cooling systems that have the ability to accept warmer chilled water (up to 65°F) while still maintaining 2008 ASHRAE standards.

As can be seen above, the typical impact of increasing the supply water temperature to the cooling equipment in the data center is often a doubling of the operational hours of the economization system. The impact of moving closer to the median outdoor temperature is quite large. Simply stepping from a 60°F chilled water temperature to a 65°F chilled water temperature doubles the hours of economizing available in most of the sites selected. The assumed ambient dry bulb temperature at the 60°F water is 53°F, and at 65°F, 58°F dry bulb. This increase can only be realized in systems that can operate at these levels. The data was acquired from NOAA (National Oceanic and Atmospheric Administration) temperature data for the year 2007.[1]

The true impact of this has to do with the elimination of the chilled water system refrigeration system. While the economization system is operational, the refrigeration circuit in the chilled water system is offline, resulting in large energy savings via the chilled water system (quantification of these energy savings can be found in other Rittal Corporation white papers).

In practice, water-side economization systems do add some additional day-one cost to the build-out of a chilled water system, and geographical location does have an impact on such a system (as seen in figure 5), but on average, Rittal has found that most systems pay for themselves in less than 3 years. The return on investment (ROI) of an economizing system can be calculated by determining the number of annual hours the system will be in operation, the energy savings when the system is in operation and the total cost of the energy saved during that time period.

Due to water-side economization's uncoupled approach to the cooling infrastructure, the risks associated with it are small. Additional controls are required to allow for the switch-over to the economization system, but failures should be minimal as the chilled water system provides a "safety net" to return to the standard operating mode if something were to ever go awry.

Air-side

The window of operation for air-side economization is highly dependent on the data center operator's allowable temperature and humidity variances in the data center space. These values are typically prescribed by ASHRAE, and have recently been expanded to allow for greater temperature variances.

In the past, data centers were operated with very low entering air temperatures to the servers, or leaving air temperatures from the cooling units. A typical set point might have been a 55°F desired temperature. Humidity was also very closely controlled, often striving for levels between 40-50% relative humidity. The ASHRAE standards of 2008/2009 greatly expanded this range, allowing for further increases in the operation of air-side economization systems. These changes allow for temperature variations between approximately 64-80°F, and relative humidity specified by dew point values of between 42-59°F, versus 68-77°F, and relative humidity values of between 40-55%.[2]

For the purposes of this paper, and to illustrate the impact of air-side economization in the data center, the same 6 cities used in figure 5 were chosen to illustrate the impact of these changes in ASHRAE's specifications. Dry bulb temperatures were allowed to drop below the minimum values, as it was felt that inlet temperatures could be boosted when required by re-circulating exhaust air from the servers to achieve the desired inlet air temperatures. For the sake of energy savings, any humidity values that exceeded or fell below ASHRAE specifications were not counted in the total economization hours value. Figure 6 demonstrates the effect of ASHRAE's changes.

Figure 6 shows that the impact of the ASHRAE standards is quite beneficial in all cases except the Phoenix area—due in part to the low number of hours either standard would allow for.

The impact of air-side economization on the data center may be larger than that for water-side economization. Switchover to the air-side economization could be achieved with controls no different than those required for water-side economization. It's true that the introduction of outside air directly into the data center space in large volumes increases the risk of contamination from the environment, but these risks can be mitigated by filtration if the user requires. Response to other

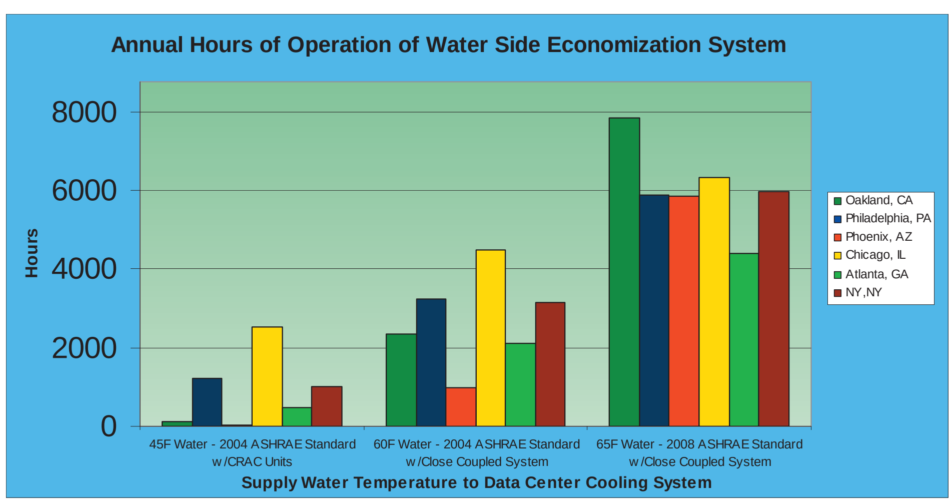
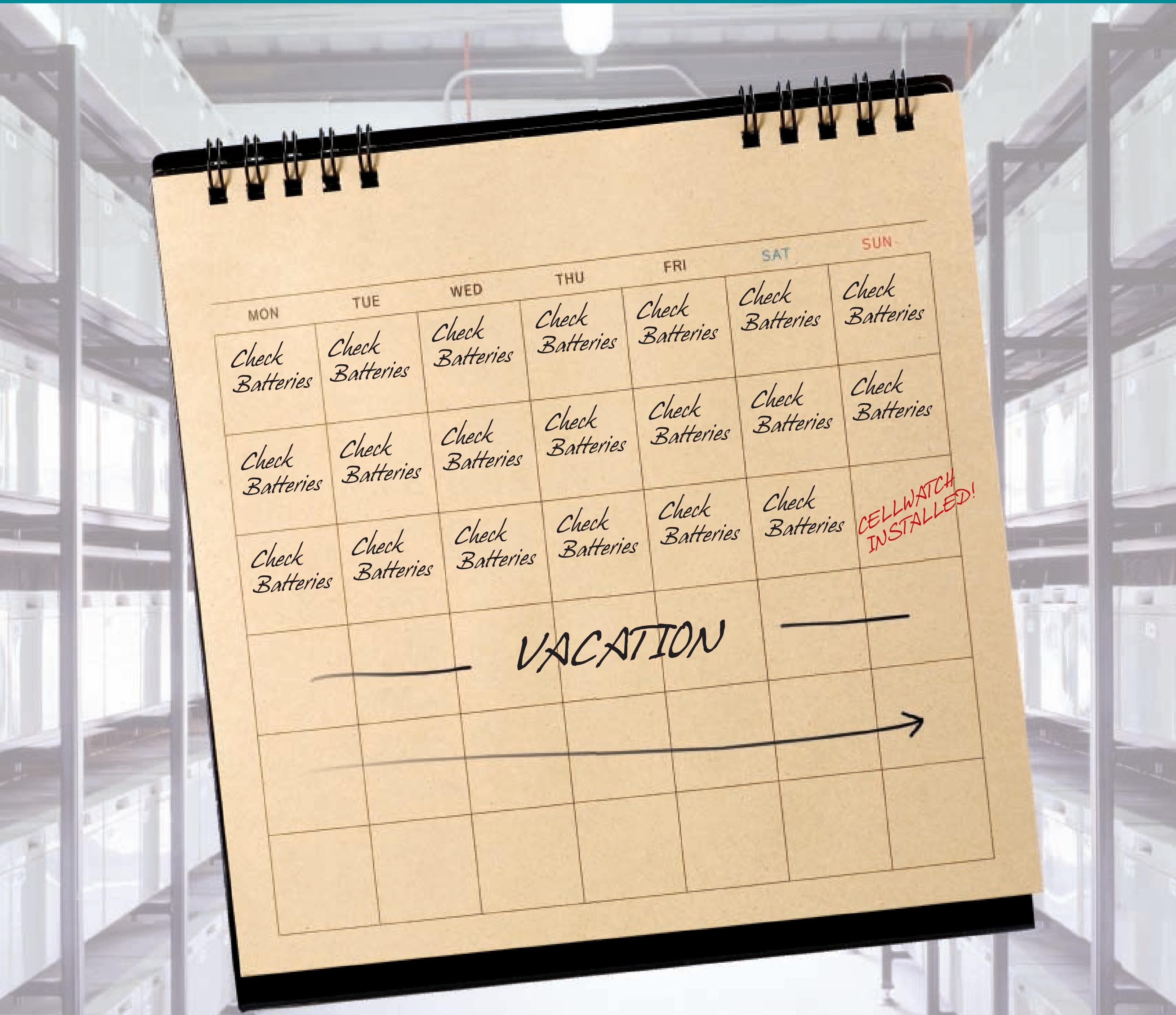


Figure 5: Impacted of increased supply water temperature on economizing system operation


MON
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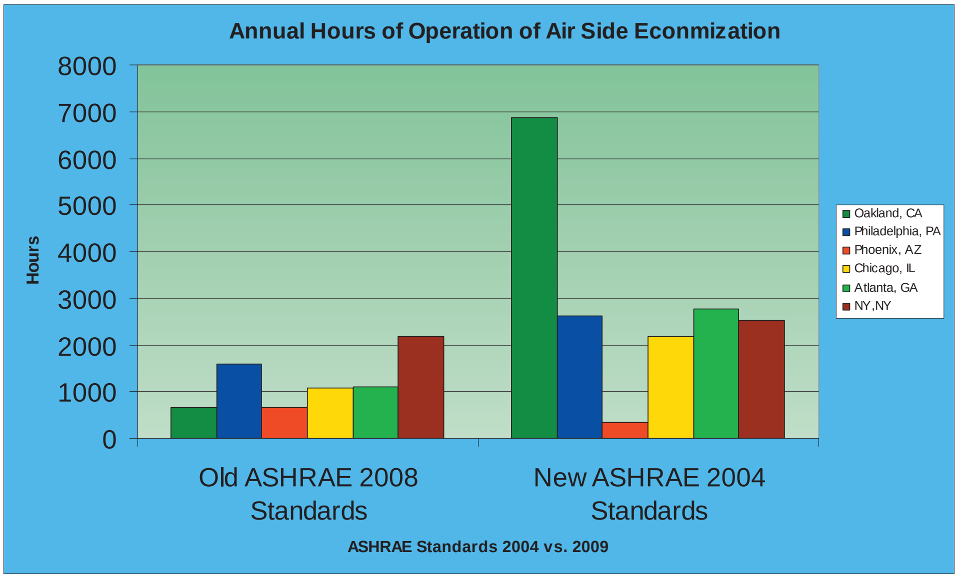

Figure 6: Impacted of new ASHRAE TC9.9 environmental values

environmental changes, such as fire, chemical or other hazards would require additional monitoring. Additionally, other factors such as air salinity or other unknown, and possibly difficult to remove pollutants, could impact server reliability. These limitations would require further investigation, however some existing studies of the reliability of data center hardware in non-data center environments suggest that servers are more capable of handling pollutants and other physical particulates than previously thought.[3]

CONCLUSION

Cooling system economization in the data center is highly dependent upon geographical location, but in many cases is a worthwhile pursuit to reduce energy consumption in the data center space. Proper evaluation of each approach requires a study of the location, as well as a full understanding of any possible risks associated with the method chosen.

