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7X24 Exchange INTERNATIONAL

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Carly Fiorina
2013 FALL CONFERENCE
KEYNOTE SPEAKER

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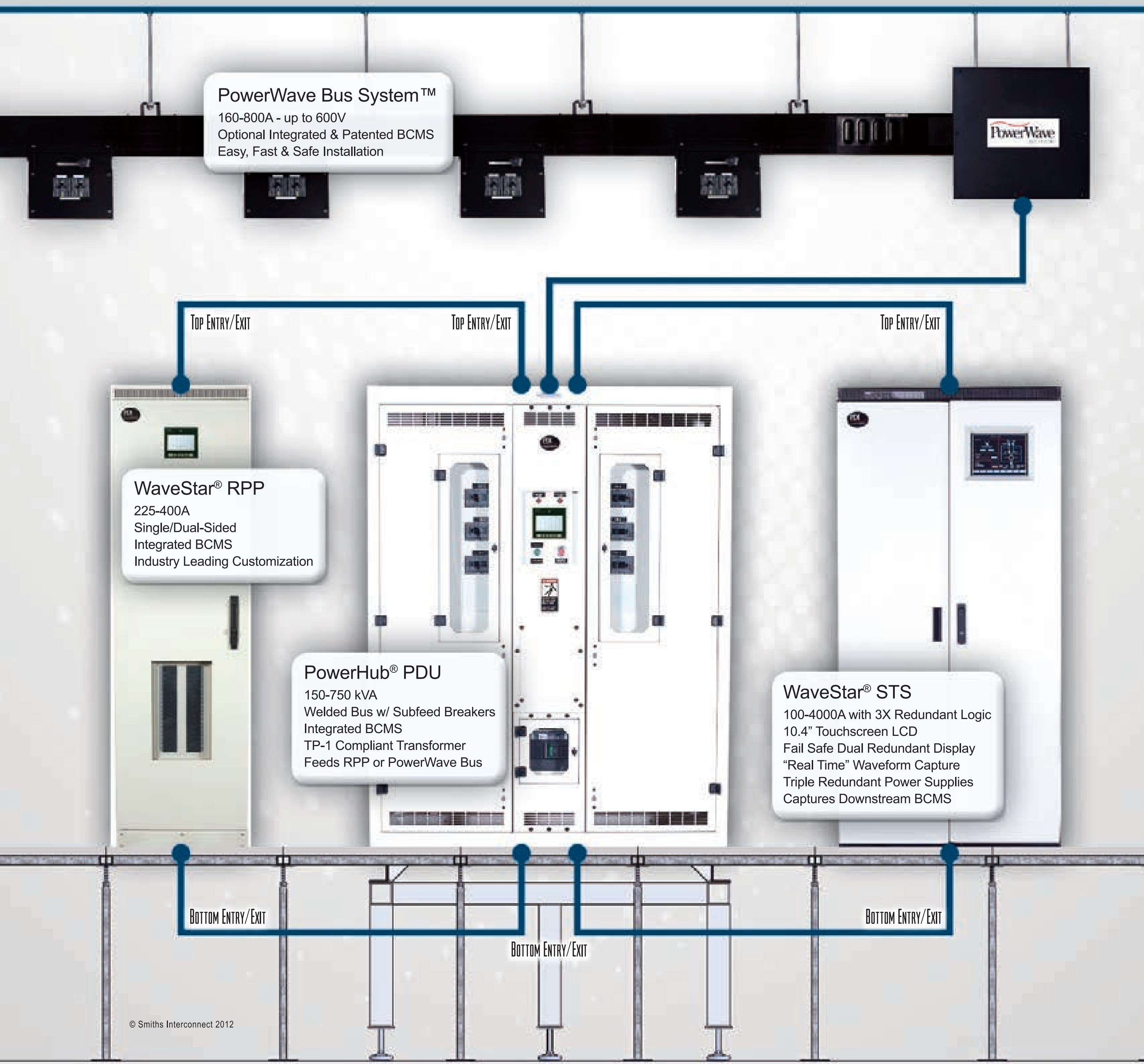
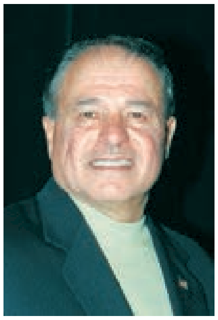


CONTENTS

CHAIRMAN'S LETTER



Robert J. Cassiliano

As summer comes to an end we welcome the fall season with all its' bright and beautiful colors!

This summer we mourned the passing of Ken Brill. Ken was a visionary and a leader whose impact was global in scope. He founded the Uptime Institute, Upsite Technologies, and was a co-founder of the 7x24 Exchange. The 7x24 Exchange and the Uptime Institute are the prominent forums in the Mission Critical Industry, an amazing accomplishment. Ken's focus on data center reliability and resiliency was unrelenting as was his passion for energy efficiency in more recent times. Whether the hot topic of the day was harmonics, watts per square foot, high density cooling, or energy efficiency Ken led the conversation, energized and mobilized resources, and most importantly turned vision into action. This past Memorial Day I was pleased when I received a call from Ken. It reminded me of days gone by when Ken would call my home on Sundays to discuss issues of the day when we served together on the board of the Uninterruptible Uptime Users Group (today the 7x24 Exchange). At the 7x24 Exchange 2013 Spring Conference in Boca Raton, Florida I had the honor and privilege to present the first 7x24 Exchange International Lifetime Achievement Award to Ken for his significant and demonstrable accomplishments and contributions to the Mission Critical Industry. In addition, donations of $5,000.00 each were given to the National Science Foundation and the ACE Mentoring Program in Ken's name. Ken will be missed, however his legacy lives on in the work he performed, the young professionals he mentored, and his industry colleagues. Ken's greatest love was his family, his wife Margot, son Jonathan and his life partner Rebecca, daughter Lora and husband Lee and Grandchildren Riley and Lauren. On a personal note Ken was a friend, a mentor, and a colleague and I thank him for all he has given me.

Lifetime Achievement Award – Kenneth G. Brill

Bob and Ken

The theme for the 2013 7x24 Exchange Fall Conference being held at the JW Marriott San Antonio Hill Country in San Antonio, Texas November 17 – 20, 2013 is End to End Reliability: "Turning Vision into Action". Conference highlights are as follows:

- Welcome Reception
- Sunday Tutorials on IEEE Std. 3006.7-2013 and Electrical Safety
- Conference Keynote: "What it Takes to Stay Competitive: Sparking Innovation for Business and Economic Growth" by Carly Fiorina – Former Chairman and CEO of Hewlett Packard
- Keynotes by Facebook and Raging Wire/Schneider Electric
- Panel on The Power of Data in Data Center Operations – Digital Realty/MTechnology/Sabey Data Centers/Uptime Institute
- Monday evening: "Marquis Plus+ Partners Showcase"
- Presentations by Caterpillar, EMC, Fidelity, GE, IBM, HP
- Exchange Tables on specific topics at Tuesday lunch
- An End-User Exchange Forum Luncheon

7x24 Exchange presents donations to the ACE Mentor Program and the National Science Foundation in Ken Brill's name. Left to right: Bob Cassiliano, Chairman & CEO, 7x24 Exchange; David Schirmacher, President, 7x24 Exchange; Dennis Cronin, Co-founder, 7x24 Exchange; and W. Pitt Turner IV, Director Emeritus, Uptime Institute.

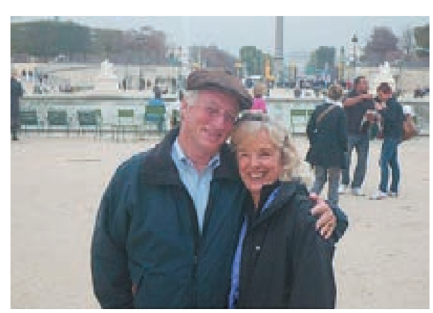
Sponsored Event: "Six Flags Over Texas at the River Walk"

The program content is designed to provide value to conference participants and their companies by focusing on important topics of the day. Modular Data Centers, Cloud Computing and Energy Efficiency are highlighted at this year's Fall event.

I look forward to seeing you at our Fall Conference in San Antonio, Texas!

Sincerely,

Bob



Ken and Margot

IBM'S LEADERSHIP DATA CENTERS

Designed for efficiency and business innovation

by Dr. Roger Schmidt

Whether it's finding innovative technologies to drive more mobile commerce transactions or using social software to assess consumer sentiment, demand for IT resources is exploding. Keeping up with that demand may be harder than you think. The need to provide support for application growth, new technology and compute models while meeting increasing availability demands and containing capital and operating costs is making data center planning and design increasingly complex.

IBM has addressed these challenges by developing data centers that are designed for efficiency and business innovation. For data center operators, this calls for optimizing availability, scalability, recoverability and agility — while also reducing risks in a cost-effective and time-efficient approach — across the lifecycle of the data center. Various studies indicate that almost 50% of enterprises report that providing sufficient data center space and ensuring availability required to meet service demands are among CEO's top challenges. Over 50% of CEO's are partnering with outside organizations to address these challenges and to help deliver value. CIOs seek a dynamic infrastructure model, which leverages resource (server, storage and network) convergence and virtualization to fully utilize DC equipment, automate resource management and integrate the management tools. And, if you're looking to capitalize on the benefits of popular models like cloud computing, the stress of more capacity, higher performance demands, and the need for cost containment can be alleviated via new approaches to storage, data management and data center design.

Designed for today's popular workloads — such as cloud computing or business analytics — IBM's Leadership Data Center (LDC) design addresses key C-suite demands with innovative techniques developed from global best practices built on our long experience in designing, building, and operating over 400 data centers around the world. The LDC design provides flexible comprehensive access to IT operations that CEO's need for growth and cost efficiencies and provides the services vital for CIOs to compete in fast changing times.

INSIDE IBM'S DATA CENTERS: BUILDING FOR FLEXIBILITY

Because demand for IT is unrelenting and often difficult to predict, a new approach was needed that *designed-in* data center flexibility to meet future needs. This Leadership Data Center design became standard within IBM after the 2010 opening of the LDC in Raleigh which was built in smaller increments or modules allowing it to fuel business growth while adapting to IT changes in a way that permits upgrades without disrupting operations. In this way, it provides flexibility to match short term capacity requirements with long term growth in a cost-effective manner.

Continuous IT growth puts ever increasing pressure on the data center to supply the power and cooling necessary to run the business applications and provide high levels of availability. IBM's Leadership Data Centers *designed-in* this need for flexibility and availability with an N + 1 concurrently maintainable infrastructure that provides power and cooling up to 32 kW per rack, 6x the industry average. These capabilities in power and cooling are necessary to meet the growing need to support increased use of virtualized and cloud environments. In addition the LDC infrastructure is designed so power and cooling can be expanded non-disruptively eliminating the need for any shutdowns for upgrades to increase capacity.

Similarly, the raised floor was provisioned for floor-based water cooling whether rack level or direct water cooled servers to support high density servers, which will become

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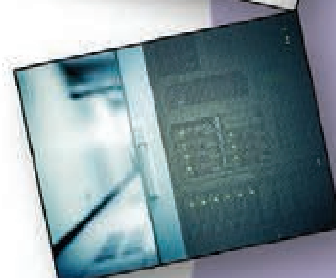

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- LEED® Certification – New or Existing Building
- Operations and Maintenance (O&M) Audits and O&M Staff Training
- Write System Operations Maintenance Manuals (SOMMs)
- "Methods of Procedure" (MOPs) Scripts for Maintenance or Construction Activities
- Incident Root Cause Analysis Investigations
- Manage and Design Data Center Circuit Additions
- Short Circuit & Coordination Studies, Arc Flash Analysis, & Harmonic Mitigation Studies
- Computation Fluid Dynamics (CFD) Studies

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more prevalent in the future. Horizontal and vertical scalability provide a flexible and a cost effective way to support new technology adoption. This *designed-in* flexibility supports a heterogeneous portfolio of IT equipment that can be air cooled, water cooled, racked or free standing.

IBM also invested in energy efficient mechanical equipment, including motors, variable frequency pumps and chillers, that deliver a return on investment of three years or less. For example, the Barrie, Ontario, Canada LDC is located in a favorable climate zone, which provides an estimated 209 days of full "free" cooling annually and 126 days of partial free cooling. This free cooling technology, also deployed in our Raleigh and Boulder LDC, is achieved via a plate and frame heat exchanger that enables chillers to be shut down to save energy and as important eliminates introduction of outside air to IT equipment that could introduce operational risk.

Plate and frame heat exchanger that enables chillers to be shut down to save energy and eliminates introduction of outside air to IT equipment

FLEXIBLE ENOUGH TO ADOPT ALL WORKLOADS AND EVERY SCENARIO

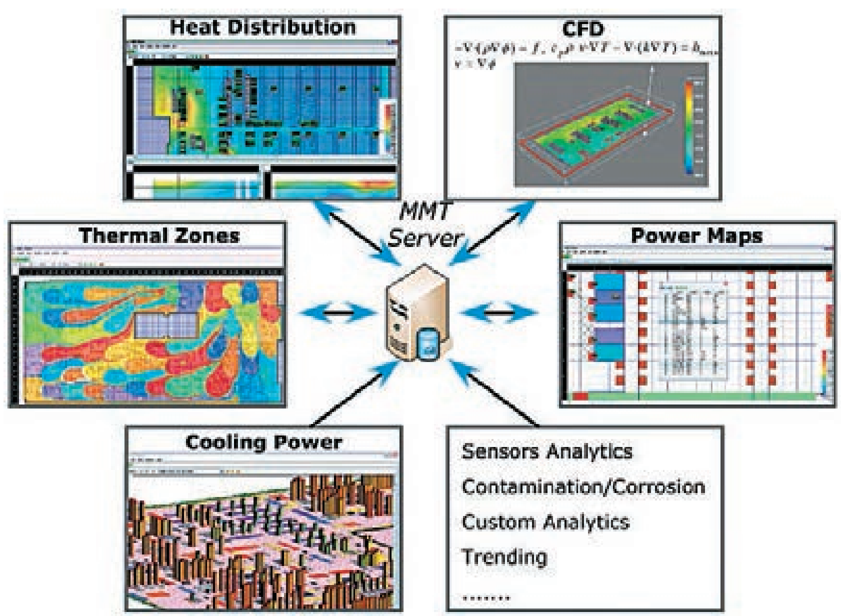
Similar to the Canadian LDC, IBM's Raleigh and Boulder LDC address client demands for flexible growth and unpredictable computing needs. They support an environment of public and private clouds, while accommodating various computing workloads of IBM clients. To provide clients the resiliency they require, the Boulder and Raleigh sites provide full backup of data through their dual site disaster recovery capabilities. IBM's latest Canadian data center in Barrie includes synchronous data replication within a 100 km network radius that incorporates the greater Toronto area.