Sources:

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3. Miller, Rich: *Data Center Knowledge, New from Microsoft: Data Centers In Tents*, Retrieved 5/28/2009 http://www.datacenterknowledge.com/archives/2008/09/22/new-from-microsoft-data-centers-in-tents/

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DATA CENTER CFD ANALYSIS

Stephen Smith

Modern companies rely heavily on computers for running core business applications, storing operational data, and communications. The central role of computing in the business world requires data centers of increasing density, complexity, and environmental space demands. High density data centers consume more energy and produce more heat than their predecessors and consequently need precise, well managed cooling.

Many data center designs utilize under floor air distribution with hot and cold aisles. Hot and cold aisles maximize equipment exposure to cooling and ensure that equipment receives proper cooling air at optimal conditions. Design guides for the construction and operation of data centers, such as ASHRAE's "Thermal Guidelines for Data Processing Environments," recommend maintaining a space temperature between 68 to 75ºF and 40 to 55% humidity. The typical cooling airflow design process is dependent on either the owner's stated requirements of size and power density or the server equipment manufacturer's recommendations.

Computer Room Air Conditioners (CRACs) are typically sized by mechanical engineers on the basis of required underfloor static pressure and estimated room equipment loads in watts per square foot. The mechanical engineer consults with the underfloor tile representative on the underfloor static pressure requirements to determine anticipated airflow delivery rates.

A potential complication arises from this design method where the data center does not contain uniform rack compositions. Differing equipment has differing heat generation rates and airflow requirements. Non-uniform airflow requirements result in potential over or under ventilation, with under ventilation being a particular concern over time. Several other issues arise from the initial server room design. Installed equipment in data centers inevitably change in type, size, power requirements, and rack configuration resulting in a change in the required cooling airflow quantity and delivery location.

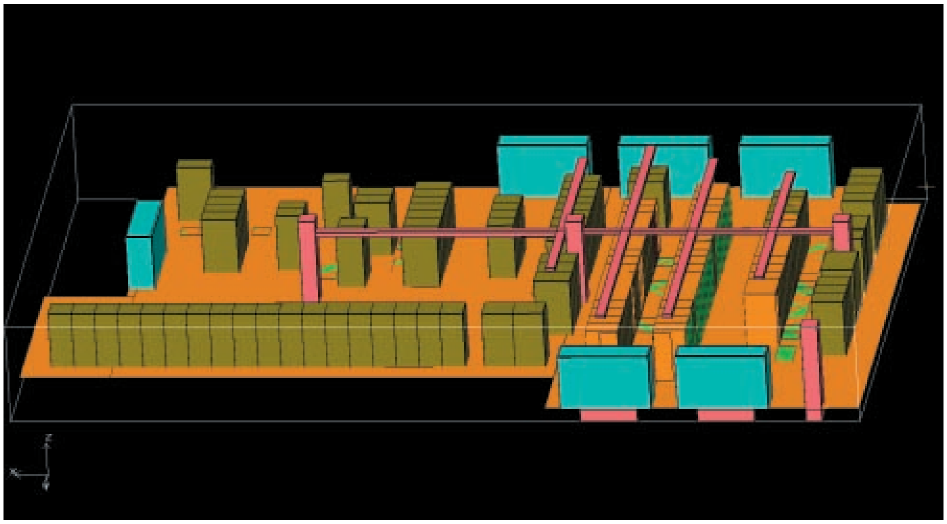
To address ventilation issues, either the number of floor tiles can be adjusted or Computational Fluid Dynamics (CFD) may be used. The problem with adjusting the number of floor tiles is the amount of static pressure available in the underfloor distribution system. If too many ventilation tiles are added to the underfloor air distribution system, pressurization will drop, resulting in less air velocity across the diffusers. Also, it is hard to estimate the air throw from the floor tiles interacting with all of the various system configurations. Too little air throw is a major concern.

A much more precise method is to use CFD analysis to predict airflows. CFD produces quantitative and visual examination of airflow paths as well as airflow characteristics of the data center as a whole. All potential influential interactions are taken into account during the modeling process.

Elm Engineering was involved in the redesign and commissioning of a large regional bank's data center. We utilized CFD to determine the optimal underfloor air distribution system layout in response to recently upgraded data processing equipment. The data center houses the bank's servers that manage the financial transactions for branch banks as well as customer online banking. Bad airflow design may result in the undesirable side effects of decreased equipment availability, wasted floor space, and inefficient cooling system operation. Inefficient cooling may lead to server under performance, or worse, downtime, affecting money, stock transfers and lost profits.

The CFD model was constructed with input from an on site survey and existing design drawings. Inventories of server rack components, location of air diffusers and cable trays, spot temperature readings for future model correlations, and CRAC unit set points were recorded for input. Thermal performance requirements of the rack components were verified with their respective manufacturers. Temperatures were measured and recorded at four equidistant locations on each rack and for each air diffuser. A CFD model was created based on existing conditions and the results were compared to the measured temperature readings from the site inspection and equipment performance specification sheets for correlation.

The correlation between the CFD model results and the measured point values was good. Results from



Constructed CFD Model

the base model suggested that additional ventilation tiles could be added to mitigate heat build up around the server racks. The next task was to evaluate the impact of additional ventilation tiles.

Locations of high temperature accumulation and stagnating airflow were identified as candidates for cooling airflow addition. Iterations of the CFD model with additional tiles were performed to investigate the effects on cooling supply as well as impacts on underfloor static pressure. The addition of ventilation tiles results in a pressure drop for the underfloor ventilation system and must be monitored so that overall ventilation tile airflow rate and throw is maintained at acceptable levels.

For the particular data center examined, the client was also concerned about the performance of the ventilation system if the electrical panels serving the CRAC units were to fail. This particular data center has six CRAC units; three in operation and three in standby. Additionally, all six CRAC units are on two electrical panels but are not split into groups based on operation status. The active units are not all on the same panel, nor are the standby units on one panel. This was done intentionally for redundancy purposes.

In addition to the floor tile placement CFD model iterations, parallel iterations were performed to examine, for each tile placement location, the effects of an electrical panel failure. A total of three modeling iterations were performed for each additional ventilation tile placement location: one iteration under design conditions and one iteration each simulating one of two panel board failures.

Examining all of the CFD modeling iterations enabled the owner and Elm Engineering to decide upon the addition of ten ventilation floor tiles to the underfloor air distribution system. Ten ventilation tiles were decided upon based on cooling and underfloor static pressure trade-offs as well as electrical panel failure performance.

One lesson learned through the modeling process is that the inclusion of a handheld air flow meter to measure floor tile diffuser air velocity yields an additional source of model validation. Although an airflow meter was not used in this case, the verification of modeling results with measured temperatures and equipment specification sheets yielded good correlation between the measured data and the modeling outputs.

Through the use of CFD in the redesign process of a datacenter, Elm Engineering was able to model, both visually and quantitatively, the internal space's response to increased server loads, aid in the design of the underfloor air distribution system and predict the cooling airflow in the event of an equipment failure.

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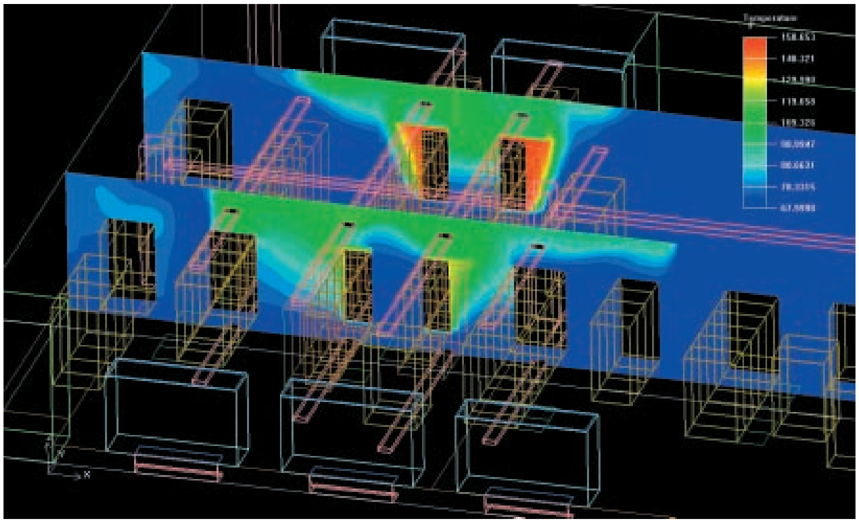
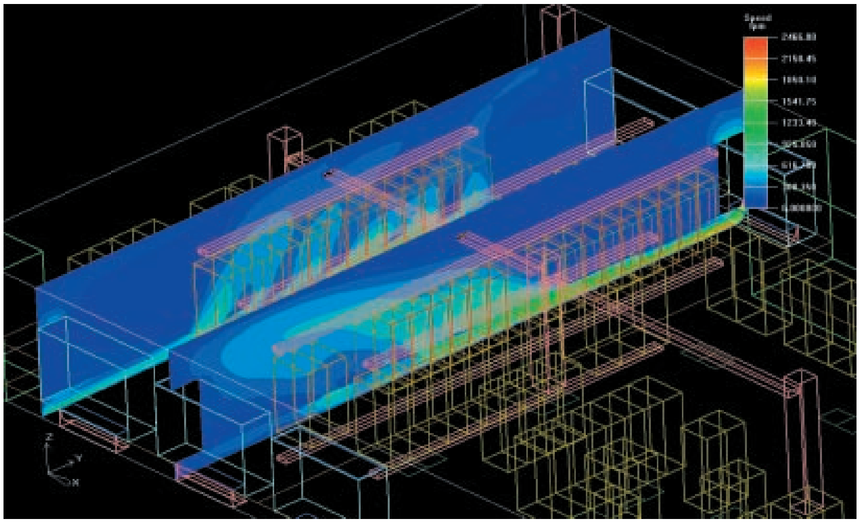
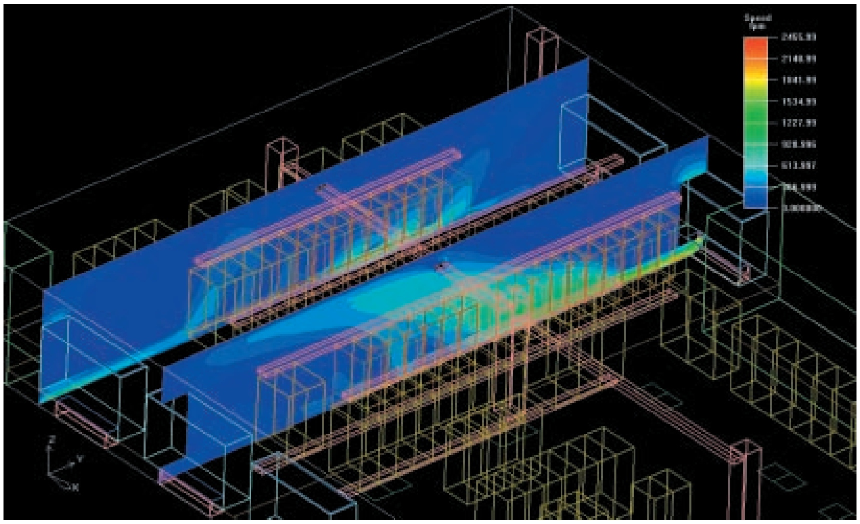


Existing Layout Temperature Distribution



Existing Layout Velocity Distribution



Velocity Distribution with 10 Additional Floor Tile Diffusers

Conferences


1989-2009
MISSION CONTROL
"ROADHOUSE RANCH
RODEO & BIKER BARBECUE"
7x24 Exchange
SPONSORED BY
ABB
ASCO
CHLORIDE
EATON
EDSA
EMERSON
PDI
SIEMENS
7x24 Exchange
The end-to-end reli
7x24 Exchange International
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Conferences


1989- 2009
7XChange
The Coral Reef
7XChange
reliability forum.
City WALK

Keeping Your Cool: GROOVED TECHNOLOGY AS A MEANS TO MORE EFFICIENT DATA CENTER CONSTRUCTION AND OPERATION

David Gibbons

For many years, air cooled systems provided sufficient cooling capacity for data centers; however, increased computing density produces more heat and, therefore, requires a more efficient cooling method. In larger data centers, the most cost effective method of cooling is a chilled water system. According to the Science of Aquatics, water is 4,000 times more efficient than air. This is why, in recent years, companies like IBM have developed methods for bringing cooling water directly into server racks.

In a chilled water system, chilled water is pumped out of the mechanical room and into computer room air handlers by way of under-floor water distribution lines. The air handler then removes heat and humidity by drawing warm air through coils filled with circulating chilled water. The water absorbs the heat from the air and circulates back to the chiller where the heat is transferred to a condenser water loop and eventually released through a cooling tower.

Hard piping utilizing carbon steel pipe or copper tubing is common in a chilled water system. Traditional pipe joining methods for hard piping systems consist of welding, brazing or flanging which generally work well in data centers; but, with increased loads, frequent changes, and system expansions, these joining methods have become problematic. Piping systems utilizing a welded, brazed or flanged joining method are not easily accessible, feature limited design flexibility, introduce fire hazards to the jobsite and require lengthy system shutdowns to perform routine or unplanned maintenance activities.

Grooved mechanical piping technology—a method of pipe joining that requires no flame—provides a reliable piping system that ensures efficiency in construction and operation of a data center by reducing deployment time, providing an easily adaptable system and reducing downtime during routine or unscheduled maintenance.

GROOVED PIPE JOINING TECHNOLOGY

In 1925, Victaulic designed the first grooved end pipe joining system for water and air service piping. Recognized for its design flexibility and speed of assembly, grooved end pipe joining technology transformed the piping industry, leading to dramatic gains in building construction productivity. That is why among HVAC specifying engineers, building owners and installation contractors around the world, grooved mechanical pipe joining is the preferred pipe joining solution for both new construction and retrofit.

The mechanical joint, or coupling, is comprised of four elements: the grooved pipe, the gasket, the coupling housings, and the nuts and bolts. The pipe groove is made by cold forming or machining a groove into the end of a pipe. The key section of the coupling housing engages the groove. The bolts and nuts are tightened with a socket wrench or impact wrench, which holds the housings together. In the installed state the coupling housings encase the gasket and engage the groove around the circumference of the pipe to create a triple seal unified joint that is enhanced when the system is pressurized.

INSTALLING A GROOVED MECHANICAL PIPING SYSTEM

The installation of the piping system using the grooved mechanical pipe joining method leads to significant on-site man hours savings. On average, field fabrication of a grooved system is up to 10 times faster than welding and six times faster than installing a field-fabricated flanged joint. The simplified assembly and installation leads to a reduction in project calendar days by as much as one half, optimizing labor risk management. The reduction in calendar days realized by installing a mechanical piping system gives owners the ability to meet, and even beat, compressed construction schedules and avoid liquidated damages.

By reducing on-site man hours and eliminating the risk of fire and release of noxious fumes, the installation of mechanical piping systems increases jobsite safety and decreases overall risk when compared with welding, brazing or soldering.

Most injuries on job sites occur via material handling, but the most significant risks—in terms of potential impact on people and businesses—are caused by fire and fume hazards. Mechanical pipe joining eliminates fire, open arcs, sparks, flames and toxic-fume hazards that are associated with welding, brazing, and soldering. Welding is associated with a number of potential health risks, as well as the risk of severe burns. By specifying a mechanical pipe joining system, an engineer reduces the owner's overall risks, especially those related to project schedule, costs and potential liability.

Depending on the type of project (e.g., new construction vs. expansion/retrofit), hazards may become a risk not only to construction workers, but also to the occupants of the structure and surrounding facilities. When someone is welding, to comply with mandatory safety regulations, all other work in the area must be postponed, leading to costly downtime and possible employee evacuation. Evacuations are beneficial to safeguard workers, but business realities lead to yet another potential danger: the pressure and rush to catch up from a shut down or loss in productivity, thus leading to an increased risk of injuries. Making wise decisions during new construction and specifying mechanical systems from the start helps to reduce downtime and alleviate the burdens often associated with future repairs, replacements, expansions and retrofits.

In addition to the elimination of flames and fumes associated with welding, the installation of mechanical piping systems increases safety by dramatically reducing the time and risk associated with re-work. Unlike the hard pipe joints of a welded spool, mechanical joints offer rotational allowance and can be easily oriented on site without potential health and safety risks. The rotational allowance of a flanged joint is determined by the incremental movement from bolt-hole to bolt-hole while the grooved system offers 360 degrees of rotational allowance for field flexibility.

Once installed, mechanical systems are easily inspected. Most grooved systems provide for quality control through visual confirmation of proper installation. When installers inspect the completed grooved joint, metal-to-metal bolt-pad contact confirms that the joint is properly and securely installed and no re-work is necessary. Similarly, flanged joints are visually inspected upon completion of the sequential bolting, however, the level of gasket compression for sealing is unknown because the specific bolt torque is unknown. Welding, on the other hand, often requires X-rays for quality inspection. Furthermore, in the case of a failed x-ray inspection, the time-consuming re-work increases facility downtime and reintroduces the risks associated with welding.

MAINTENANCE AND EXPANSION OF GROOVED MECHANICAL PIPING SYSTEMS

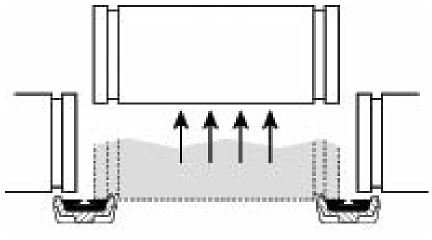
Over the operating life of a data center, a piping system requires three basic categories of maintenance: routine inspection and maintenance, physical changes or expansion, and unscheduled repairs. Because of its intrinsic design qualities, grooved mechanical pipe joining makes maintenance and system access easy, fast, and safe while minimizing downtime.

Grooved couplings provide a union at every joint, allowing for easy system access, maximum field flexibility for on-site decision making and flexibility for future system expansion. To access the system, a worker needs to de-pressurize the system and simply unscrews two nuts. No torches, saws, or welding machines are needed. Required maintenance, such as cleaning strainer baskets or replacing corrupt pipe sections or adding in a tee to expand or join piping systems, is then easily accomplished. To complete the job the gasket is re-installed, the coupling housings are placed back on the pipe or fitting and the bolts are tightened. Welded systems don't have unions; to repair the piping system, workers actually have to cut out the damaged pipe section, which causes operational concerns and safety hazards, particularly in exiting facilities and occupied spaces. Additionally, because grooved mechanical pipe joints can be installed on wet lines, there is no time required to let the system dry out.