ACTIVATING REAL-TIME ANALYTICS FOR OPTIMIZATION AND COST SAVINGS

To enable dynamic response to changes in demand for power and cooling capacity and reduce the need for employee involvement to provide for improved efficiency, a typical leadership data center has more than 40,000 monitoring sensors across IT equipment, data center facilities, cooling systems, and environment and building management systems. But optimization is not just about capturing the data. Optimization is driven by real time analytics with continuous feedback loops making operational improvements and adjustments. Several years ago, IBM Research created a measurement and management technology (MMT) which captures large amounts of sensory data from the data center to create real-time Computational Fluid Dynamics 3D maps of temperature, humidity, pressure and corrosion from which control of cooling facilities can be implemented to maintain the optimum environmental parameters. This technology has been deployed throughout our Leadership Data Centers world-wide and has proven to further reduce cooling power consumption by 20- 50%!

IBM's Boulder site is one of Colorado's largest single-point users of wind energy with a commitment of 1000 megawatt hours

IBM's commitment to sustainability and the environment was showcased in the Raleigh LDC which was awarded LEED Gold certification in 2010. Additionally, IBM's Boulder site is one of Colorado's largest single-point users of wind energy, with a commitment of 1000 megawatt hours. IBM was recognized as the greenest company in the U.S., according to the Newsweek 2012 Green Rankings.



Analytics are a key component of our Measurement and Management Technologies deployed in a number of IBM's 430 world wide data centers as well as for many of our clients

Rear door heat exchangers shown here in our Singapore Data Center have proven to be a reliable, energy efficient cost effective technology

IBM always looks for ways to improve upon our data center efficiency and performance as new data centers are deployed. Each data center must be designed for the particular site location's characteristics, as evidenced in IBM's newest client facing and production data center located in Singapore. Singapore has a challenging year round climate that is hot and humid, which required innovative data center design technologies not needed in most other parts of the world. Some of the unique features of this data center design were the use of a chiller to deliver warm water (63°F) to rear door heat exchangers installed on server racks and a very small energy efficient separate chiller to control the humidity levels in the data center.

CHANGE OFFERS NEW OPPORTUNITIES

Today's leading CEO's and CIO's are embracing change. They understand that change brings opportunity — the opportunity to differentiate their business to meet the demands of informed and socially aware customers; and the opportunity to adapt their business models to take advantage of stronger collaboration, partnering and global integration.

By innovating our approach to data center design, construction and operations, IBM has identified new ways to manage capacity growth to better match business growth, and to adopt new technology. Come visit IBM's Leadership Data Centers in Barrie, Raleigh, Boulder and Singapore. Our team would be proud to showcase the most innovative capabilities for our business. For a peak into IBM's smarter data center in Canada, take a look at *http://www.youtube.com/watch?v=H2BFV3IGJvc*

Dr. Roger Schmidt is an IBM Fellow and Chief Engineer of IBM's Data Center Energy Efficiency. He can be reached at c28rrs@us.ibm.com.

Special acknowledgement goes to Todd Traver, IBM Strategic Outsourcing Strategy, for his contributions to this article.

"After a rigorous review and evaluation process across Europe we concluded that Sweden offered the best package of resources."

Tom Furlong
Director of Site Operations at Facebook

WHAT MAKES SWEDEN AN IDEAL DESTINATION FOR DATACENTERS?

1. Low and reliable electricity prices
2. Green power
3. Extremely robust electricity grid and infrastructure
4. Power production surplus
5. Excellent communications infrastructure
6. Attractive corporate, real estate and investment tax schemes
7. Outstanding engineering and ICT skills
8. Favorable climate for free cooling
9. Accelerated due diligence and site selection
10. Security and stability – political, economical, physical

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HOW DATA CENTERS **Benefit Communities**

by Tracey Hyatt Bosman

"Every day, we create 2.5 quintillion bytes of data – so much that 90% of the data in the world today has been created in the last two years alone," according to IBM[1]. Despite a slow growing economy, the world's seemingly insatiable demand for data is, in turn, driving demand for data center capacity. Over 80% of data center owners/operators have built a new data center or upgraded an existing facility within the past five years reports the Uptime Institute in a 2012 Data Center Industry Survey. Over half of those same respondents indicated their future data center budgets will be greater due to increased computing demands and the rising costs and investments required to keep data centers reliable, secure, and up to date.[2]

Data centers have become an integral component of the IT infrastructures for most large companies and, at a macroeconomic level, integral to a vibrant economy, in some regions one of the most active sectors in an otherwise weak economy. At the same time, data centers offer tangible benefits to the communities in which they locate, leading the way in redefining the digital economy while providing concrete economic benefits, including a steady flow of increased tax revenues, job creation and the opportunity for enhanced infrastructure, enabling even greater development opportunities.

Economic Stimulus

Data centers are far more complex than traditional office operations. They require enormous investment in highly sophisticated design and engineering to maximize the space for the servers and computer equipment. To ensure reliability of operations, the data centers require state-of-the-art mechanical systems for HVAC, air conditioning and power generators to reduce down-time or damage to the equipment. According to Data Center Knowledge, Google invested $600 million in its Council Bluffs, IA facility, and Facebook invested $210 million to build the first phase of its new data center in Oregon.[3] Investments like these have significant positive impacts on real property taxes for a community.

However, real estate taxes are just the beginning of a longer list of revenue streams generated by data centers. They also make large investments initially and ongoing in communications and computer equipment, servers, and security equipment. Based on BLS & Co's experience and interviews and discussions with data center operators and industry experts, investing $200 million in computing equipment is common, with many investments far exceeding this number. Although the exact amount of investment depends on the size and layout of the facility, this typically equates to $5,000 per square foot or more.

The extent to which purchases of equipment and construction materials occur within the host community will vary according to which products are available locally. Fiscal impact models can project the full range of estimated tax revenues, and broader economic impact models can be used to estimate the portion of the investment that will be spent in the local area and resulting regional stimulus. (See the case study at the end of this article for an illustration.)

Attracting a data center is comparable to a community investing in an annuity, delivering a recurring stream of payments to the investor. This is because data center operators "refresh" computing equipment frequently (typically a minimum of every three years) due to the need to expand capacity, advances in computer equipment, software and security upgrades. As a result, the host community receives not only the initial investment needed to construct and equip the data center, but continuous large re-investments throughout the life of the data center. Additionally, data centers contribute to the host economy with on-going operational expenditures, such as routine maintenance and vendor/service contracts. Collectively, ongoing capital and operational expenditures generate a steady stream of tax revenues and economic stimulus.

Employment

Community and even business leaders have a tendency to underestimate the employment impact of data centers, failing to consider:

1) The impact of indirect and induced employment creation;

2) The impact of the related construction jobs; and

3) The growing tendency of companies to collocate IT staff, sales staff and other employees at the data center.

The Green Data Center blog[4] explored the employment counts in mega data centers of major technology companies. Google reportedly hired 200 employees for its data center in Altoona, Iowa. In Quincy, WA. Ask.com, Intuit and Microsoft hired a combined total of 180 workers – Ask.com has 30 employees and the others each have 50. Data centers operated by a third party also have staff to support the tenants. (For example, a facility in the 175,000-250,000 SF range may have 20-25 employees.) Such facilities require a manager, engineers, and

network administrators to troubleshoot issues that surface during daily operations. These positions, for the most part, require advanced level degrees and are high-paying, with average wages typically exceeding $60,000. Non-IT related staff typically includes a security team, janitorial staff to maintain the common areas, and a marketing staff to assure full occupancy.

Within the environment of third party-hosted data centers, the tenants also have employees on site to interact with the equipment, host meetings with clients or showcase their technological capabilities to win new clients. In fact, a recent trend in co-location facilities has been to increase the footprint of dedicated space for employees and tenants. According to Data Center Knowledge there has been renewed attention on the data center as a facility for IT professionals who need to be more productive and even unwind during long hours. "The nondescript concrete bunker of the past is giving way to campuses optimized for humans, complete with comfortable offices, conference rooms, theaters and gaming areas."[5] Kevin Knight, Sales Director for Digital Realty, confirmed this trend noting, "We find ourselves planning for larger office areas in our data centers because our customers are demanding it. They want to have a place for their staff to work while on-site, in many cases temporarily but, increasingly, on a permanent basis."

Fiscal Impacts

As noted, the economic stimulus and employment created by the data center generates fiscal (tax) benefits to the host community, but a more specific understanding of the scale of fiscal impacts is warranted. The largest revenue opportunity occurs from property taxes. Whether development of a data center represents redevelopment of a previous use, or first-time development of a "greenfield" site, it virtually always means a significant increase in the assessed value of the property and a resulting increase in property tax revenues.

The Washington Research Council, which assessed the impact of data center development in three counties in the state, reported in the city of Quincy, WA where Yahoo and Microsoft located their data centers that "regular property tax values in the city grew nearly three-fold between 2006 and 2009, from about $260 million to $764 million… property tax collections in the city grew by more than $1.4 million over the period — a 178% increase."[6] Increased collections of utility taxes, employment taxes, corporate and personal income taxes, permit fees, and utility connection fees are also potential fiscal benefits, varying according to state and local tax structures, as well as the nature of the data center operation itself.

In addition, these fiscal benefits can be achieved with minimal cost. While data centers entail more direct employment than is generally assumed, they are nonetheless much less employee and traffic intensive than office buildings, equating to an increased ratable tax base without the burdens on municipal services, such as schools public works, public safety, etc. (See the case study at the end of this article for another example of "net" fiscal impacts.) In some situations in which a community is competing with other locations in an attempt to attract a new data center, it may choose to forego a portion of its fiscal benefits, in the form of economic incentives, in order to gain the remaining fiscal or employment benefits.

Additional Benefits to Utilities

Data centers consume large amounts of power, so it's no surprise utility companies view them as extremely attractive revenue generators. However, data centers also offer desirable "load characteristics." Data centers operate 24/7 with a very steady, consistent "load," — i.e., a predictable level of usage. This predictability makes it easier for utilities to balance the data center's usage with that of other customers on the system. Furthermore, as Mark James, Vice President Economic and Business Development with American Electric Power notes, "In some cases, the addition of a large, steady requirement to a utility's customer base enables the utility to justify and finance upgrades and expansions to its systems, which can improve reliability and availability to all of the system's customers."

Urban and rural appeal

From a planning and development perspective, data centers offer opportunities for both urban and rural communities. Data centers near metropolitan areas typically utilize adaptive re-use of land or buildings. Two of the more well-known examples of data center-driven urban redevelopment are Chicago's 350 E. Cermak Avenue, which was once home to the printing press for the Yellow Book and Sears Catalog until the early 1990's; and New York's 60 Hudson Avenue, the former Western Union building. Both buildings are now sought-after data centers housing an array of telecom, internet, and financial tenants.

Rural areas have also benefited from the data center boom. Since 2007 Microsoft, Yahoo, Google, and Intuit, just to name a few, have invested billions of dollars into mega data centers in rural communities of Washington, Oregon and Iowa. These locations offer abundant land, electricity, cooler weather (facilitating "free cooling" of the data center by using outside air rather than artificially cooled air), and are not as disaster prone as some coastal locations. Just like their urban counter-parts, these facilities are redefining the landscape and bringing economic opportunities for rural communities in ways not conceivable just a few years ago.

Anchoring a New Economy

Data center developments also afford communities an opportunity to transition towards the digital economy. Improving the "tech" image of a community can enhance the location's competitive advantage for a wide range of investment projects. Data centers serve as an advertisement for the area's overall

(Continue to Page 18)

IMPACT ANALYSIS CASE STUDY:

Proposed Data Center Development

Building Specifications	
Building Size:	**230,000 SF**
Interior Portion of Building to Be Renovated in Phase I:	**58,800 SF**
Rack Space (raised floor computing area available to tenants):	*30,980 SF*
Network Operations Center (NOC):	*3,700 SF*
Mechanicals and Supporting Infrastructure:	*6,300 SF*
Office:	*6,800 SF*
Miscellaneous (restrooms, etc.)	*11,020 SF*
Total Estimated Construction Expenditures	**$54,319,795**

Employment Projections

Job Title	Employees	Average Wage*
Security	8	$25,220
Salesperson	2	$77,740
Engineers (Hardware and Software)	2	$90,080
Building Cleaning Worker	1	$28,460
Data Center Manager	1	$115,240
Data Center Technicians & Network Admin.	8	$77,150
TOTAL Jobs/Weighted Average Wage	**22**	**$59,014**

** Based on U.S. Bureau of Labor and Statistics. May 2011 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates. Chicago-Joliet-Naperville, IL Metropolitan Division.*

Estimated Economic Impacts (Direct, Induced and Indirect) Over Ten Years

Impacts to COOK COUNTY, IL	Job Creation			Earnings Added to Local Economy*
	Direct	Indirect and Induced	Total	
Construction Phase	NA	642	642	$30,103,111
Ongoing Operations	22	143	165	$72,022,310
Potential Implications Over Ten-Years	***22***	***78*** *(temp + permanent)*	***807*** *(temp + permanent)*	***$102,125,451***

** "Earnings" refers to total earnings added to the local economy, not the specific revenues of the data center itself.*

Estimated Net Tax Revenues

Taxing District	Net New Tax Revenues Over 10 Years
Chicago Board of Education	**$2,810,080**
City of Chicago	**$850,020**
Cook County	**$451,700**
Forest Preserve District of Cook County	$56,700
Metropolitan Water Rec. Dist.	$312,850
City of Chicago Library Fund	$108,500
City of Chicago School Building & Improvement Fund	$116,350
Community College District #508	$161,300
Chicago Park District	$338,830
Total	**$5,206,700**

This case study presents the findings of an impact analysis performed for a proposed Tier III co-location center in Chicago. The proposed project is an adaptive re-use of a vacant 230,000 square foot food processing plant. The analysis considered both the potential economic and fiscal benefits of the project.