In a traditional flanged system, multiple bolts are needed to create the seal, and removing these bolts is a time-consuming process. For example, when working with a 12-inch ANSI Class 150 flanged system, 12 bolts need to be removed to gain access to the system. These torqued bolts employ a very high compressive load on the gasket, which is required to form and maintain the seal. When the multiple bolts are removed and the flanges are pulled apart, the gasket will tear and therefore needs to be replaced.

With a mechanical coupling, the compression loads on the gasket are different than the flange. The gasket has a C-shaped cross section seal that is pressure responsive and designed to handle cyclical loading. Systems can be pressurized and depressurized repeatedly for many years without fatiguing the elastomer material. Once installed, these couplings do not require any routine or periodic maintenance and can be left in place for the life of the system.

Operating efficiency is maintained during retrofit work, and systems can remain live without interrupting cooling because properly placed butterfly valves installed using grooved couplings provide "dead-end" shutoff service for isolation allowing for easy system expansions or re-routing with little to no interference with existing operations. Expansion projects can be completed in occupied buildings without vacating the space because mechanical grooved piping does not release noxious fumes or introduce a fire hazard eliminating the need for hot-works permits or fire watch.



Exaggerated for clarity

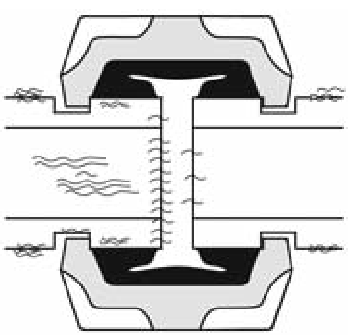
Grooved piping systems provide a union at every joint for ease of maintenance and future retrofits.

PROTECTING EQUIPMENT USING GROOVED MECHANICAL PIPING SYSTEMS

In addition to making maintenance fast and safe, a grooved mechanical pipe joining system accommodates movement and deflections within the piping system reducing the need for periodic product repair or replacement and maintaining the operational integrity of the piping system. Traditional welded or flanged piping systems have rubber bellows or a braided flexible hose to accommodate these movements; however, these materials often wear out over time requiring costly and time-consuming replacement.

Flexible mechanical systems are engineered to allow the pipe to move and vibrate within the coupling, therefore localizing vibrations generated by HVAC equipment and reducing the amount of noise transmitted down the pipe line. The elastomeric gasket, contained inside the internal cavity of the ductile iron housing, creates a discontinuity in the piping system which aids in isolating vibrations therefore, protecting vital cooling equipment within the piping system. Furthermore, the ductile iron housings and gasket material have vibration dampening qualities of their own, also serving to absorb vibrations. Testing has shown that systems utilizing three consecutive flexible couplings near a source of vibration will experience a similar level of noise dampening as those systems using specialty products. Additionally, the ability of grooved systems to accommodate system movement reduces loads at equipment connections and keeps vital cooling equipment operating at peak efficiency.

Nowhere is it more important to plan ahead for disasters than in a data center. According to The Uptime Institute, in 2001 a Tier III data center allocated 1.6 hours per year for IT downtime and only 0.4 hours of downtime in a Tier IV. Because the cooling system is vital to the operational integrity of the IT equipment, when the cooling systems goes down it is only a matter of minutes before the IT equipment begins to overheat.



Exaggerated for clarity

The flexible grooved-pipe couplings reduce the transmission of stresses through a piping system, while the gasket and ductile iron housing combine to dampen vibration.

Piping systems in earthquake prone areas will be exposed to forces and deflections beyond normal static conditions. These seismic forces can cause extensive damage when piping systems cannot accommodate these movements. Mechanically joined grooved systems can be designed so that the differential piping movement associated with a seismic event will be accommodated. The inherent deflection capability of the flexible grooved pipe coupling reduces transmission of stresses through piping systems. The deflection allowed by a flexible grooved-pipe coupling reduces the transmission of stresses through a piping system thereby minimizing potential system damage. As mentioned above, flexible and rigid couplings also provide discontinuity at each joint which helps minimize pipeline stresses generated during seismic movement.

Testing performed at the Real-Time Multi-directional Experimental Laboratory at the Center for Advanced Technology for Large Structural Systems at Lehigh University in Bethlehem, Pennsylvania; U.S.A proved the suitability of Victaulic grooved mechanical couplings to maintain operational integrity of piping systems during seismic events.

CONCLUSION

Owners, engineers and contractors are challenged to design, operate and maintain reliable and easily adaptable facilities that accommodate a revolving door of innovative technology. And while there are many construction and operational concerns to take into consideration, a data center's cooling strategy is vital to all business operations. For cooling strategies that include chilled water systems, grooved mechanical piping technology provides a reliable piping system that maximizes efficiency by reducing deployment time during new construction, reducing downtime during maintenance and/or system expansions and maintaining operational integrity of the piping system and equipment on a day–to-day basis and in the unfortunate event of a natural disaster.

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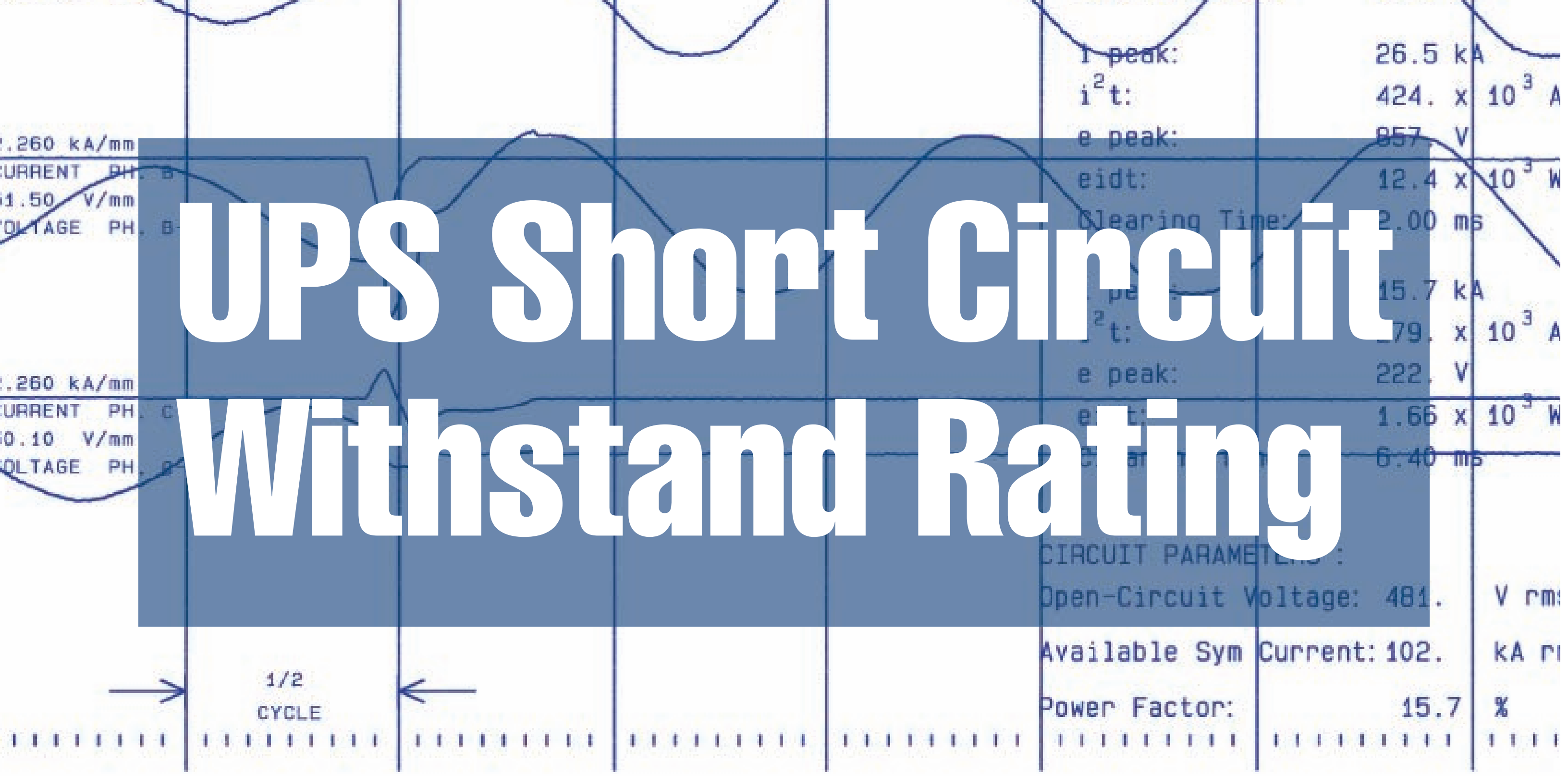

UPS Short Circuit Withstand Rating

William Vassallo • Lakshmi Prasad

INTRODUCTION EQUIPMENT DESIGN

Large UPS systems are often installed in close proximity to the power source in a facility, and are therefore more likely to be subjected to high fault currents than smaller UPS systems. Examples are large data center installations that frequently have a combination of upstream sources (transformers and/or generators) that could provide up to 100kA of fault current to the UPS input terminals during a short circuit event.

PURPOSE

The 2nd Edition of UL 1778 (standard for Uninterruptible Power Supply unit) addresses short circuiting of the UPS output, but does not specifically address "Short Circuit Withstand Ratings". UL issued a Bulletin to UL 1778 on July 5, 2000 regarding optional short circuit withstand rating tests. This paper defines the testing required to qualify specific UPS modules for installation in electrical systems with high available fault currents, using the criteria defined in UL 891 and UL 924 (as described in the July 5, 2000 Bulletin), and the results of specific testing on large General Electric UPS equipment.

For a given UPS to qualify for installation in an electrical system with 100kA available fault current, it must demonstrate the following, both during and after the testing:

1. No safety risk to personnel near the UPS
2. Minimum damage to UPS
3. Fast MTTR (mean time to repair) or quick restoration of UPS to service. This testing must be conducted with a source calibrated to provide 100kA of fault current into a bolted fault. It is understood that during a high-current fault event, the power to the downstream load will be interrupted.

APPLICABLE PRODUCT RATINGS

GE Digital Energy Power Quality has voluntarily qualified the below large UL Listed UPS systems to high fault currents to ensure safety and functionality during and after a fault event:

SG Series 400kVA, SG Series 500kVA & SG Series 750kVA

The UPS module (Fig. 1) is designed with an internal automatic bypass circuit, including an integral over current protective device. The purpose of this over current protective device is to protect the UPS internal bypass components (semiconductors, contactors, bus work etc.), as well as external input and output power wiring.

Both circuit breakers and fuses were investigated for use as the over current protective device for this application. A circuit breaker takes 2-3 cycles (30-50 milliseconds) to clear a fault, with no ability to limit peak let-through current. While circuit breakers are good at coordinating with other circuit breakers, this clearing time makes them almost impossible to coordinate with the semiconductors in the static switch, which require protection in 2-3 milliseconds. A properly selected current limiting fuse allows coordination of both peak let-through current and total clearing time. This allows the fuse's I2T rating to be accurately coordinated with the I2T rating of the semiconductors used in the static switch. Hence, a current limiting fuse was chosen for this application.

SELECTIVE COORDINATION

The most common location for a fault in a data center is on the secondary side of the downstream PDU's (power distribution unit). This is where there

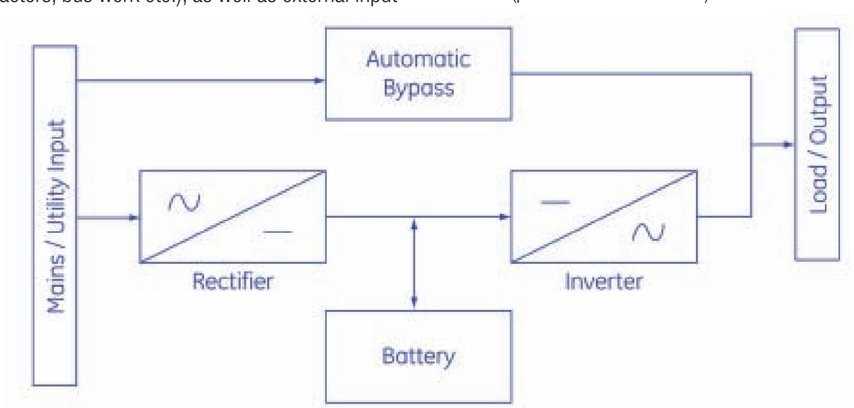

Fig. 1 – General UPS Configuration

are a large number of flex conduits under the raised floor, and the likelihood of an accidental short circuit is relatively high. For a typical PDU, the expected secondary fault current is about 8,000 amperes. This translates to a fault current of about 3,500 amperes on the primary (480V) side of the PDU transformer. This low level of fault current is easily coordinated with the current limiting fuse inside the UPS:

Single 400/500kVA UPS Module (1000A fuse) – will support 3500A for at about 2 seconds (Fig. 2)

Single 750kVA UPS Module (1800A fuse) – will support 3500A for at about 100 seconds (Fig. 3)

SYSTEM OPERATION

During normal operation the UPS operates from normal input power, with the inverter feeding the load precisely synthesized and controlled power. During an overload event the inverter will continue to power the load up to a maximum overload rating of 150%. Above this, the inverter will phase back to maintain the current within safe operating levels. This results in a drop in the inverter output voltage. As the voltage begins to drop, this drop is sensed and used to initiate a transfer to bypass.

A high-level fault (or short circuit) initially appears as an overload to the inverter. The difference is that the voltage drop is very fast. The UPS control circuits sense the rate of change of voltage (dv/dt) as well as the absolute voltage drop and use this information to initiate a transfer to bypass before the voltage drops appreciably. Once the fault has been transferred to bypass the internal fuses will limit and interrupt the fault current, protecting the static switch and other automatic bypass components.

TEST SOURCE CALIBRATION

The test source was calibrated to supply 100kA of fault current to the test equipment configuration, including all cables to the UPS module and the shorting breaker.

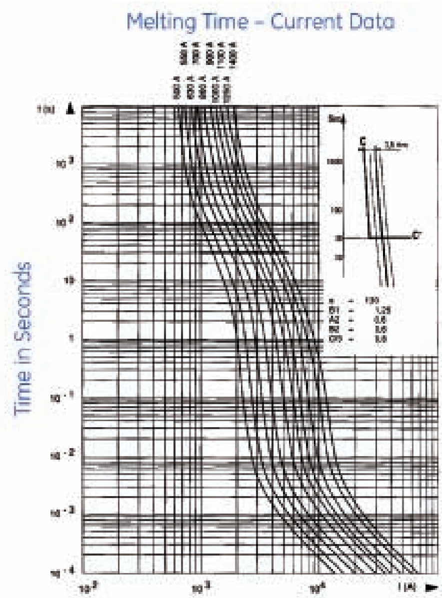

Fig. 2 – Fuse (400/500kVA) – 1000A

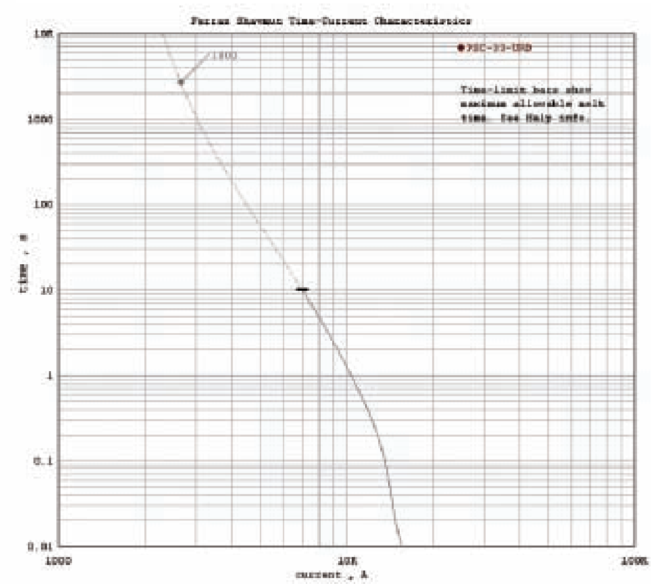

Fig. 3 – Fuse (750kVA) – 1800A

Current in Amperes Current in Amperes

This selective coordination ability is further enhanced when multiple UPS modules are paralleled (Fig. 4). In this case there are multiple fuses effectively paralleled, each one contributing to the overall short circuit capability of the system.

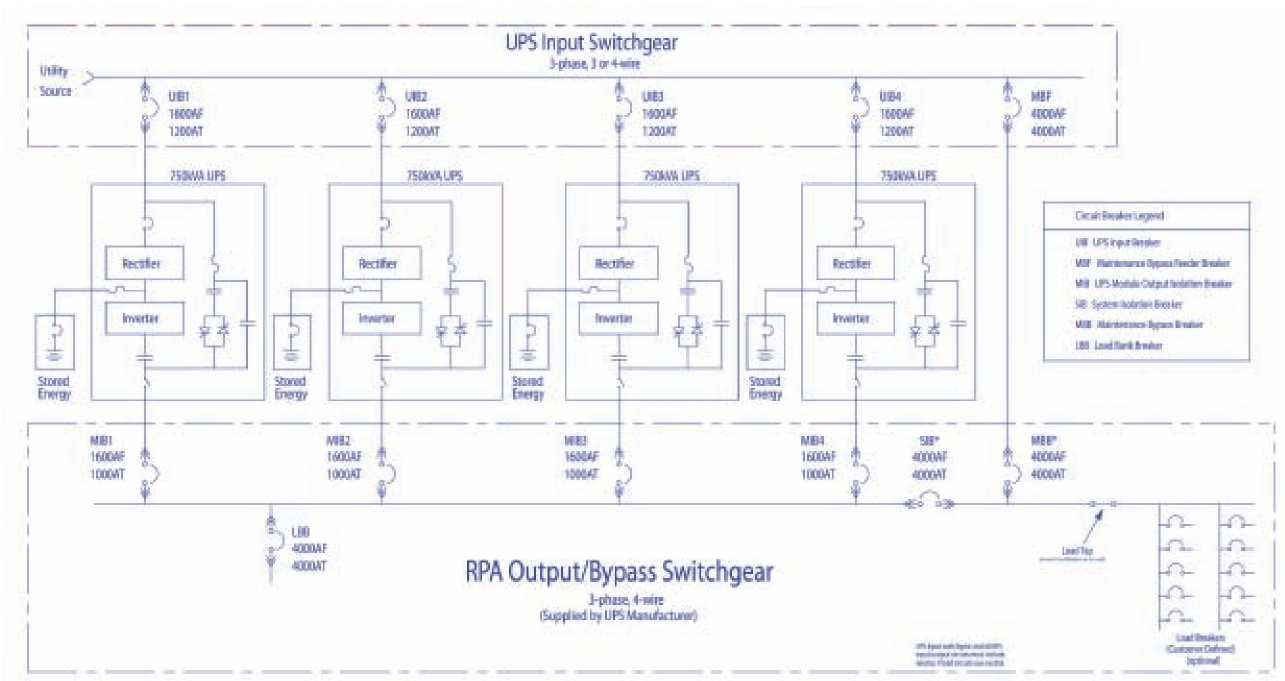

Fig. 4 – A Typical Large System Diagram

TEST CONNECTIONS

The UPS equipment was connected to the source and at the load with the recommended cables as designed for normal operation. A 30-ampere (enclosure ground fuse), non-delay-type cartridge fuse was connected from the UPS enclosure to Phase B of the test source. The purpose of this fuse is to verify there has been no electrical arcing to the UPS enclosure during the test.

TESTING SCOPE

The short-circuit withstand tests on both SG 500kVA and SG 750kVA UPS units were witnessed by UL.

TEST PROCEDURES

Short Circuit Withstand Test (from UL 891)

The Short Circuit Withstand Test is to be conducted at the rated voltage corresponding to the maximum short-circuit rating of the equipment. The test circuit is to be closed on the equipment with all switches, output-circuit protective devices, and all the main overcurrent-protective devices or short-circuit current limiters, integral or separate, in the fully closed position. For magnetically operated devices, the magnet is to be held closed electrically. If the enclosure is provided with a door or cover, it is to be closed during the test

Following the Short-Circuit-Withstand Test, the equipment shall comply with UL 1778 Paragraph 47, the Dielectric Voltage-Withstand Test.