Economic Impact

The economic impact model employed utilized the Regional Input Output Modeling System (RIMS II) developed by the U.S. Bureau of Economic Affairs. The RIMS II system provides estimates of the inputs needed for a given economic output, (i.e., a stimulus such as the proposed project). In the context of this analysis, we utilized RIMS II multipliers to estimate the increased demand for the labor, construction materials, and computing equipment that would be required to establish and operate the proposed data center. The economic impact of the proposed project was broken down into two phases:

- Construction jobs and earnings impacts, and
- Permanent jobs and earnings impacts from the on-going operation of the data center. This includes the impacts of both on-going maintenance and service to the data center, as well as the technology refresh investments.

Fiscal Impact:

When functioning as a food processing facility, the operation may have employed as many as 500 persons over its almost 100-year history. While the facility was operational, the City of Chicago provided it with a range of municipal services, including police, fire, streets and sanitation, public health, transportation, emergency management, etc. With the cessation of operations and the vacancy of the property, the valuation (assessment) and, simultaneously, the tax revenues generated by the property have decreased substantially.

The analysis concluded that the proposed redevelopment of the property will not only restore the assessment (and accompanying tax revenues) to the taxing jurisdictions, but will yield even greater tax revenues while creating less burden on governmental services than the previous use. Meanwhile, all taxing bodies, including the City, would recognize increased tax revenues, with the school district realizing the greatest gain.

It should be noted that the case study and its results should not be interpreted as a guarantee of the outcomes or success of a project. It is intended to serve as a tool to help understand the potential impacts of the proposed project. It should also be noted that this analysis is unique to the proposed location: Potential impacts will vary by project, location and that location's tax structure.

THERE ARE THREE PRIMARY TYPES OF DATA CENTERS:

1) Co-location centers are typically owned and operated by a third party company that has server space they lease to companies while sharing common infrastructure and facility management. In some instances the owner/operator is leasing space in the facility and the tenant furnishes their own electronic and computer equipment, and other facilities where the tenant will rent space on the servers and utilize paid staff of the co-location center.

2) Enterprise data centers are data centers that house the IT infrastructure of an individual company that require reliable power, security and control.

3) Mega data centers are facilities supporting large cloud and data infrastructure for companies like Amazon, Google, and Wal-Mart. Almost all large companies and most mid-sized businesses have some level of need for data center operations.

DATA CENTERS CONTRIBUTE TO LOCAL EMPLOYMENT IN THREE FORMS:

1) Direct jobs – employees of the data center.

2) Indirect jobs – jobs created within the data center's supplier network to service the new facility.

3) Induced jobs – increased employment in the consumer sector as a result of the spending of wages in the local economy to pay for groceries, clothes, entertainment, haircuts, etc.

attractiveness — e.g., utility costs, availability and reliability; the quality and quantity of fiber infrastructure; its access to IT talent; and available land and buildings — enabling communities to attract a broader array of information technology companies and a deeper professional services cluster.

The benefits of this dynamic are most immediately felt when an "anchor" data center project that enters a new market inspires other data centers to follow. As Rich Miller points out in Data Center Knowledge, Microsoft's decision to locate in San Antonio was followed by companies siting their data centers nearby, including HP, Lowes and Citigroup[7]; North Carolina is now home to Apple, Google, American Express, and IBM. New Albany, Ohio (near Columbus) is enjoying data center stardom, having most recently announced that Discover Financial Services and Compass Data Centers will be constructing new facilities. Chicago has seen a flurry of planned activity in the South Loop area of the city[8], where 350 East Cermak, reputedly the world's largest data center[9], is located.

To truly "anchor" a community's transition to a new economy, data centers must be reliable, long-term investments. And they are just that. Companies don't invest hundreds of millions of dollars and many months (if not years) in designing and equipping a data center only to close shop overnight and move to another location. Rather, a data center is a long-term commitment to a location.

Conclusion

As former Microsoft CFO Mike Brown said in a Seattle Times commentary, "They [data centers] create jobs to build, operate and service, they pay property taxes that provide economic stability to the counties and schools where they are located, and they attract suppliers and support infrastructure firms that are drawn to locate nearby."[10] Data centers are reshaping the economic landscape and in doing so they represent an opportunity to expand the economic base of a community while generating a return on that investment. Even when competition for such projects requires states and/or localities to offer incentives to be competitive, the enormous tax and other fiscal benefits of such projects create opportunities for public/private partnerships that offer extremely attractive and long-term benefits for the communities that are successful in attracting data center projects.

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STARLINE

MANAGING FIRE SPRINKLER SYSTEM RISK IN A MISSION CRITICAL DATA CENTER SETTING

by Jeffrey T. Kochelek

Proper management in the mission critical data center space revolves around the incorporation and integration of systems and designs that optimize uptime. One of the primary elements of this approach is redundancy. One of the gauges of critical systems performance therefore is the degree to which back up accommodations are present in a system design to mitigate the risk of system failure and the associated potential downtime.

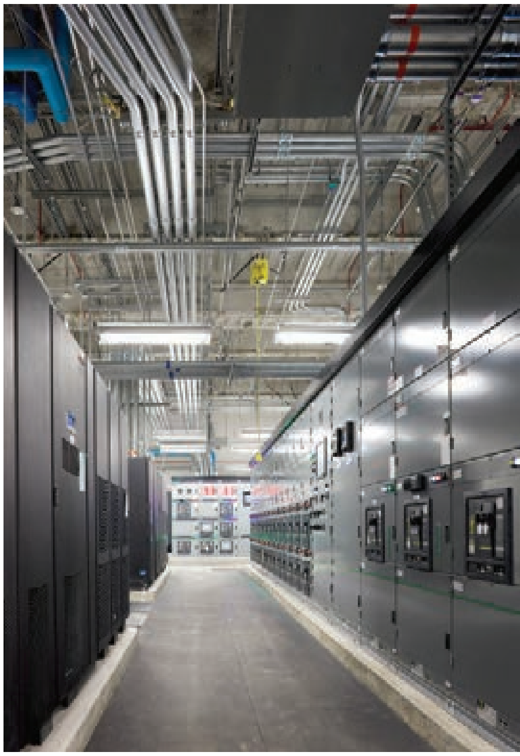
Yet, even with systems in place to manage downtime, the Uptime Institute identifies "human error" as the leading cause of data center downtime. In many industries, the appropriate response to human error risk is the development of detailed protocols, sometimes referred to as administrative controls, for mitigating errors in human judgment. The Uptime Institute's new Management & Operations (M&O) Stamp of Approval is designed to assess the risk and provide a protocol for improving performance and reducing risk.

There is however a commonly unidentified risk within the data center environment associated with fire sprinkler systems. This risk is one that few owners consider and even fewer properly understand. Most IT professionals who manage data centers are very uneasy at the thought of water filled pipes above their data halls. As such the "typical" fire sprinkler design employs double-interlock preaction systems which do not have pipes in the ceilings that are filled with water. In the double-interlock preaction design water fills the fire sprinkler piping only after the designated detection system(s) and a sprinkler activation (which is recognized by a quick pressure loss in the system). The system incorporates redundant detection in order to reduce the chances that a false alarm or the loss of supervisory gas pressure will fill the pipes with water and discharge water through any open sprinkler(s).

Despite the obvious advantages of these systems, they introduce another risk that is often overlooked, a high propensity for internal corrosion in the fire sprinkler piping. To address this risk of corrosion, most data center double-interlock preaction fire sprinkler systems also employ galvanized steel piping to provide an additional layer of protection to prevent corrosion related leaks. The industry started using galvanized steel piping several decades ago as a response to corrosion problems in black steel piping. The most common application for galvanized steel piping was generally for water filled domestic supply pipes that had regular water flow. Galvanization was shown to significantly delay the normal occurrence of corrosion in ordinary domestic piping. The use of galvanized steel piping was applied to preaction fire sprinkler system piping because it was known to be vulnerable to accelerated corrosion rates.

The use of galvanized piping drove up the cost of the systems but the investment was considered appropriate as the presence of corrosion in fire sprinkler piping could cause plugging at the sprinkler due to the creation of corrosion by-product and corrosion tuberculation in the piping. Galvanized piping was also recommended by insurance companies to insure optimal performance of the suppression systems. However, recent research[1] has suggested that galvanized steel piping may in fact be more vulnerable to corrosive degradation than was previously believed. Numerous recent case studies in the last four years have validated the suspicion as highlighted below:

Case No. 1: Large co-location data center operator in the Eastern US spends in excess of $1MM replacing corroded galvanized steel piping over a "live" data center. The system was less than 10 years old and showed significant


corrosion and through the wall failures throughout the piping network. The failed galvanized steel piping was replaced with galvanized steel piping.

Case No. 2: Leak in 3" fire sprinkler main line above a data hall in the Midwestern US. Subsequent video inspection of the internal surfaces of the fire sprinkler piping revealed significant trapped water throughout the fire sprinkler system. Analysis of fire sprinkler pipe samples from the system indicates 60%+ pipe wall penetration in many locations.

Case No. 3: Entire double-interlock preaction fire sprinkler system in the Southwestern US is replaced by general contractor in a new data center after less than five years of service due to corrosion related leaks. Galvanized steel piping had been used throughout the systems.

Case No. 4: Leaks in fire sprinkler piping in a multi-story data center facility in the Midwestern US. An analysis of the failed galvanized steel piping revealed corrosive attack of the pipe seams under trapped water within the systems. This same type of corrosion related failure of the galvanized pipe identified on several different floors of the facility.

In one last sample case study located in the Southeastern US a wet pipe fire sprinkler system in the office floor above a data hall failed and flowed for 20 minutes producing 6 inches of standing water. As the fire sprinkler water cascaded onto the data hall below, the data center was shut down. In this particular mission critical setting the resulting costs due to the shutdown were estimated at $100M. A gasket in a fire sprinkler main coupling failed after a repair for a corrosion related leak. So although the corrosion leak did not occur in the data hall piping, the line failure that occurred after the leak repair indirectly caused the shutdown.

Unfortunately, these case histories are only a small sampling of the many unexpected incidents I have been requested to investigate. More importantly, these incidents are from diverse geographical regions and data center types.

The record of these dire events reveals several significant facts regarding galvanized sprinkler system piping and the associated corrosion problem. It is evident that the problem:

- is very widespread
- is not limited to a certain geographic region
- can occur very early in the life of the piping system
- is not necessarily limited to certain locations or joints in a system
- is not necessarily confined to where a pinhole occurs
- can be present in a very large portion of the system
- can have severe ramifications
- can be extremely expensive to remedy

These observations can hardly be considered to be overstatements for the cases speak for themselves. They reflect the sobering discoveries within these data centers and are provided simply to communicate the experience of various unrelated data centers across the industry. However, as a scientist reviewing these case history events, the data from the field is quite compelling regarding corrosion in fire sprinkler systems and the potential for the number and frequency of corrosion related failures to occur.

CONTRIBUTING FACTORS

The problem with the fire sprinkler industry relative to mission critical data center installations is that there are currently no "standards" for fire sprinkler design and installation that take into effect the elevated risks associated with corrosion. In general, all businesses carry four different types of fire sprinkler system related risk:

- **Life safety risk** – will the fire sprinkler system provide the appropriate level of response to prevent injury or loss of life?
- **Catastrophic structure risk** – will the fire sprinkler system prevent loss of the structure?
- **Piping failure risk** – will the sprinkler piping fail and leak during a dormant period resulting in water damage to the structure and contents?
- **Business continuity risk** – will the failed (leaking) fire sprinkler system cause business interruption?

It would appear that all businesses bear some level of risk from each of these categories. However, data centers carry a very disproportionate risk in two key areas: ***Hardware risk*** and ***business continuity risk***. Even a small leak in the fire sprinkler piping above a data hall can easily damage the water sensitive hardware stored and operating in the data hall. A leaking pipe could easily destroy a stack of servers resulting in a million dollar loss. But the million dollar hardware loss is dwarfed by the loss potential that resides in the business continuity risk. For example, shutting down a data center serving a financial institution that is active during the trading day on the stock exchanges could result in multiple millions of dollars in losses not to mention the liability risks associated with their client's losses. In data center colocation installations the chain of liability risks associated with a leak failure could be myriad with many lawyers and many parties pointing fingers.

In the past, the data center industry has believed that they were managing risk by using dry pipe (preaction) fire sprinkler systems in place of the water filled wet pipe systems. Further there was a strong belief that the use of galvanized steel piping in data centers would mitigate the leak risk. All of the other risk management energy within data centers focused on HVAC cooling systems, electrical

systems, air quality systems, back-up power systems and reserve fuel storage systems. It would be unfortunate if a catastrophic fire sprinkler system failure was the necessary impetus that generated the necessary focus on this potential problem.

The source of the risks that are created within fire sprinkler systems in the data center setting come from a variety of areas within the chain of involved parties. A ranking of the risk elements that contribute to corrosion risk is as follows:

1. Design Practices

For the most part fire sprinkler specifying engineers for the data center industry have chosen to use a design that on the surface appears to mitigate risk, i.e. the double-interlocked preaction fire sprinkler system using schedule 10 galvanized steel piping. First of all, the preaction system is a "dry pipe" system wherein the piping above the ceiling is not completely filled with water during the pre-response time interval. Second, the double interlocked design puts time into the fire sprinkler response equation because it requires more detection signals before the preaction water valve is opened. Unlike a simple differential pressure dry pipe valve which is mechanical, a preaction system requires an electrical signal to open the water valve. Third, the use of galvanized steel pipe ostensibly provides another margin of safety for protection against corrosion of black (mild) steel piping.

The National Fire Protection Association (NFPA) requires that all dry and preaction fire sprinkler systems be hydrostatically tested before they are commissioned for service. The result of this necessary exercise is that there are always small pools of trapped water in the fire sprinkler piping. It is virtually impossible to drain out all of the water after the test. Additional amounts of water are added to the piping during periodic system testing (also required by the NFPA). A third source adds moist air each time the pressure maintenance compressor clicks on to keep the piping pressurized. The moisture in the air eventually condenses to produce condensate water within the piping. Until the 2007 edition of the installation standard for fire sprinkler systems, NFPA 13 did not require preaction fire sprinkler systems be "pitched" to allow draining of trapped water from the piping. This means that most preaction systems installed before enforcement of the 2007 edition of NFPA 13 are not pitched and invariably contain significant amounts of trapped water.

Corrosion cannot occur without liquid water. In the case of preaction fire sprinkler pipes, all of the necessary elements are present: the steel piping, water and plenty of oxygen. Corrosion is inevitable in these systems and depending on the number of trapped pools of water, the amount of water and the amount of oxygen the corrosion rates can be quite high.

One other ironic twist in the corrosion equation is that any pin holes that develop are always in intimate contact with the pool of water that formed them. Further, they are almost always located at the 6 o'clock position in the fire sprinkler piping. The net result is that the corrosion hole almost always delivers a significant quantity of water into the protected space when the leak finally breaks open. The pressurized air pushes rusty water through the pin hole as a fine mist propelled by the pressurized air in the system onto the electrical circuitry of the servers below.

2. Construction Materials

Fire sprinkler systems in data centers use galvanized steel piping almost exclusively. In fact although the NFPA does not require galvanized steel piping in dry and preaction systems, insurance underwriters have recommended/required its use in most of their client data center installations for at least the past 15 years. The problem with galvanized steel piping is that the most recent findings from the field and the laboratory indicate that it is more susceptible to corrosion related leaks than black steel[2,3]. If schedule 10 piping is used, documented failures in fire sprinkler piping have occurred in as little as 12 months[4].

Our extensive case log of data center fire sprinkler piping failures proves conclusively that galvanized steel is more susceptible to corrosion related leaks than black steel. Further, in order to reduce the corrosion risk removing oxygen from the piping atmosphere appears to be the only remedy to the corrosion problem. Even if expensive dryers are employed to reduce the amount of water that is introduced by the pressure maintenance compressors, small amounts of trapped water are inevitable because of the commissioning and testing protocols for fire sprinkler systems.

Another factor contributing to corrosion related leaks is the lack of heat annealing of the weld seam on fire sprinkler piping. The current ASTM Standards for the fire sprinkler industry do not require that the weld seams be heat annealed, the result is that the piping is subject to "knife cut" corrosion wherein the weld metal and the heat affected zone adjacent to the weld corrode preferentially to the rest of the pipe. If the weld seam happens to end up installed under trapped water, failures in schedule 10 galvanized steel piping have occurred in as little as 12 months.

3. Installation Practices

As with any trade in the construction industry the quality of the finished product varies with the quality of the installing contractor. Unfortunately, in the case of the fire sprinkler system the burden of risk that is attributable to a poor installation ultimately falls on the data center operator. The most common problems include:

- Fire sprinkler piping that is not pitched to drain effectively
- Water traps that are inadvertently created within the piping network
- Insufficient number of auxiliary drains within the systems to remove accumulations of trapped water
- Systems that leak air from the piping in much greater quantities than the code permits which result in more frequent addition of warm, moist oxygen from the pressure maintenance compressor

RECOMMENDATIONS

The greatest risk to data center uptime may be the risk that has not yet been sufficiently recognized or quantified. There is now a significant body of field and laboratory evidence that suggests that many data centers may start seeing increased leak frequency in the fire sprinkler systems that protect the data halls. As data centers age the likelihood of leaks related to corrosion grows. As more and more data centers are constructed to support the expanding need for IT services the contributing risk factors will need to be addressed to protect against downtime.

For existing data centers

1. Employ a corrosion engineering firm that is well versed in the unique attributes of fire sprinkler system corrosion to evaluate the current failure risk and to design a comprehensive remediation and corrosion management strategy moving forward.
2. Perform internal video assessments of the existing double-interlock preaction fire sprinkler systems to determine the current level of risk using an experienced fire sprinkler system corrosion engineering firm.
3. Retrofit and remediate existing fire sprinkler systems to reduce the current level of risk:
   a. Replace piping that has deteriorated beyond its usable life.
   b. Install auxiliary drains as necessary to ensure adequate drainage of trapped water.
4. Install an integrated **Dry Pipe Nitrogen Inerting (DPNI)** system to remove oxygen and prevent oxygen corrosion within the fire sprinkler system piping.
5. Develop a set of standards for DPNI systems that address the unique needs and risks for fire sprinkler systems in the data center industry.

For new data centers

1. Utilize a competent corrosion engineering firm that is knowledgeable in the unique attributes of fire sprinkler system corrosion to integrate a comprehensive corrosion control strategy into the fire sprinkler system design.
2. Stop using galvanized steel piping in data center fire sprinkler systems.
3. Create a more stringent installation standard — consider certifying or otherwise qualifying fire sprinkler contractors.
4. Integrate **Dry Pipe Nitrogen Inerting (DPNI)** into the fire sprinkler system design to prevent oxygen corrosion and to reduce the leak risk in data center double-interlock preaction fire sprinkler systems.
5. Develop a set of standards for DPNI systems that address the unique needs and risks for fire sprinkler systems in the data center industry.

The bottom line is that data center professionals cannot afford to ignore the risks that corrosion in fire sprinkler piping creates within their data halls. Standards must be developed and adopted for the design, installation and maintenance of fire sprinkler systems in the mission critical setting. Management of the risks associated with these systems must become an integral part of the uptime management process.

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11 DATA CENTER MYTHS & DESIGN ISSUES

by Dennis Julian, PE, ATD, DCEP

Data center design has seen a vast change in approach and priorities. As designs evolve to address energy efficiency and costs, some key points to consider and understand are:

1. PUE does not equal electric service size or generator capacity.

Power Usage Effectiveness (PUE) is a measure of the ratio of total data center power divided by the total IT power. PUE that is measured instantaneously is not valid to determine the total electrical power required unless it is measured at the precise peak power usage of the facility. A correctly calculated PUE uses annual averages to account for seasonal variations. It is possible for the PUE to vary from a monthly high of 1.9 to a monthly low of 1.3 (RTU system in the Northeast) with an annual average of 1.4. If the electrical service was designed based on the 1.4 PUE the service and the engine-generator system would be undersized.

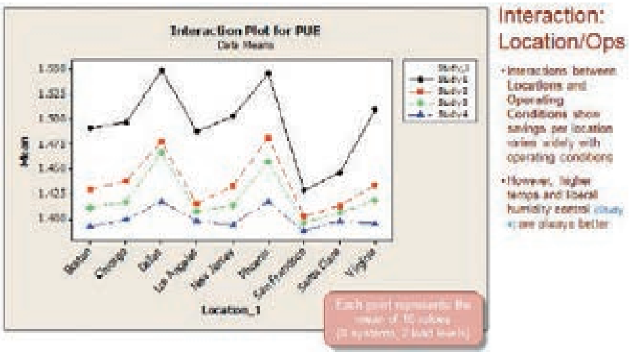
a. Example: Assuming a 1000kW IT load:

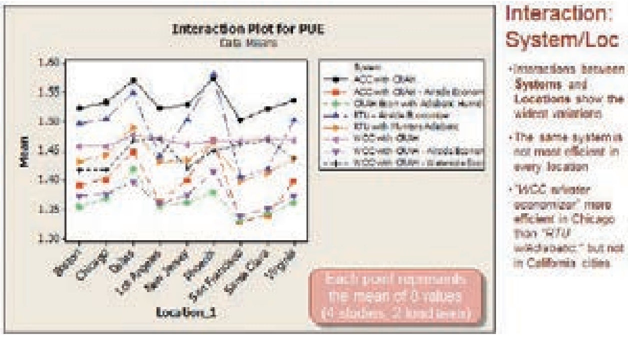
- At an average PUE of 1.4 the electrical service and generator system would be sized for 1400kW.
- At the peak PUE of 1.9 the electrical service and generator system would be sized for 1900kW.
- The system would be short 500kW at peak load, undersized by approximately 35%.

2. Air economizer is not the optimum system everywhere.

The energy savings obtained depends heavily on the operating temperature and humidity requirements of the computer room and the geographic climate in which the site is located. Roof top units (RTUs) with airside economizer can vary from an annualized PUE of 1.23 in San Francisco, CA to 1.35 in Dallas, TX. Other cooling systems can have lower PUEs varying from 1.18 to 1.31 respectively, for the same locations and operating parameters. Local air pollution and environmental threats need to be assessed and a solution discussed to mitigate the potential risks. The difference in PUE for air economizer systems and closed systems with water side economizers, pumped refrigerant, indirect adiabatic cooling, etc. is slight, the closed system could have a better PUE, and may be offset by the additional risks involved.

a. Not reflected in the PUEs indicated above, chilled water systems can be designed to further lower the PUE by using warm water temperatures of approximately 55°F - 59°F (13°C - 15°C). This allows the chiller to operate more efficiently and to take advantage of many more economizer hours. To increase efficiency, the redundant air handling units (CRAHs, AHUs, etc) can all be operated thereby reducing the average fan power and increasing the heat rejection at warmer water temperatures. If redundant units are not available or if room humidity needs to be lowered, than the chiller water temperature can be reset to a lower level to provide the additional cooling capacity and dehumidification required. Chillers also allow the use of localized cooling with rear door heat exchangers, or water cooled cabinets which will reduce the total fan power required to cool the space.



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3. Air economizer design and operational issues.

Air economizers introduce a vast quantity of air into the data center. This is different than past designs which typically were closed systems with precision air conditioners maintaining tight restrictions on the recirculating air within the data center. New designs using outdoor air economizers for “free cooling” have brought with them a number of design challenges that require detailed solutions for a successful implementation.

a. Typical data center airflow could be approximately 1.5 room air changes or more per minute.

b. Transitioning to and from economizer means outdoor conditions are reflected indoors quickly and may violate ASHRAE TC9.9 rate of change recommendations of:

- Maximum rate of humidity change is less than 5% RH per hour, and no condensation.
- Maximum rate of temperature change is 5°C/hr (9°F/hr) for data centers employing tape drives and 20°C/hr (36°F /hr) for data centers employing disk drives.

c. Outdoor air contamination concerns including pollen, dusts, leaves, etc require additional and bulky filtering systems which can be expensive and require high maintenance.

d. Smoke brought into the facility from outdoor building or forest fires can activate interior alarm systems and potentially shut down the air handling cooling systems.

e. Air contaminants can be from localized air pollution from people or industries or from environmental events such as forest or building fires.

f. Air borne threats, accidental or targeted. A crash adjacent to the site or a specific terrorist attack on the facility, or an adjacent neighbor, could allow contaminants to enter the facility faster than the system can react, assuming it has sensors to detect that particular threat.

g. Pressurization control is vital. Due to the large volumes of air, slight differences in supply and exhaust systems can result in rooms being over or under pressurized causing roofs to balloon up or walls to move. Damper opening and closing times must be coordinated, air flows must be balanced and controls must be robust. Outdoor air leakage through air handling units must be minimized. Controls need to consider failure scenarios and the system should build in pressure relief, both positive and negative.

h. Mitigation: Controls and sensors must be provided to respond to these operational threats. Designs must consider these real world risks and provide practical solutions. Theoretically, sensors can detect and systems can respond by closing outdoor dampers but the reality is that these operations take time to occur and at the high air volumes being provided there is little time to react, literally only a few seconds. If sensors are set too sensitive, and react to often, the planned for benefits of air economization may never be obtained.

4. The optimum cooling system is not obvious.

In a study comparing multiple system cooling systems in the same geographic location (Virginia) and computer room operating temperatures and humidity levels (ASHRAE recommended temperatures and allowable humidity levels) the following annual PUE values were calculated:

System	Annual PUE
Air cooled chiller (ACC) with CRAH	1.40
Air cooled chiller (ACC) with CRAH and airside economizer	1.30
Air cooled chiller (ACC) with CRAH and airside economizer with adiabatic humidifier	1.27
Roof top unit (RTU) with airside economizer	1.33
Roof top unit (RTU) with evaporative adiabatic humidifier	1.30
Water cooled chiller (WCC) with CRAH	1.38
Water cooled chiller (WCC) with CRAH and waterside economizer	1.28
CRAC units with pumped refrigerant economizer	1.25

a. A PUE difference of 0.01 for a 1000kW IT load and an electrical equivalent cost of $0.14/kWh equals $12,264 per year.

PUE High Low	TRADITIONAL - 78F Return air, 35%-55% RH, 45F CHW (Operating Condition 1)							
	ACC with CRAH	ACC with CRAH – Airside Economizer	CRAH Econ with Adiabatic Humidifier	RTU – Airside Economizer	RTU with Munters Adiabatic	WCC with CRAH	WCC with CRAH – Waterside Economizer	WCC with CRAH – Airside Economizer
Dallas	1.55	1.52	1.49	1.68	1.58	1.44	1.43	1.40
Boston	1.50	1.46	1.37	1.67	1.45	1.42	1.36	1.39
Virginia	1.52	1.48	1.41	1.66	1.50	1.43	1.40	1.38
New Jersey	1.51	1.47	1.40	1.67	1.48	1.42	1.39	1.39
Chicago	1.50	1.45	1.40	1.63	1.49	1.42	1.38	1.37
San Francisco	1.48	1.33	1.33	1.45	1.42	1.42	1.42	1.30
Santa Clara	1.50	1.35	1.35	1.46	1.46	1.43	1.43	1.31
Phoenix	1.55	1.55	1.45	1.71	1.53	1.43	1.42	1.43
Los Angeles	1.51	1.44	1.42	1.58	1.53	1.43	1.43	1.37

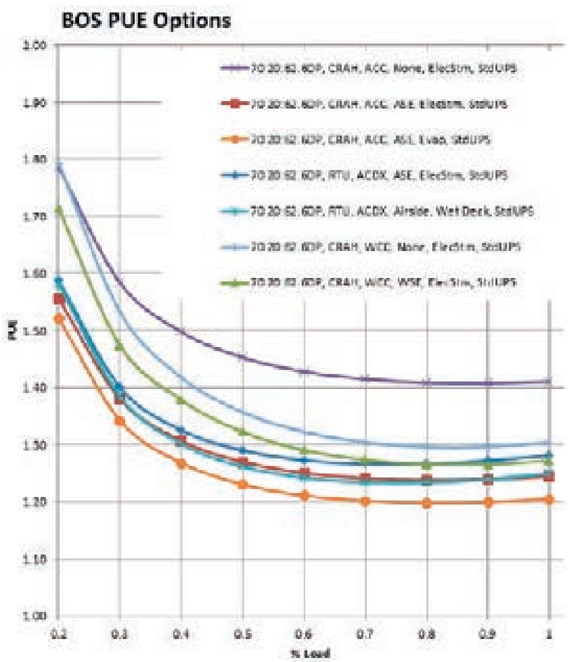
	ASHRAE A1 Hybrid - Recommended Temp, Allowable Humidity (Operating Condition II)							
	ACC with CRAH	ACC with CRAH Airside Economizer	CRAH Econ with Adiabatic Humidifier	RTU – Airside Economizer	RTU with Munters Adiabatic	WCC with CRAH	WCC with CRAH – Waterside Economizer	WCC with CRAH – Airside Economizer
Dallas	1.52	1.31	1.29	1.40	1.37	1.43	1.42	1.31
Boston	1.47	1.29	1.29	1.37	1.37	1.41	1.37	1.29
Virginia	1.49	1.28	1.28	1.37	1.36	1.42	1.39	1.29
New Jersey	1.49	1.29	1.28	1.37	1.36	1.41	1.38	1.29
Chicago	1.49	1.29	1.29	1.38	1.38	1.41	1.37	1.30
San Francisco	1.47	1.27	1.27	1.34	1.34	1.42	1.42	1.29
Santa Clara	1.49	1.27	1.27	1.36	1.36	1.42	1.42	1.30
Phoenix	1.54	1.33	1.28	1.43	1.37	1.42	1.39	1.31
Los Angeles	1.49	1.27	1.27	1.36	1.36	1.42	1.42	1.30

Difficult to read but resulting PUE color formatted so that green represents the lowest PUE and red the highest.