The Short Circuit Withstand Test is initiated by energizing the UPS and then closing the shorting breaker on the output of the UPS. The breaker is closed after the UPS has stabilized in normal operation.

Short Circuit Closing Withstand Test (from UL 891)

The Short Circuit Closing Withstand Test is to be conducted at the rated short circuit current corresponding to the maximum rated voltage of the equipment. The sample may be a previously untested sample or the one used for the Short Circuit Withstand Test described above. The test procedures and conditions are to be identical to those for the Short Circuit Withstand Test. With all circuit breakers connected into the test circuit and with the main overcurrent-protective device, integral or separate, in the fully closed position, each switching device of the equipment is to be closed on the test circuit.

Following the Short-Circuit-Closing-Withstand Test, the equipment shall comply with UL 1778 Paragraph 47, the Dielectric Voltage-Withstand Test.

The Short Circuit Closing Withstand Test is initiated by closing the shorting breaker on the output of the UPS module prior to energizing the UPS. After the breaker is closed, power is applied to the UPS input and the UPS is allowed to power-up into the short circuit.

Qualification Requirements (from UL 891)

After the equipment has been tested under any of the short circuit conditions described, the results are acceptable if the equipment is effectively in the same mechanical condition as prior to the test, and if:

a) There is no permanent distortion or displacement of a bus bar or strap that would reduce an electrical spacing to less than 75 percent of its original values.

b) A bus bar insulator or support or cable restraint has not separated into two or more pieces. Also there shall be no cracks appearing on opposite sides of a base and no cracks, including surface cracks, running the full length or width of the support. Other cracks, chips, or the like, which are not considered to reduce the structural integrity of the support may be used if the resulting spacings are not reduced to less than 75 percent of it original values.

c) The enclosure ground fuse has not opened.

d) The enclosure or part of the enclosure such as a filler plate, door, or the like, has not been damaged nor displaced to the extent that a live part is accessible per UL 1778 Paragraph 7 Protection of Users and/or 39 Protection of Service Personnel.

e) No conductor pulls out of a terminal connector, and there is no damage to the conductor insulation or to the conductor.

f) Complies with the Dielectric Withstand Test.

TEST RESULTS

Short Circuit Withstand Test

This test was conducted at 480VAC using a source calibrated to provide 100kA to the test configuration (Fig. 5). The test circuit was closed on the UPS with all switches, protective devices and/or short-circuit current limiters, in fully closed position. All enclosure doors and covers were closed during the test. Immediately following the Short Circuit Withstand Test, the UPS equipment was verified to comply with UL 1778 Paragraph 47, Dielectric Voltage-Withstand Test. The current limiting fuses were then replaced, and the UPS was verified to be fully functional.

Short Circuit Closing Withstand Test

This test was conducted at 480VAC using a source calibrated to provide 100kA to the test configuration (Fig. 5). The test UPS was previously used for the Short Circuit Withstand Test described above. The test procedures and conditions were identical to those for the Short Circuit Withstand Test. With all circuit breakers connected into the test circuit and with the main over current-protective device in the fully closed position, each switching device of the UPS was closed on the test circuit. Immediately following the Short Circuit Closing Withstand Test, the UPS equipment was verified to comply with UL 1778 Paragraph 47, Dielectric Voltage-Withstand Test. The current limiting fuses were then replaced, and the UPS was verified to be fully functional.

In all cases, the tested General Electric UPS systems were returned to operational condition by replacement of the current limiting fuses. There was no permanent distortion, displacement or cracking of mechanical components, and no reduction in electrical spacing or degradation to insulation systems.

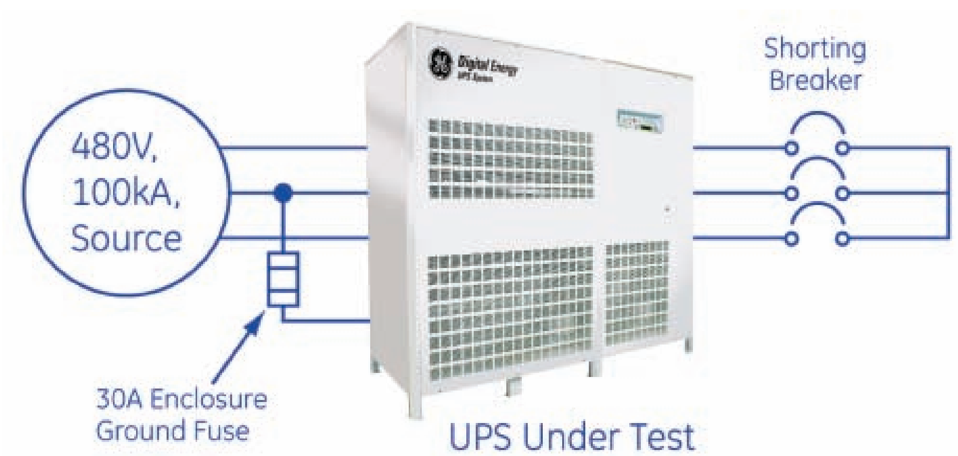

Fig. 5 – Test Circuit

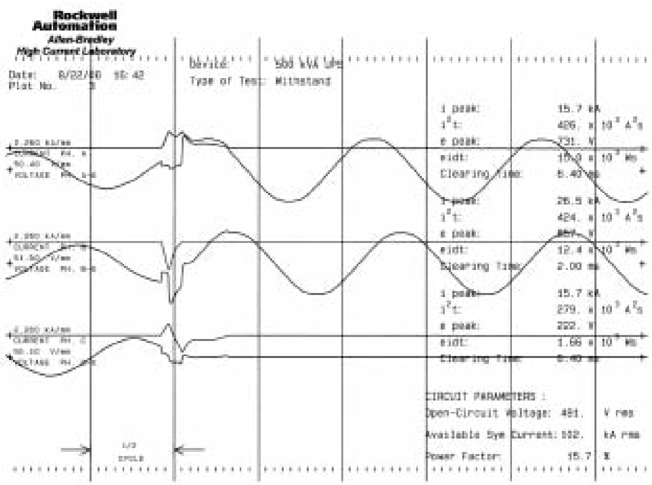

Fig. 6 – SG500kVA UPS Withstand Test

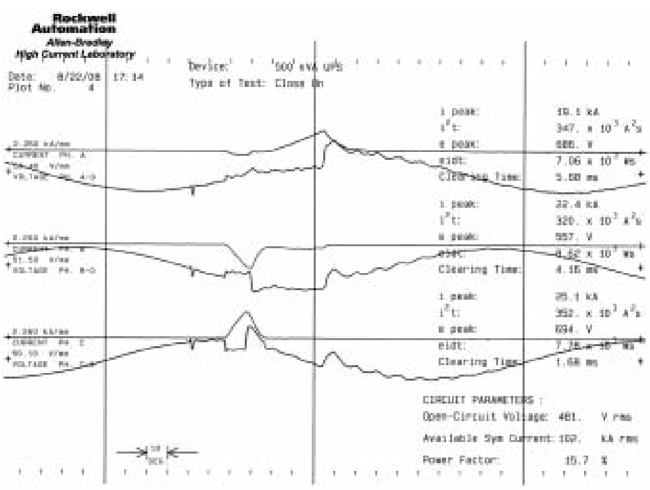

Fig. 7 – SG500kVA Close on Test

Fig. 6 and Fig. 7 capture the voltage and currents during the withstand and close on tests.

While the test source supplied 100kA through the UPS, the current was limited from 15-25kA because of the current limiting action of the fuses.

Even though the static switch is designed to withstand a bolted fault and is fully operational after replacement of the current limiting fuses, it is recommended that the semiconductors in the static switch be replaced at the next planned maintenance event. It is also advisable to inspect, clean and (if required) replace K6 (back-feed prevention contactor).

CONCLUSION

The extreme electromagnetic forces created by a high-level fault are capable of bending/deforming metal and destroying insulators. The only way to verify a UPS has been properly designed to withstand these forces is through testing. It is the user's responsibility to demand UL Certification that the UPS has been designed and tested to withstand these forces without suffering undue damage and without creating a danger to personnel.

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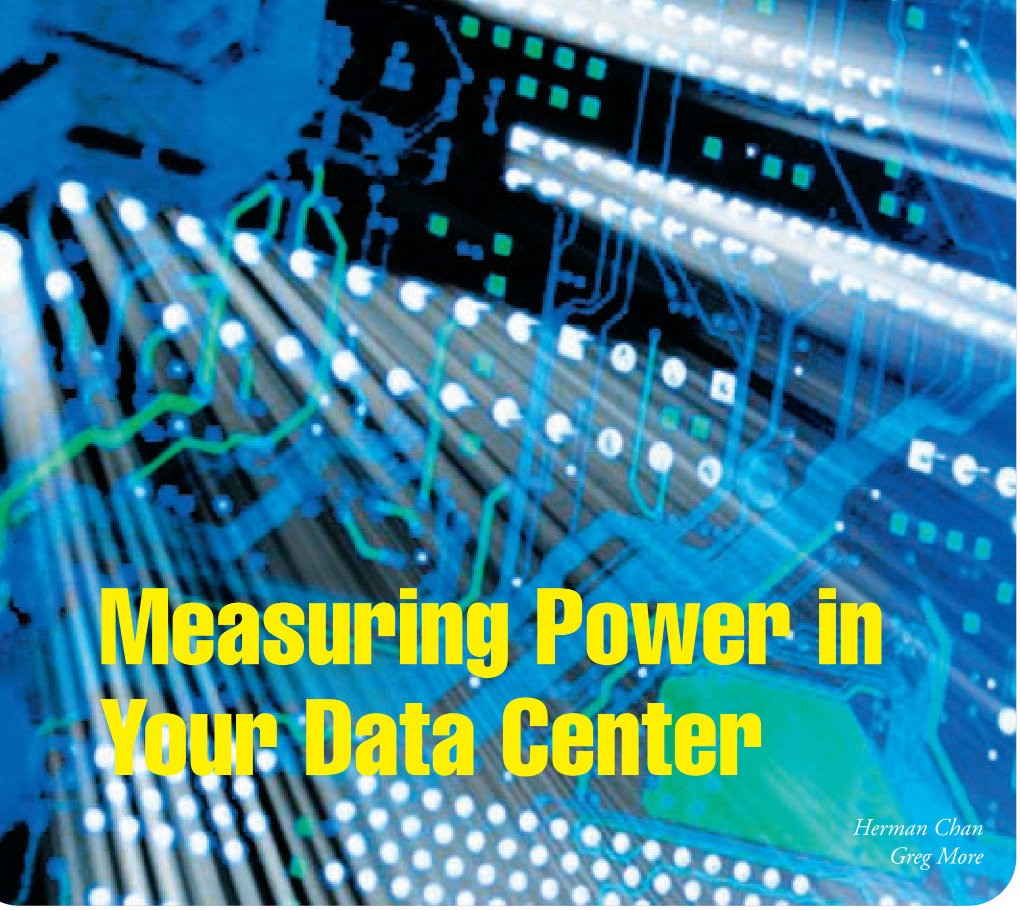