5. Conclusions from the PUE study:

a. PUE varies by load. 100% loaded systems tend to be the most efficient.

PUE Variations for Different Systems and Load Levels



b. The major factors effecting PUE are the operating temperatures and humidity levels required in the computer room.

c. Warmer IT equipment input operating temperatures allow maximum economizer hours, higher supply air temperatures and warmer chilled water.

d. Wider humidity limits allow maximum economizer hours, in particular in cold weather with low outdoor humidity and in humid climates.

e. No one HVAC system is the optimum solution in all geographic locations.

6. Water cooled chiller ROI may not be better than air cooled chillers.

Water cooled chillers are assumed to have the lowest operating cost. On a kW per ton basis this is typically correct. In a study performed for a Virginia location the following was found:

a. The results of the analysis show that in all years the Total Cost of Ownership (TCO) is highest for the water cooled chiller (WCC) system compared to the air cooled chiller (ACC) options with and without waterside economizer. The WCC system does have the lowest annual energy cost, however this is offset by the higher initial capital costs of the chillers, cooling towers and water storage, and the higher annual operating cost for water, sewer and maintenance required for the WCC system.

b. Highlights of the study:

- 7.2 MW of IT equipment load.
- Operating Conditions: Cold Aisle Temperature Control, 77°F setpoint, 20%-80% RH, Max DP = 62.6°F, chilled water temperature = 59°F.
- 57.8 million gallons of water per year required for cooling tower operation.
- 11.6 million gallons of water dumped to sanitary per year for tower blow down.
- First year TCO is $3.5 million less for air cooled vs water cooled chillers due to initial equipment and water storage costs.
- Tenth year total TCO is $4.6 million less for air cooled vs water cooled chillers.

7. Humidity – Relative Humidity (RH) vs Dew Point (DP).

Absolute humidity is the water content of air. Relative humidity, expressed as a percent, measures the current absolute humidity relative to the maximum humidity the air can hold at that temperature.

Relative Humidity varies with temperature for the same quantity of water in the air (absolute humidity). Location of humidity sensors for service level agreements (SLA) are critical. Dew point sensors are not sensitive to hot or cold aisle placement, but RH sensor measurement will vary widely. The same dew point measured in a hot aisle will be different that the same dew point measured in a cold aisle.

a. Recommended ASHRAE limits, based on the inlet of the IT equipment:

- 5.5°C DP to 60% RH and 15°C DP
- 41.9°F DP to 60% RH and 59°F DP

b. Allowable ASHRAE limits, based on the inlet of the IT equipment:

- 20% to 80% RH
- Maximum Dew Point 17˚C (62.6°F)

c. ASHRAE Maximum Rate of Humidity Change:

- Rate of change of humidity is less than 5% RH per hour, and no condensation.

d. The graphic indicates the ASHRAE environmental envelopes for the various classes of electronic equipment (Class A1 is the typical computer room). The curved lines show how relative humidity varies with temperature. The dew point (moisture content) is indicated on the right axis and is constant across the range of temperatures.

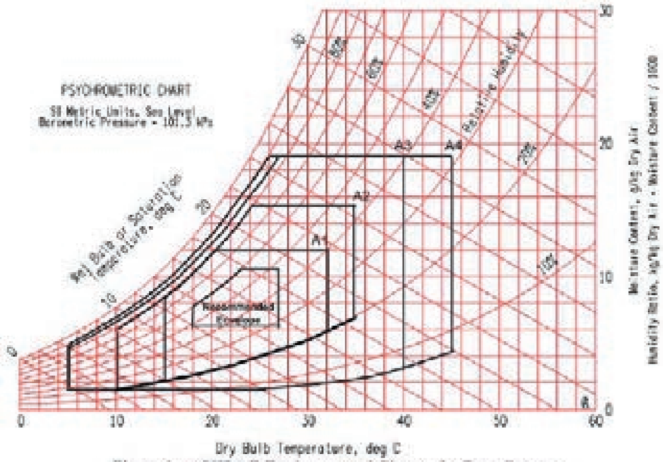


Figure 2. ASHRAE Environmental Classes for Data Centers

8. Fuel oil systems need to be robust, weatherproof, and of a waterproof design if appropriate.

Flooding can occur due to storms, clogs, backups, pipe breaks or other reasons. If tanks are above ground they can and should be designed to operate under water, similar to designs used for underground tanks. Back up alternate fuel system piping with valved connections with power outlets for pumper trucks should be provided to allow temporary emergency fuel to be supplied in case of a fuel system failure. Tanks should be securely tied down to overcome the buoyant effect of fuel oil in water.

9. Multiple string batteries designed as a N+1 system should be considered.

This design allows de-energized battery maintenance while the UPS is operational with battery backup thereby minimizing risks.

a. Transformerless UPS systems increase the likelihood of a dangerous ground fault during maintenance, do not isolate the fault from the remainder of the power system and may cause a much larger outage to occur which may affect IT operation.

b. Arc flash considerations may require battery maintenance to occur while the batteries are de-energized.

c. The number and capacity of the strings must be sized correctly so the UPS will operate with one string disconnected. Having multiple VLRA cabinets with individual disconnects does not necessarily allow one of the cabinets to be disconnected while the UPS maintains battery backup protection. The system must be designed to provide enough power and voltage (number of battery cells) to allow the batteries to carry the load with one string disconnected. Typically this would be with less battery protection time, but adequate to support the load and allow time to get to generator power.

10. Nitrogen purge systems.

Nitrogen purge systems for preaction sprinklers deal with leaks, corrosion and microbials, by eliminating water vapor and oxygen from the piping system.

a. Even galvanized piping used in pre action systems can develop leaks from corrosion or microbial action. Oxygen and water left in the system after testing or vapor contained in the compressed air in the system can contribute and enhance these corrosion effects. The nitrogen purge system fills the piping with nitrogen eliminating the oxygen and water vapor and therefore minimizing the risk of corrosion. Nitrogen system sensors monitor the nitrogen in the system and purge to eliminate water vapor and oxygen. Use of a nitrogen purge system could allow the use of black iron pipe in lieu of galvanized, due to the reduction in corrosion risk.

11. Hot aisle / cold aisle operational issues.

Elevated operating temperatures caused by higher supply air temperatures and better separation of hot and cold air streams leads to operating conditions for devices and materials that may reduce useful life or cause nuisance failures or alarms.

a. Standard smoke detector devices are rated for a maximum ambient of 100°F (38°C).

b. Smoke detectors are available rated for a 120°F (49°C) ambient.

c. Heat detectors rated 135°F (57°C) are rated for a maximum ambient of 100°F (38°C).

d. Heat detectors rated 190°F (88°C) and higher ambient of 120°F (49°C) are available.

e. Lighting fixtures are rated for typical office temperatures. Ambients over 90°F (32°C) will affect light output and life expectancy of the lamps and ballasts.

f. Typical 135°F sprinkler heads are rated for use in a 100°F ambient. Intermediate rated heads at a higher temperature rating are recommended to minimize potential false activations.

g. DX cooling systems using compressors such as rooftop units, CRAC units with condenser water or refrigerant heat rejection systems have limitations on the temperature of the return air they can handle without shutting down. This temperature can be as low as 95°F (35°C).

h. High temperatures in particular when associated with high humidity levels can affect personnel working in the computer room. Regulations restrict the time that can be spent in hot areas. This could affect personnel productivity.

- OSHA (Occupational Safety & Health Administration) Technical Manual Section III, Chapter 4 ISO (International Organization for Standardization) 7243, "Hot environments – Estimation of the heat stress on working man based on WBGT index".

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Average Wet-Bulb Globe Temperature (WBGT)

The “wet-bulb globe temperature” (WBGT) is an index that measures heat stress in human work environments.

For indoor and outdoor conditions with no solar load, WBGT is calculated as: **WBGT = 0.7*NWB + 0.3*GT**

NWB Natural Wet-Bulb Temperature

NWB is measured by placing a water-soaked wick over the bulb of a mercury thermometer. Evaporation reduces the temperature relative to dry-bulb temperature and is a direct representation of the ease with which a worker can dissipate heat by sweating.

GT Globe Temperature

For a data center, the dry-bulb temperature can be used in place of GT without compromising accuracy.

DB Dry-Bulb Temperature

“Dry-bulb” refers to temperature measured using a typical analog or digital thermometer.

OSHA Technical Manual SECTION III: CHAPTER 4 HEAT STRESS

TABLE III: 4-2. PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUE

------- Work Load* -------

Work/rest regimen	Light	Moderate	Heavy
Continuous work	30.0°C (86°F)	26.7°C (80°F)	25.0°C (77°F)
75% Work, 25% rest, each hour	30.6°C (87°F)	28.0°C (82°F)	25.9°C (78°F)
50% Work, 50% rest, each hour	31.4°C (89°F)	29.4°C (85°F)	27.9°C (82°F)
25% Work, 75% rest, each hour	32.2°C (90°F)	31.1°C (88°F)	30.0°C (86°F)

Values are in °C and °F,* **WBGT.

These TLV's are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C (100.4° F).

NOAA's National Weather Service
Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Caution

Extreme Caution

Danger

Extreme Danger

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

i. Transformers are designed to operate in maximum room ambient temperatures of 104°F (40°C), with an average room ambient temperature not to exceed 86°F (30°C) in accordance with NEMA standards. Ambient temperatures above these values over a 24-hour period require either a larger KVA rating or a special low temperature rise transformer.

j. Electrical equipment, including panelboards, RPPs, and circuit breakers are designed to operate in a maximum 104°F (40°C) ambient. This includes the temperature rise within the equipment due to internally generated heat rise. Locating equipment in a 104°F (40°C) ambient will lead to internal temperatures within the equipment that exceed the ratings.

Dennis Julian, PE, ATD, DCEP is Principal at Integrated Design Group. He can be reached at djulian@idgroupae.com

DCIM: The Missing Piece of Any Co-Location Puzzle

by Sev Onyshkevych

It's no secret, today's data centers sit at the core of any successful business. No longer viewed as cost centers, IT infrastructures are central to driving business services and profitability. But make no mistake: these service and profitability resources are expensive. From capital expenditures on facility equipment to power and cooling, a data center represents one of the largest costs for running any business. That's why many organizations turn to colocation (Co-Lo) facilities as the viable alternative to in-house data centers.

This puts the reliability, security and availability pressure squarely on the shoulders of these third-party service providers. Co-Los realize that poor and inefficient management of customer services means loss of business. To help maintain top quality services, Co-Los are deploying Data Center Infrastructure Management (DCIM) solutions to help meet their service level agreements (SLAs).

Co-Los: A Viable Alternative

To keep expenses in check, in-house data center expansion isn't a viable alternative for many organizations, that's why Co-Los are becoming more attractive. These secure facilities allow companies to place servers within their racks and share the bandwidth. Co-Los handle all management, power and cooling, which drive significant cost reductions compared to expanding or building a data center. Simplistic in concept, but powerful in business services, Co-Los offer, Bandwidth — a low-cost, limited bandwidth business-grade DSL line runs about 200 dollars. Service providers provide higher bandwidth and redundancy for network connections at the same price.

- **Outage Protection:** Co-Lo providers have perfected secure sites with multiple forms of power and data storage back-up.
- **Scalability:** Service providers easily keep pace with business needs, scaling up or down based on customer growth patterns.
- **Security:** The model offers multiple layers of facility and data security, guaranteeing data is always safe.
- **Cost-Efficiency:** The model removes costs and worry associated with data center footprint expansion, new staff, power usage, or more crucial, downtime.

Given the state of today's data centers, the Co-Lo model has never been more essential. The Uptime Institute recently noted nearly 40 percent of data centers would run out of power, cooling or space by 2012. According to the report, data center operators must now explore options to handling the load. More than a quarter of those surveyed planned to lease colocation space as an alternative.

In addition, a recent article in Computerworld notes: *"Even in today's challenging economy, enterprises are facing rising internal and external demands for IT services. When an existing data center can no longer shoulder an enterprise's IT burden alone, or when it becomes necessary to establish a secondary site to provide enhanced business continuity or regional network support, an important decision point has been reached. For a number of enterprises, the obvious solution is to add another data center, and for many of those it means partnering with a colocation facility."*

It's estimated there are more than 1,000 Co-Lo data centers in the United States. Analyst firm Research and Markets also reports the data center Co-Lo service market in North America will grow at a CAGR of 13.36 percent by 2016.

This translates into big money, as underscored by a study in IBISWorld which pegged total revenues for the market at $18.5 billion between 2007 and 2012.

But this is by no means easy money, and the pressure is on Co-Los to closely track uptime, security, reliability and costs to construct appropriate SLAs. A necessary tool to help track these key measurements is a comprehensive monitoring solution that focuses on everything from the reliability and efficiency of core infrastructure components to efficient use of power

and cooling to support it. For many Co-Los, a Data Center Infrastructure Management (DCIM) solution is the missing puzzle piece.