Measuring Power in Your Data Center

Herman Chan
Greg More

Typically, data center managers have not worried about power consumption, but this is quickly changing as 1) additional power is often not available, 2) the cost of power is becoming a significant cost of operating a data center and 3) companies are placing a higher value on green initiatives.

Based on the simple premise that "you can't manage what you can't measure" data centers are undertaking steps to measure device-level power consumption. No longer do rule-of-thumb estimates suffice – because they can turn out to be just plain wrong, leading to unnecessary and sometimes quite substantial costs. Devices that were thought to be consuming very little power may be consuming quite a lot, even while simply sitting idle doing no useful work.

The first step is to baseline current power consumption. Ideally, this will be done in a way that provides useful statistics to be compared over time. Early measurements and estimates may be rough, but can be refined as the power deployment inside and outside the data center is better understood and as the measurement quality improves.

There are many ways to manage power consumption in a data center but without some baseline measurements it is difficult to know where to start or what efforts will have the greatest impact. Also, without baseline measurements it is impossible to show management past levels of consumption and how you have improved.

EFFICIENCY METRICS

An efficiency metric receiving a lot of attention is the power usage effectiveness (PUE). It is the ratio of the total energy used by a data center, including IT equipment, and the energy consumed by the IT equipment only. The total energy includes lighting, cooling and air movement equipment and inefficiencies in electricity distribution within the data center. The IT equipment portion is that equipment which performs computational tasks.

$$\text{PUE} = \frac{\text{TOTAL FACILITY POWER}}{\text{IT EQUIPMENT POWER}}$$

A data center which only supplies power to IT equipment would have a PUE = 1.0 because the numerator and denominator would both be IT equipment power. This is obviously not a realistic situation. Even in a lights-out data center power will be consumed to provide cooling and air movement and there will be electrical distribution inefficiencies. DCiE is simply the inverse of PUE and won't be covered here.

$$\text{PUE} = \begin{matrix}\text{(FACILITY EFFICIENCY)} \\ \text{X} \\ \text{(IT ASSET EFFICIENCY)}\end{matrix}$$

Corporate average data center efficiency (CADE) takes into account the energy efficiency of facilities, their utilization rates and the level of utilization of servers.

- Facility Efficiency = Energy delivered to IT / energy drawn from utilities
- IT Asset Efficiency = Average CPU utilization across all servers, often a small percentage such as 5 percent, until efficiency efforts like virtualization are undertaken.

WHERE AND HOW TO MEASURE — THE CHOICES

In a data center there are several locations where power can be measured. Moving from the coarsest measurement to the most detailed the first is the power entering the data center. If the data center is a stand-alone structure this is simply the power feed from the utility. This would be the total power number in the numerator of a PUE calculation.

Very often it's not this easy. The data center may be a floor in a building in which case a submeter for that floor or room should be installed. This submeter would record the total power number provided the data center doesn't share power or building facilities such as cooling equipment. If facilities and power are shared, which is often the case particularly in urban data centers, then work will need to be done to at least get an estimate of the total power consumption of the data center, possibly from several different sources, e.g., the submeter measuring the feed into the data center plus some percentage of the power used by the building cooling equipment.

The next place where power is often measured is at the UPS. If it only provides power to IT equipment then this data can be used as an approximation for the denominator of a PUE calculation. However, this is only an approximation because the power inefficiencies of the UPS itself should not be part of the IT equipment power. The UPS may also provide power to rack-based cooling equipment.

A third place to measure power is at the rack itself with metered rack PDUs. These figures are generally considered to represent the IT equipment, aggregated to a rack, unless there are fans or rack-side cooling units.

A fourth place to measure power is at the individual outlets of a rack PDU. These intelligent PDUs also typically provide aggregated rack power consumption as well. Monitoring the power at the outlet level ensures that IT equipment power consumption can be uniquely identified for a PUE calculation. By providing power information at the individual device level, specific actions can be taken to improve efficiency.

The fifth place to measure power is at the CPU. This gives the purest measurement of what power is actually going into doing purely computational work. In practice, this is not widely used today. In terms of taking actual energy conservation actions, the CPU level is not very useful since, in most cases, an entire device, blade or other piece of IT equipment is what data center staff can change or decommission, not a CPU. The most typical approaches to measuring power consumption in a data center are metered rack PDUs and intelligent rack PDUs that monitor individual outlets.

WHAT TO DO WITH THE DATA GATHERED

Depending on the measurement locations and method of measurement chosen, various energy efficiency initiatives may be taken. Individual outlet-level metering is recommended for IT equipment because if provides useful, actionable information.

Monitoring the power consumed at a rack allows data center managers to determine if their original power allocations make sense today. Quite often, power is allocated to IT equipment on the basis of nameplate ratings which are conservatively high. Even when a percentage, say 70 percent, of nameplate power is used power is often over allocated. This means more power is going to an IT equipment rack than what will actually be consumed. This “stranded power” could be deployed elsewhere but how do you know you’re not leaving the rack vulnerable to running out of power in a peak load situation?

Monitor each individual device at regular intervals, the shorter the better, to ensure that no peak periods are overlooked. With individual device power consumption figures it is possible to set up racks such that equipment power consumption patterns compliment each other and thus more IT equipment can be supported with the same amount of power. If a rack is close to consuming all the power allocated to it, and therefore at risk of tripping a breaker, having individual IT equipment power consumption data allows IT staff to remove equipment in a logical manner so as to minimize the risk of a breaker tripping while maintaining useful loading levels.

Through tests in its own data center, Raritan determined that rules-of-thumb percentages of nameplate ratings simply don’t work. Across 59 servers, 15 had average power consumption of 20 percent or less, 29 had 21 to 40 percent, 9 had 41 to 60 percent, 4 had 61 to 80 percent and 2 had 81 percent or more. Even at peak power consumption 49 of the servers were 60 percent or less of their nameplate rating. Many data center planners use 70 percent of nameplate which means there is a lot of stranded power in many data centers.

On the other hand, at peak power consumption 5 of the 59 servers were at 81 percent or more of nameplate and therefore at risk of shutting down. The message is that in terms of power consumption, it is important to know what is going on at the individual device, not some aggregated average which may mask problems both on the high and low side.

ENVIRONMENTAL SENSORS: THEIR IMPACT ON POWER AND COOLING EFFICIENCY

Environmental sensors make an important contribution to power efficiency. It is common for cooling to consume 30 percent or more of a data center’s total power. IT equipment vendors provide inlet temperature specifications. As long as the inlet temperature is within the specification the server will perform fine. These specifications are often substantially higher than what is typically provided in data center cold aisles. Thus, the temperature can often be turned up which leads to less power

consumption by the cooling equipment.

Temperature sensors should be placed at the bottom, middle and top third of racks on the cool air inlet side. Cooling IT equipment to temperatures lower than required consumes a lot of power without any beneficial effects. Due to a lack of at-the-rack instrumentation, data center managers often overcool to be confident IT equipment won't fail.

NEW TECHNOLOGIES AVAILABLE

Taking an individual snapshot of power consumption at one point in time is not sufficient. IT devices may consume a lot less power at 2 a.m. than they do at 8 a.m. and may hit peak power consumption at 4 p.m. on Thursday. Power consumption can also vary by time of year such as online sales during December.

There are hardware devices that can take snapshots of power consumption at user defined intervals as often as once every few seconds. Software programs are available to turn these data points into calculations of power usage where the unit of measure is kilowatt hours (kwh). Sophisticated tools can calculate carbon footprints based on energy usage. With actual individual device information data center staff can know the biggest contributors to carbon generation and therefore what needs to be most closely managed.

WHAT TO LOOK FOR IN POWER MEASUREMENT

Accurate: As carbon caps, credits and trading are adopted, accuracy becomes important. +/- 5 percent accuracy, assuming perfect sine waves which rarely occur in the real world, may be acceptable to determine if a rack is operating with about a 25 percent margin before circuit breakers trip. It is not acceptable when dealing with regulations and carbon credits to be verified and traded on exchanges. Nor is it accurate enough for billing or charge backs.

Open and interoperable: Many data centers have deployed an IT management system. To tie such a system to power measurement look for open standards for integration and interoperability with existing equipment. Ease of use is a key consideration so power management does not become a time-consuming project for already busy IT staff.

Secure: Power is the life blood of data centers. It is important that access to the power management system be secure. Look for systems with high levels of encryption such as 256-bit AES and the ability to set authentication, authorization and permissions.

Raritan hopes that this article has helped you to outline a plan to deal with power consumption in your data center. That plan should begin with a program to gather information to establish some baselines. Collecting data now, and taking a stab at data center metrics such as a PUE calculation, will put you on a path to more efficiently manage power and power costs.

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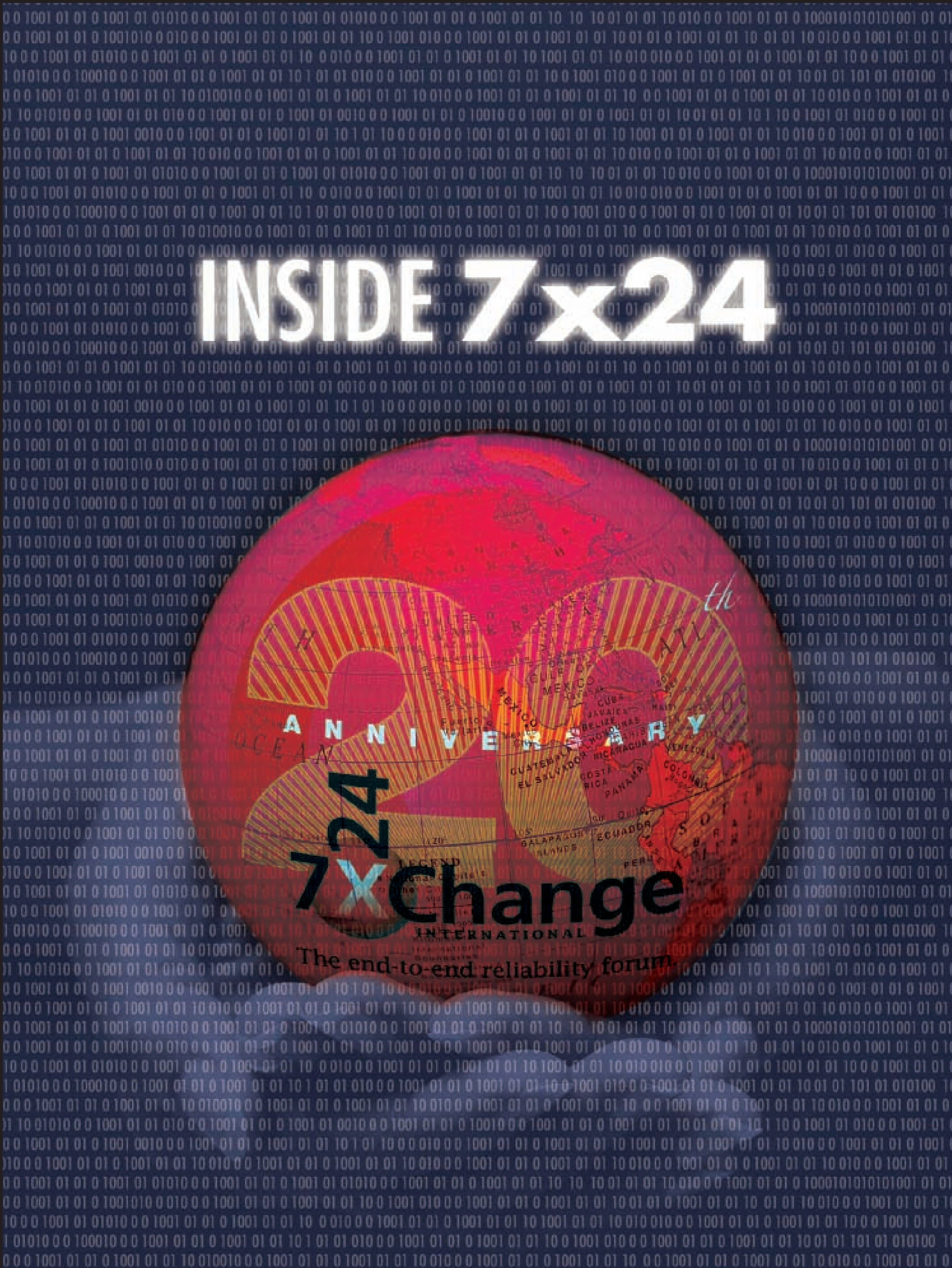

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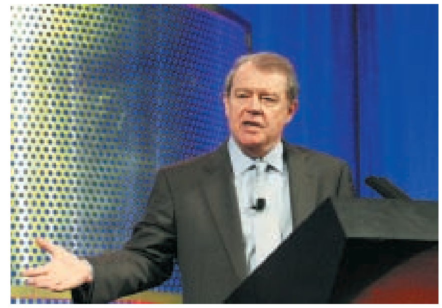
2009 FALL CONFERENCE HIGHLIGHTS

The Fall Conference themed **"End-to-End Reliability: The Changing Landscape of Data Centers"** will be held November 15-18 at the JW Marriott Desert Ridge in Phoenix, Arizona. The Fall Conference will feature compelling keynotes, Sunday workshops, concurrent breakout sessions, sessions on energy efficiency, cooling, cloud computing, and the changing landscape of data centers, a spectacular vendor event, and more...

Kirk S. Lippold, Commander of the USS Cole will kick off the conference with a session entitled **"Leadership and Accountability When It Matters"**. In addition, a panel of recognized industry leaders from SUN, Verari, IBM and HP moderated by Brandon Lorenz, of Building & Operating Management Magazine entitled "The Changing Landscape of Cooling: Air vs. Liquid" will share their views on the topic and discuss the pros and cons of air vs. liquid cooling solutions. Steven Sams of IBM will deliver a session entitled 'Achieving Data Center Availability and Energy Efficiency " on Tuesday morning. Don Beaty of DLB Associates, will close the conference with a keynote entitled "Global Economic Impact on Data Centers". In keeping with the theme, additional presentations on the changing landscape of data centers will be delivered with topics such as:

- The Changing Landscape of Cooling: Air vs. Liquid
- Cloud Computing and the Data Center Transformation
- EPA – Energy Efficiency Opportunities and Updates for the Data Center
- BOM Magazine – Impact of the Cap and Trade Legislation on Data Center Operators
- MTechnology – The Future of Data Centers
- Data Center Pulse – Readout & Stack Panel Discussion
- Tough Economic Times Deliver Aggressive Bidding Environment – A Medium-Density Data Center for the State of Tennessee, Designed for Flexibility and Growth
- Intentional Electromagnetic Interference – The New Remediated Threat, an End to End Solution: "Zap, What Happened to My Data?"



Stuart Varney, Business and Financial Journalist for Fox news kicked off the 2009 Spring Conference with a presentation entitled "The Economy in the Age of Obama".

In addition to enhanced programming *7x24 Exchange* International presents **Punt, Pass and Kick** at the Phoenix Stadium with *7x24 Exchange*! The University of Phoenix Stadium, with its retractable roof & field, is unlike any other stadium in North America and a marvel of design, engineering, and technology. The stadium opened in August of 2006. and is home to the NFL's Arizona Cardinals, as well as the annual Tostitos Fiesta Bowl, the newly created BCS National Championship game, concerts, trade/consumer shows, corporate events and special occasions of all kinds.

The exterior skin represents a barrel cactus. The interior building features alternating sections of shimmering metal panels intended to reflect the shifting desert light alongside magnificent vertical glass slots allowing patrons a spectacular view of the horizon from any level of the exterior. There are 21 vertical slots on the exterior wall of the stadium.

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For the complete Fall Conference program and registration information please visit 7x24exchange.org or call (646) 486-3818.

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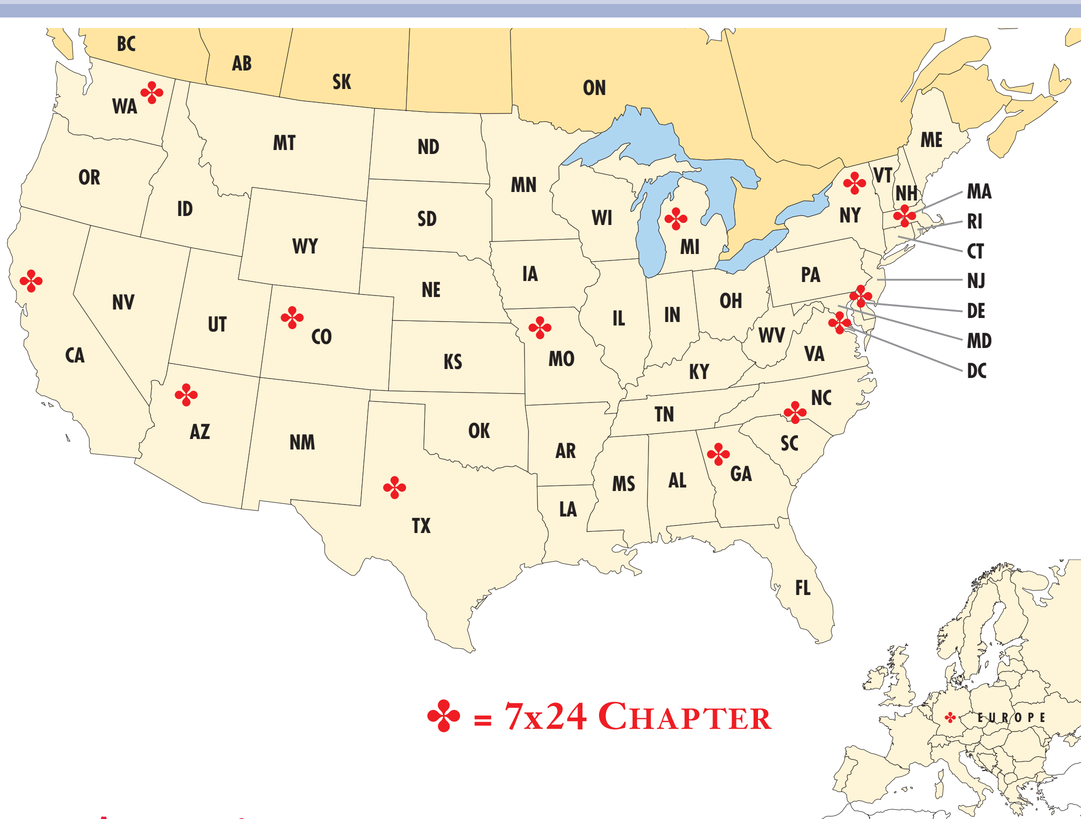

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