It's All About Management & Monitoring

Using DCIM, Co-Lo's can monitor and manage all facility and IT resources in real-time. A good DCIM solution collects and presents information on power systems, power distribution, cooling management systems as well as space management including racks, cabinets and containers. In addition, DCIM solutions also provide valuable information on hardware components, so IT personnel can obtain utilization, reliability and availability stats.

Quickly summing it up, DCIM solutions offer:

- **Actionable Intelligence:** Better planning via real-time information on current and future infrastructure needs.
- **Predictability:** Greater predictability from deep insight into space, power and cooling capacity.
- **Availability:** Less downtime by providing current IT, power, and cooling data.
- **Reduced OPEX:** Reduced operating costs led by energy usage and efficiency tracking.
- **Asset Management:** Better performance driven by in-depth views into efficiency of IT components.

According to 451 Research, the market is responding with 2010 market revenues for DCIM of $245 million. This number will experience a compound annual growth rate of 39% through 2015 — growing the marketplace to more than $1 billion.

Underscoring the 451 Research, Gartner analyst David J. Cappuccio believes data center managers and Co-Los providers cannot survive without tools like DCIM: *"Data center managers must have the information they need to make informed decisions for effective planning and management of data center assets and physical infrastructure to ensure the service levels the company expects. They also must have the insight needed to properly plan and forecast future data center capacities: including space, power, cooling and network connection....DCIM provides insights and drives performance throughout the data center, including data center assets and physical infrastructure."*

The Gartner Group estimates DCIM tools can reduce operating expenses by as much as 20% and extend the life of a data center by as much as five years. In terms of dollars, the firm reports: *"In data centers of 8,000 square feet, we have seen energy costs exceed $1.6 million/year in North America, and these were not high-density environments. Those that have drilled down to understand the true costs of operations have quickly realized that there are potentially ongoing savings of 20% to 30% and operational benefits to be attained through more rigorous management of the physical environment."*

Bringing the pieces together, the benefits of DCIM in a colocation environment are undeniable.

DCIM and Co-Los – The Perfect Match

Perhaps the biggest impact of DCIM is found in the Co-Lo sector. And it makes perfect sense, because the model is all about service, uptime, and reliability. As VentureBeat points out, even a little downtime can be devastating to the bottom line. "Businesses lost about $70 million in the past five years just by having intermittent downtime."

In addition to reduced downtime, recent surveys of Co-Lo providers show DCIM drives energy savings and increased capacity utilization and faster issue resolution.

Power and cooling is certainly top of the list. DCIM visualizes true power usage — helping immediately locate inefficient and "stranded" power sources. Real-time energy usage reports eliminate infrastructure overbuilds and maximize total power usage. Taking this one step further, DCIM offers real-time views into the entire cooling infrastructure. The technology helps Co-Los more effectively manage cooling in real-time — providing accurate views into capacity and utilization.

In fact, a recent survey by industry analyst firm, Enterprise Management Associates (EMA) notes active thermal management via DCIM effectively results in the safe reduction of Power Usage Effectiveness (PUE) ratios by 16 percent. In real-world environments, this equates to annual cost savings of nearly $150,000 per 10,000 sq. ft. of managed floor space. For Co-Los, this means doing business more efficiently and improving profit margins.

Capacity management is another key area where Co-Los look to DCIM for help. Dynamic views into both IT and facilities resources can eliminate costly new projects, asset purchases, or power upgrades. Inefficient components — such as cooling units, branch circuits, UPS and servers — are quickly located and replaced or "rescued" as necessary. Unused resources are quickly found to eliminate expensive build-outs. EMA also backs this up, reporting that continuous monitoring and alarming of IT and environmental components can reduce unnecessary hardware replacements by an average of $20,000 per year.

Perhaps the biggest benefit of DCIM is problem resolution. Downtime is a business killer — for both provider and customer. With a real-time view into facility and IT performance, Co-Los can resolve issues before downtime causes SLA violations. Real-time monitoring through DCIM significantly reduces MTTD (Mean Time to Detect) and MTTR (Mean Time to Resolution), avoiding lengthy outages that cost some companies as much as $100,000 per hour.

At FieldView Solutions, we've seen these benefits play out in the real world time and again. To validate this statement, we recently collaborated with CoreSite Realty Corporation — a provider of cloud-enabled data centers. We noted how the company was leveraging a single pane-of-glass for in-depth views into constrained facility and IT resources — including power, cooling, and space allocation, across all their entire data centers. The end result was a unique competitive offering, superior data center performance, and a significant acceleration in new business.

DCIM: Missing Piece of the Puzzle

Colocation services are a viable alternative for organizations looking to grow and manage their facilities and IT resources. Beyond enhanced CAPEX and OPEX savings, consumer of these services benefit from the highest levels of security and disaster recovery. But none of this success is possible without an accurate view into IT and facilities resources. The fact is, DCIM has become a valuable resource for Co-Lo providers and will continue to provide a return on investment.

Sev Onyshkevych is Chief Marketing Officer for FieldView Solutions, award-winning Data Center Infrastructure Management (DCIM) providers.

He can be reached at sev@fieldviewsolutions.com

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Emissions and Silencing for On-site Power

Exhaust System Integration Continues

by Bob Stelzer

The EPA's RICE NESHAP initiative has accelerated the integration of the emissions system and the silencer for on-site power applications. As emission standards continue to tighten it is likely that we will see continued exhaust system integration. A "single cube" exhaust system makes it easier for engine manufacturers, dealers and packagers to meet the regulatory requirements for any air shed in North America and beyond. To be effective, the single cube approach needs to accommodate any required combination of emissions control and silencing while ensuring that engine back pressure specifications are met. The single cube approach allows the system designer to meet the liabilities associated with engine exhaust requirements by dealing with a single supplier.

OVERVIEW OF EMISSIONS REQUIREMENTS

For diesel engines, in addition to the silencer, all or some of the following emissions devices may be required:

1) Diesel Oxidation Catalyst (DOC) to reduce unburned Hydrocarbons and Carbon Monoxide (CO)

2) Diesel Particulate Filter (DPF) to reduce Particulate Matter (PM)

3) Selective Catalytic Reduction (SCR) to reduce Nitrogen Oxides (NOx).

The required combination of these emission devices can vary from application to application. Some projects may require DOC + DPF + SCR to meet Tier 4 or Euro VI requirements. A "Tier 4 Final" (T4F) certified engine will come equipped with all of these capabilities "built in" by the engine manufacturer. However not all applications require a certified T4F engine. Many T4F engines with SCR systems turn off the engine when low urea (aka Diesel Exhaust Fluid) levels occur — an unacceptable situation for some applications. There are many cases where it may be more appropriate to use a Tier 2 or Tier 3 engine coupled with a third party exhaust after-treatment and silencing system. For example in some cases, especially for large engines, the space requirements may not allow placement of the engine manufacturer's T4F solution, yet there may be a regulatory requirement to achieve certain CO, PM or NOx targets. Another example is international projects where there may be a desire to eliminate visible smoke and reduce NOx, but cost requirements may make it more attractive to use a Tier 2 or Tier 3 engine with a third party exhaust system. Another example is emergency standby engine/generators. Typically an engine used for emergency standby does not need to be Tier 4 certified. Often for these applications Tier 3 or Tier 2 engines are used. In some instances, especially for emergency standby engines in heavily populated areas, there may be a requirement for NOx reduction in addition to silencing. In these cases the engine will require an exhaust system that has both an SCR and silencing.

For natural gas engines used in on-site power, the situation may be somewhat different. Many natural gas engines operate in prime power mode. Often they are used as part of a Combined Heat and Power (CHP) system. Many of these engines require a combination of Oxidation Catalyst (similar to a DOC) to reduce CO and an SCR to reduce NOx. CHP applications typically also have heat recovery devices in the exhaust. These devices reduce the available back pressure — leaving less available back pressure for the emissions and silencing system.

Of course both natural gas and diesel engines require silencing. The silencing requirements can vary

ANY MOTORMOUTH CAN YAP ABOUT RELIABILITY.

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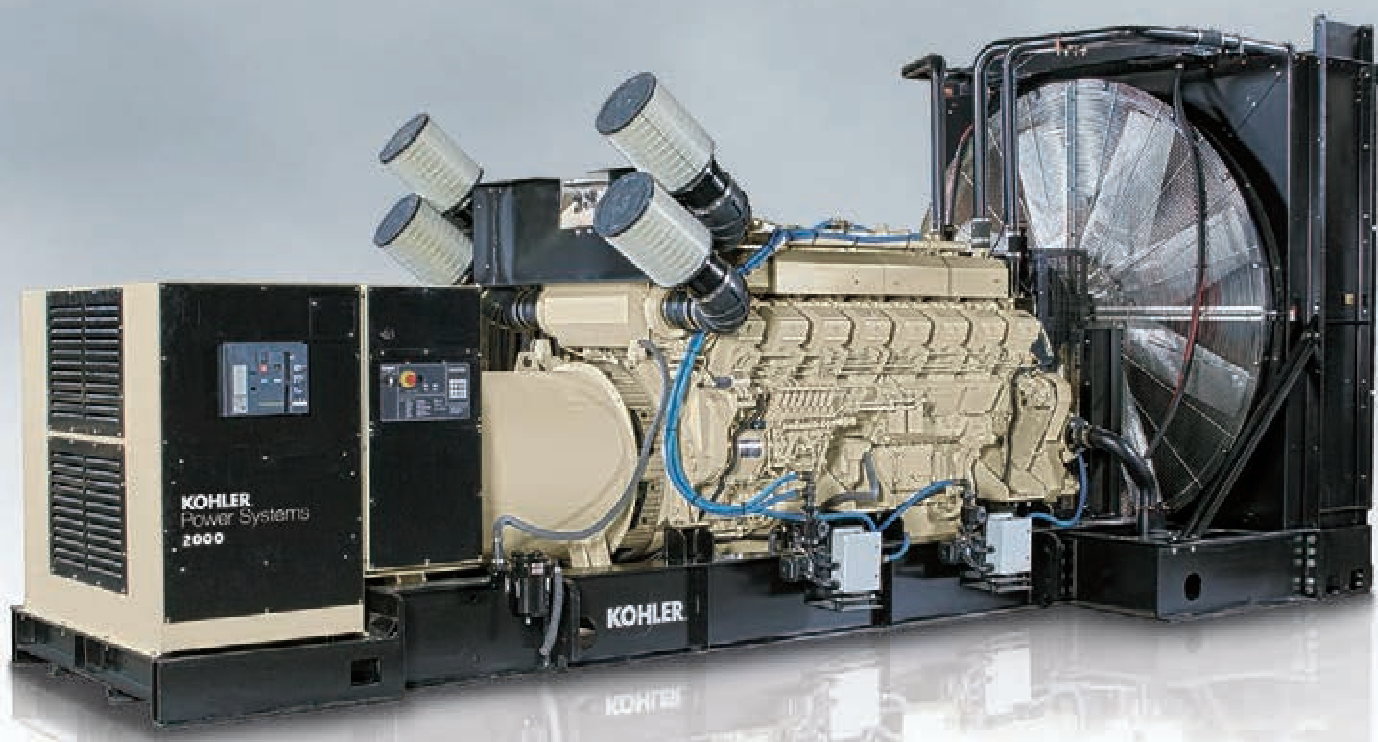

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depending on the site and its local regulatory requirements. Silencing requirements typically vary from a reduction of 20dBA to a high of 40dBA across a predefined set of octave bands.

As a result, there are many different combinations of silencing and emissions control that can make it difficult to select the right solution.

For example an engineer must consider the engine out emissions and the local regulatory requirements before selecting a silencer and associated emissions solution. In addition, if multiple components are required, such as a separate SCR, silencer, DOC and DPF, the engineer has to allow enough space for the components and must ensure that the allowable pressure drop for the engine is met. This can create a challenge. For example, Figure 1 shows a drawing for an SCR and a silencer for a 2MW engine. As can be seen in Figure 1 there are many expansion joints and a significant amount of piping that interconnects the devices. In addition a lot of space is required for both the silencer and the SCR.

A further complication for the engineer is how to package the emissions system with the engine. For example, is the emissions system going to be installed on top of an enclosure for outdoor application or will it be hung indoors from a ceiling above the engine? Is there enough space to mount the emission system horizontally or must it be mounted vertically? Will the exhaust enter the emissions system at a side wall or from the bottom? Dealing with these packaging constraints is a challenge which is especially important when there are tight space constraints.

Figure 1: Example of Multiple Exhaust Devices

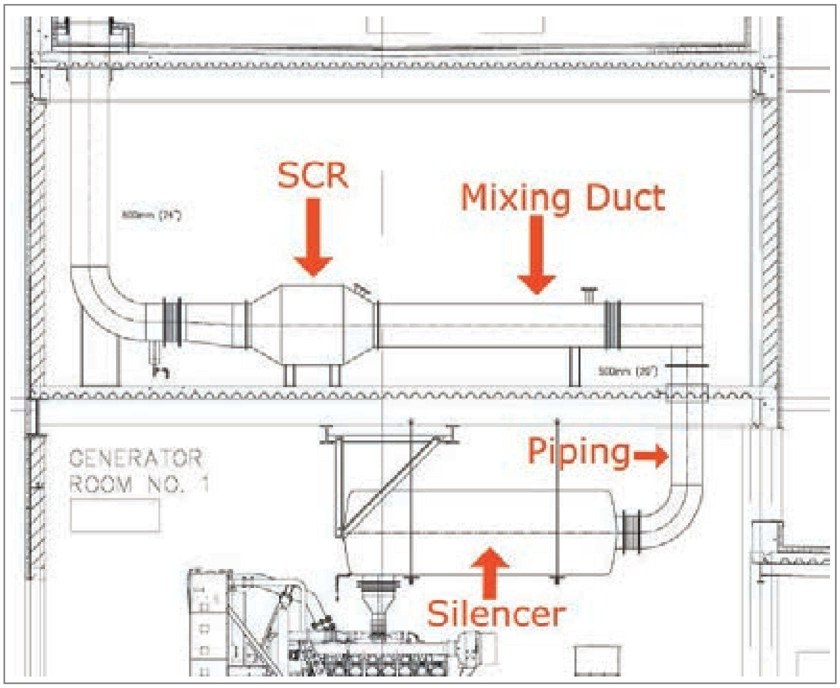
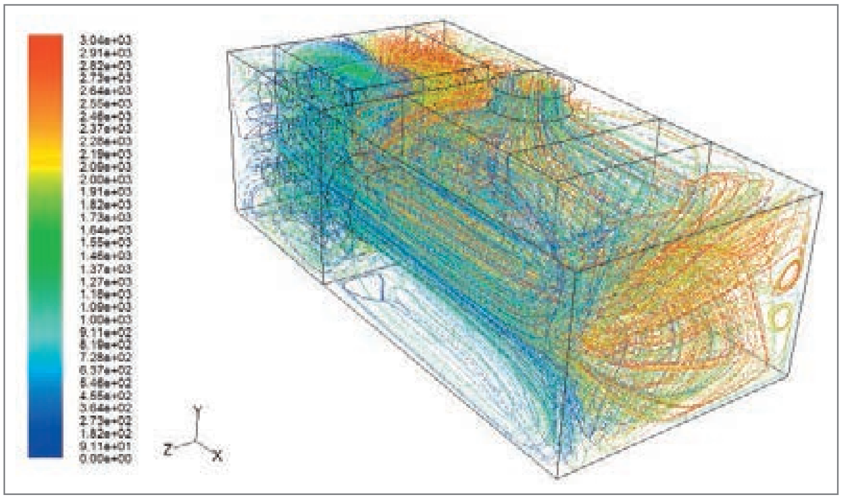


Figure 2: Example of CFD for a Single Cube Solution



AN INTEGRATED APPROACH TO EMISSIONS AND SILENCING

An ideal solution for engine manufacturers, dealers and packagers is the single cube approach discussed earlier. In this approach, a single device handles any combination of silencing, DOC, DPF and SCR. The ideal single cube solution would allow the engine exhaust to meet most regulatory requirements for noise and emissions anywhere in the world. In addition, the ideal cube approach would allow highly flexible packaging of the device if there are space constraints.

In order to create a single cube solution, a product family is required to deal with the various emissions, silencing and allowable pressure drop required for the many available engines that could be used in on-site power applications. To ensure that the cube is as small as possible the entire product family should be pre-engineered with Computational Fluid Dynamics (CFD) software to ensure optimal flow with minimal pressure drop. An example of a typical CFD streamline plot for a single cube is shown in Figure 2.

By incorporating the mixing tube required for an SCR inside the cube, the overall size of the SCR portion is reduced. The cube approach also allows integration of any combination of silencing, DOC, DPF with the SCR. For example, with the cube approach, it is relatively easy to configure an SCR plus Oxidation Catalyst and silencer for a natural gas engine or to configure a full Tier 4 solution for a diesel. If the cube is pre-engineered then the pressure drop for the combined system is automatically determined when the system is configured. Several different silencer inserts are available to meet different acoustics requirements. Figure 3 shows the packaging of modules in a single cube equipped with all of the available modules.

In addition to having a single cube solution to emissions and silencing, a significant number of interconnecting pipes and expansion joints can be avoided thereby reducing installation time and cost. The cube can be easily mounted on a genset enclosure or can be ceiling hung in a building application. Often it takes up not much more space than a conventional standalone silencer. The cube is suitable for indoor or outdoor mounting.

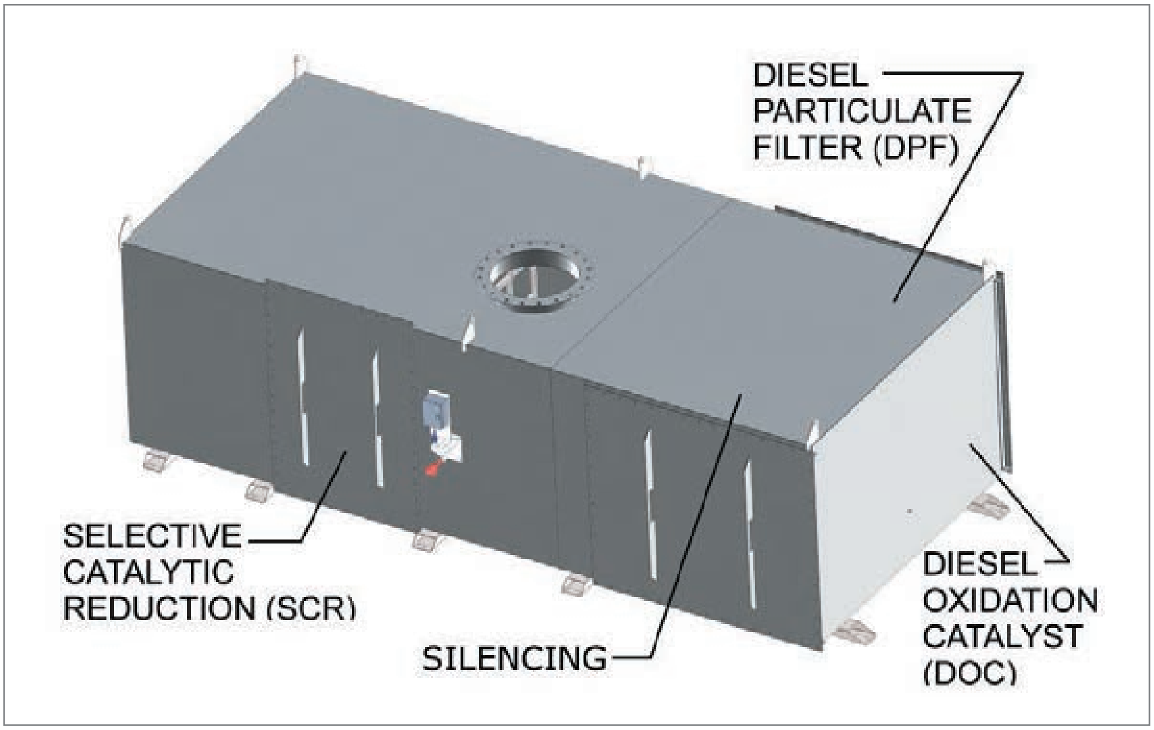
FUTURE DIRECTIONS FOR EMISSIONS AND SILENCING

The integration of technology to deal with the reduction of engine emissions and silencing will continue to become an important aspect of exhaust systems for on-site power. In the future there will be continued enhancements of the overall exhaust system leading to smaller, less costly and more efficient solutions to the ever increasing demand to further reduce emissions from engines used for on-site power applications.

IN CONCLUSION

Regulatory requirements and overall system cost will continue to drive exhaust systems that have tight integration between emissions control and silencing. Some engine manufacturers and system integrators will find a single cube solution to be a cost effective approach to meeting their customers' requirements.

Figure 3: Example of a Single Cube Solution



Bob Stelzer is the Chief Technical Officer for Safety Power Inc.
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IT'S NOT YOUR FATHER'S STATIC UPS

by Christopher M. Johnston, P.E.

When I first became involved in critical facilities design in 1988, I immersed myself in learning how static UPS systems operated and what their limits were. My mentor Raymond Daniell, who had years of experience in the field by that time, rightly told me that understanding UPS design and operation was the key to the data center. He was right, and the hours I spent on job sites looking over the UPS technicians' shoulders served me well.

The static UPS at that time was transformer-based, with input and output isolation transformers, an SCR-based rectifier, and an SCR-based inverter *(see Figure 1)*. The static switch was in the module for single module systems, and in a system control cabinet for multimodule systems (centralized or system-level static switch). It was a battleship with several weak points:

- Separate products for single module and multimodule systems,
- Low operating efficiency, particularly at part load (90% full load and 80% at 25% load),
- Large sensible cooling load (waste heat generated that requires air conditioning),
- Large physical footprint,
- Analog controls that needed adjustment every six months, and
- Difficulty getting the inverter offline quickly in case of failure or a downstream fault.

Figure 1

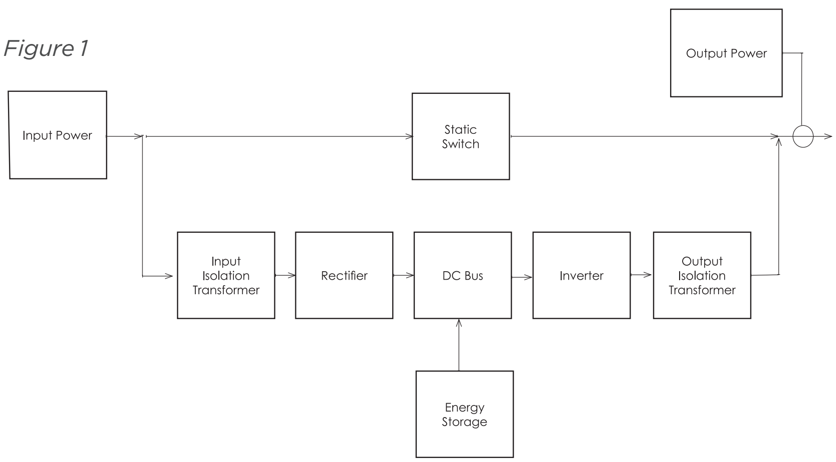
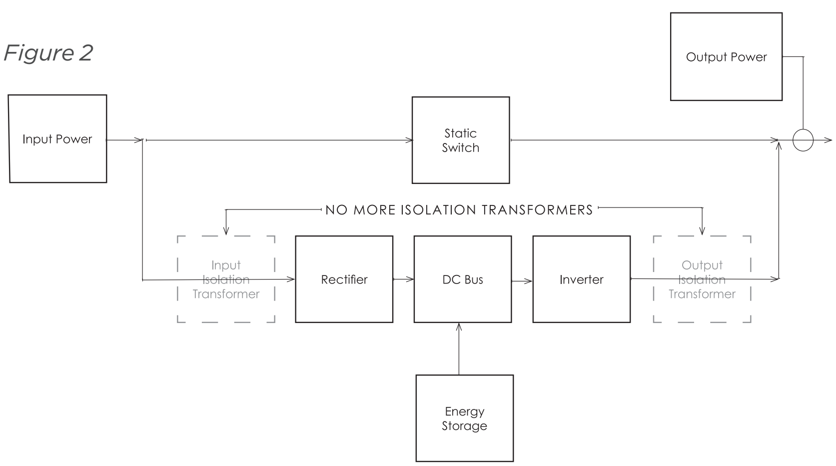


Figure 2



In the 25 years since, the static UPS product has changed a lot. Today's typical static UPS has an IGBT-based rectifier, an IGBT-based inverter, and perhaps an IGBT-based DC/DC converter between the DC bus and the energy storage *(see Figure 2)*. IGBT (Isolated-gate bipolar transistor) is a newer technology utilizing a three-terminal power semiconductor device primarily forming an electronic switch that combines high efficiency and fast switching. The input and output isolation transformers are gone, although some manufacturers still supply them in a few models. By the time the next generation of static UPS makes its way to the market, I predict all manufacturers will have eliminated the isolation transformers. The centralized or system-level static switch will also be gone, replaced by a distributed static switch in each module. Like the input and output isolation transformers, two manufacturers still supply centralized or system-level static switches, but I

Is DCIM worth it?

Actual cost savings achieved by FieldView customers – per 10,000 ft^2 of data center floor space†					
	Annual Power Consumption Reduction	Average Annual Carbon Emissions Reduction	Annual Hardware Cost Savings	Annual Staff Time Savings	Average Annual Cost Savings
Server Consolidation*	1,934,926 kWh/year	2272 tons	$149,000		$232,191
Thermal Management	1,241,666 kWh/year	1444 tons			$149,000
Immediate, Automated Hardware Monitoring			$20,000	1,200 hrs.	$110,000
Simplified IT Operations				4,920 hrs.	$369,000

*assuming 497 servers consolidated to blade servers at a ratio of 9:1 and a PUE of 2.00

Ever wonder if DCIM Solutions justify the investment? Download EMA's white paper, "Quantifying Data Center Efficiency: Achieving Value with Data Center Infrastructure Management" which was done in collaboration with FieldView customers.

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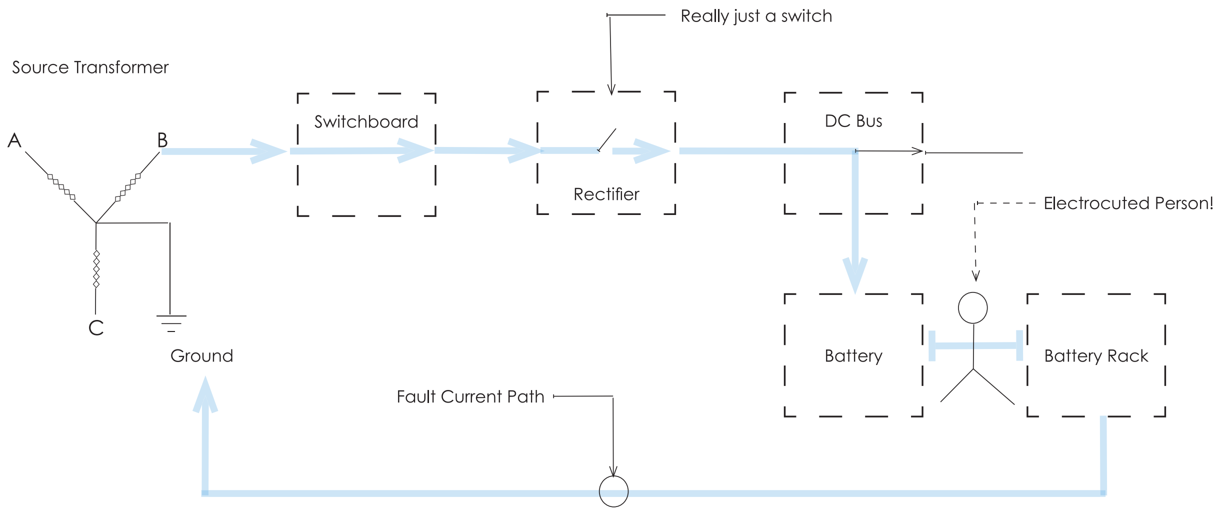
†Chart based on independent research conducted with a representative sample of FieldView Customers. Independent research and analysis of actual numbers conducted by Kaplan Associates, Crain Associates and Enterprise Management Associates.

Figure 3



predict they will soon vanish. Today's static UPS has remedied the weak points of the legacy static UPS:

- Same product used for single module and multimodule systems,
- Greatly increased operating efficiency, particularly at part load (94%-95% at full load and 92% at 25% load),
- Greatly reduced sensible cooling load,
- Much smaller physical footprint,
- Digital controls that are much more stable, and
- Ability to get the inverter offline quickly in case of failure or a downstream fault.

However, the new static UPS technology has created some new weak points of its own:

- The DC bus is no longer galvanically isolated,
- The output voltage can lose its neutral–to-ground reference during stored energy discharge, and
- The ability to provide a resistance-grounded output is questionable.

Since these weak points are not yet widely appreciated in our engineering community, let's examine each of them.

A galvanically isolated DC bus is isolated from the safety ground and provides a safer work environment. If a person simultaneously contacts either (of two) DC buses polarity and ground, the person may sense a tingle but will not be at risk of electrocution. The older static UPS provided this feature since it had both input and output isolation transformers, but today's transformerless static UPS does not *(see Figure 3)*. This places a person at risk if they are exposed to either DC bus polarity. If the energy storage device is a flywheel, preventive maintenance can be performed with the UPS module and flywheel shut down and de-energized. However, if the energy storage device is a vented lead acid battery or a valve regulated lead acid battery, voltage measurements must be made during routine preventive maintenance procedures while the battery is float charged. If these voltage measurements are made on a battery connected to a galvanically isolated DC bus, then the technician is not at risk. But if the DC bus is not galvanically isolated, the technician is at risk of electrocution. So, it's important that a battery monitoring system be installed on every battery supplying today's transformerless UPS systems.

When today's static UPS operates in its normal rectifier-DC bus-inverter power path operation, the output voltage waveform is referenced back to the neutral-to-ground bond of the upstream power system supplying the rectifier. When the rectifier turns off, the static switch is open, and the energy storage device supplies the critical load through the inverter, the output waveform loses its neutral-to-ground reference and floats with respect to ground. If a line-to-ground fault develops while the waveform floats with respect to ground, the other two phases and the neutral will shift with respect to ground. For example, let's assume the UPS output is 480Y277 volts, 3 phase, 4 wire, and output phase A becomes grounded. Phases B and C voltages to ground increase to 480 volts and the neutral voltage to ground increases to 277 volts. If there are any downstream loads with neutral connections on the 480Y277 volts system, they will be at risk. Likewise, if there are any surge protective devices downstream on the 480Y277 volts system, they may well conduct and cause a UPS system outage and loss of the critical load. So, how can we mitigate this risk?

- If the UPS has a 3 phase, 3 wire rectifier input, bypass input, and module output, your choices are limited. When the UPS is operating on the stored energy and a phase-to-ground fault occurs, you can select to either alarm the condition or shut the module down. Which option to select

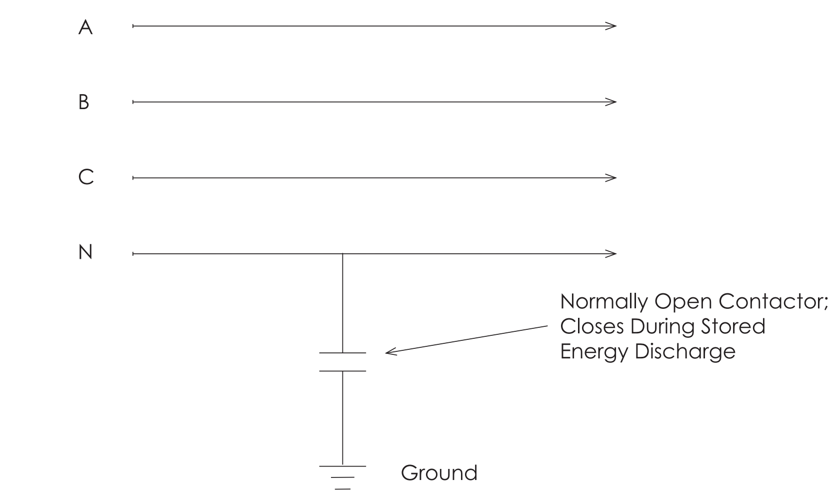


Figure 4

is a value and safety judgment of the the engineer/owner. Examples of this type of UPS are Emerson NX, Mitsubishi 9900A, and Toshiba G9000.

• If the UPS has a 3 phase, 4 wire module output, one has two choices. The first is to install a neutral conductor in the bypass feeder and connect it to the inverter output neutral terminal. The output neutral should not be grounded, ensuring the output is not a separately derived system *(see Figure 4)*. This technique will also work for a 3 phase, 3 wire inverter output, provided that an inverter output neutral terminal is available. The second choice is to install a 3 phase, 3 wire bypass feeder and have the UPS manufacturer provide a normally open contactor between the inverter output neutral terminal and ground *(see Figure 4)*. When the energy storage discharges, this contactor should close and ground the output neutral. Note that this second choice may require some discussion with the Authorities Having Jurisdiction since the UPS will operate as a separately derived system during battery discharge but not as a separately derived system at other times. The example of this type of system is Eaton 9395.

The legacy static UPS could be adapted by the manufacturer to provide a resistance-grounded output, if desired. The UPS system could be operated as a separately derived system with the grounding resistor connected to the output isolation transformer neutral, or as a non-separately derived system with the grounding resistor connected to the upstream source transformer neutral. Either method was a bit troublesome to implement but worked after some effort. With today's transformerless UPS the task will be more challenging:

• If the UPS has a 3 phase, 3 wire rectifier input, bypass input, and module output, it cannot support resistance grounding during battery discharge.

• If the UPS has a 3 phase, 4 wire bypass input and module output, it can be operated as a non-separately derived system. The grounding resistor connected to the upstream source transformer neutral will also serve the module output.

• Regardless, you should anticipate problems with excessive ground current. I was recently involved with replacing multiple, multimodule, legacy static UPS systems with later vintage systems. The Owner dictated we would have input and output isolation transformers so each module's DC bus would be galvanically isolated for safety, and we would retain the resistance-grounded output feature. The UPS manufacturer guaranteed we would have no problems since they had provided resistance-grounded systems many times over the years. They had, but not on their later systems with IGBT inverters. It took the manufacturer a number of weeks to eliminate the excessive ground current provided by all of the EMI/RFI filtering provided as standard. Their standard product provides EMI/RFI filtering that meets EU standards, which are more stringent than US standards. They finally removed all EMI/RFI filtering not required by US standards and reduced the ground current within specifications.

In summary, we've reviewed the weaknesses of the older legacy static UPS and how today's transformerless UPS product remedies these weaknesses. We've reviewed the not yet well understood weaknesses of today's transformerless UPS, and methods to remedy these weaknesses. I'm certain that I've overlooked something, but together we'll learn more about the transformerless product. And, just about the time we feel we understand it, the next new UPS product generation will hit the market.

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RELIABILITY DEPENDS ON EFFICIENCY –

by Aaron Rallo

"Superstorm Sandy" wasn't just the most powerful and destructive storm of the 2012 Atlantic hurricane season: it would prove to be the second-costliest hurricane in US history, surpassed only by Hurricane Katrina.

Understandably, few people at the time were thinking much about region's data centers. But for those in the industry—particularly in hard-hit New York and New Jersey—the storm brought with it one of our worst fears: sustained blackouts.

Thousands, perhaps even millions, of servers were left without electricity from the power grid, relying for days on secondary power sources. In most cases, that meant diesel.

Weak links in the supply chain

Diesel generators are the conventional back-up power source of choice at data centers. They are simple. They are familiar. And the technology itself is proven.

However, when data centers started to go down in the wake of Sandy, several weak links became obvious. These included flooded basement generator rooms, inadequate on-site fuel tanks, disruption to fuel delivery infrastructure like roads and truck fleets, and priority delivery of limited diesel resources to hospitals and other critical facilities.


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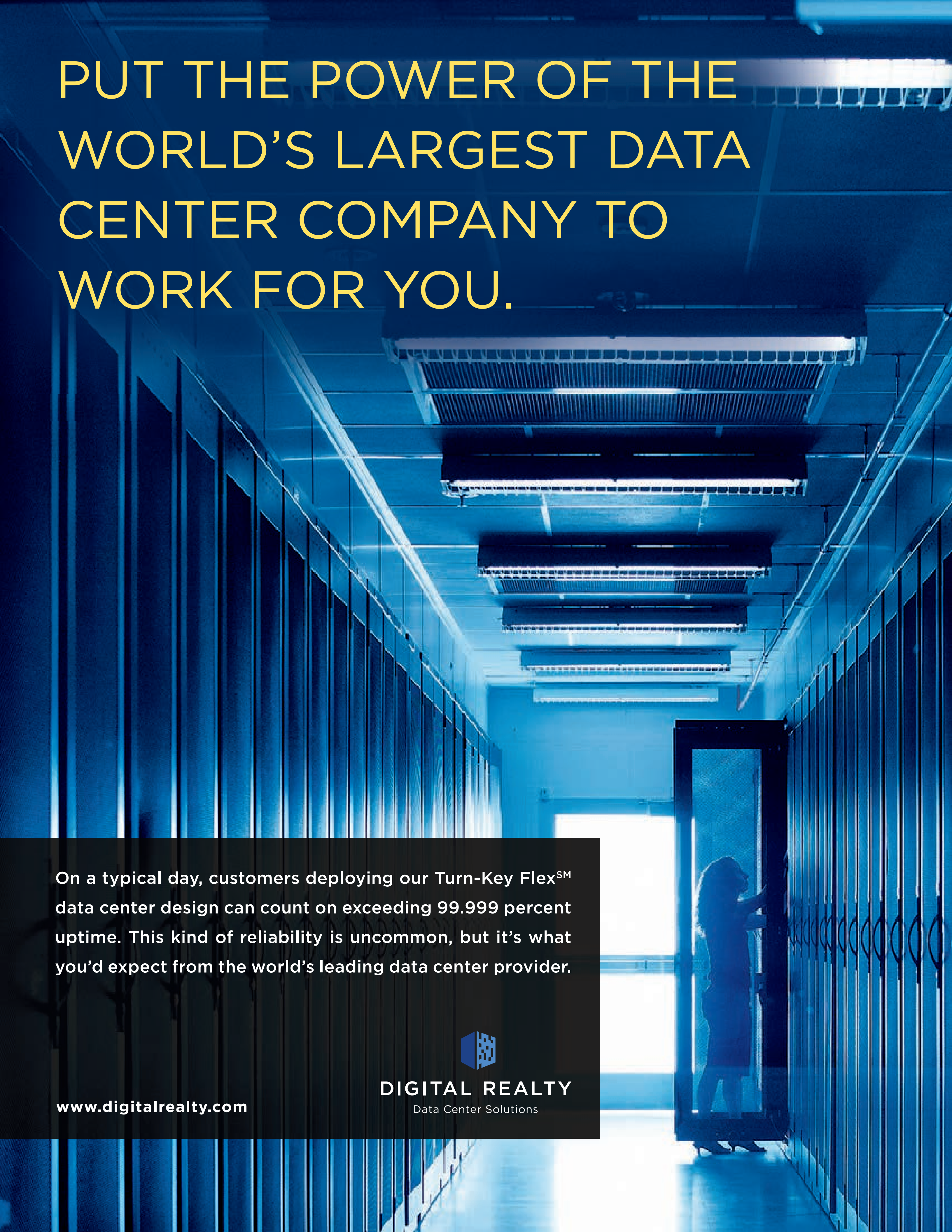
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It all comes down to the fact that diesel quickly runs out—and if you're not efficiently managing your power to ensure that you are only supporting critical operations, it runs out even faster. In a few cases, volunteer bucket brigades were even called on to move fuel up high-rise buildings in a desperate bid to keep servers up and running.

Not surprisingly, the storm was a major wake-up call.

The next big storm is naturally what data centers in the region worry about, especially since we are again in Atlantic hurricane season. But it's not just storms. Increasingly unpredictable weather patterns bring more mundane threats to power security as well; think about what happens when you combine sweltering summer days with an aging power infrastructure.

The root causes may be complex, but the lesson is clear: we need to do more to properly protect our uptime during power shortages, blackouts, and disasters, because those problems are definitely not going away.

Planning for tomorrow's shortages

Sandy left many companies reflecting on their disaster recovery planning and how to better protect their uptime when shortages strike. There are as many planning approaches as there are companies doing the planning, but here are a few common themes in more robust plans:

- **More intelligent power management.** Most companies already know what their most critical business applications are, but they may not have tools in place to preferentially protect those applications when sudden shortages hit. Intelligent, responsive tools such as application-aware power management software can help to ensure that limited power always goes to where it's needed most.
- **Protective, proactive efficiency.** When your data center is already energy efficient, and you're already accomplishing more with less resources, you're automatically in a more competitive position when it comes to riding out a shortage or disaster
- **Flexible, responsive, and tested.** Data centers should have plans in place to deal with both short-term and long-term power shortages and interruptions. In the case of major disasters and supply chain interruptions, they should also have an additional, redundant recovery plans in place. All of these plans should include regular check-ups and back-up testing to ensure that they are always up to date and ready to go.
- **Alternative back-up power.** Diesel generators will likely have their place in protecting uptime for the foreseeable future, but many companies are exploring greener, more cost-effective renewables as an additional layer of protection between grid power and diesel generation. These include biomass, solar, and wind generation.

Within these four themes, there are numerous solutions to explore. However, when it comes to disaster recovery planning, intelligent power management and energy efficiency are probably the least familiar approaches, so let's take a closer look at the contribution that they can make during a shortage.

Know where your power is going

How can you make informed decisions during a shortage?

Whether you're mandated to use minimal power or you're cut off from the grid completely, intelligent power management can have a central role in maintaining server performance and mitigating interruptions to customer experience.

A good power management solution that includes application-level inspection can provide you with detailed, real-time monitoring of where exactly your power is going, down to individual servers and applications. This allows you to understand how much electricity is being used for what, how quickly your secondary power is being depleted, and how long you can support your critical applications.

During an unfolding crisis, real-time data aids in making real-time adjustments to your planning, especially as the length of the interruption and the availability of back-up fuel become clearer. But even on a day-to-day basis, all of this data can help ensure that both your capacity planning and your disaster recovery planning accurately reflect the reality of your data center.

In the context of a disaster like Sandy, more accurate advance planning results in fewer unpleasant surprises at a time when you're the most vulnerable.

Get the most from limited resources

How can you do more with less?

Last year, the New York Times and consulting giant McKinsey and Company estimated that true server utilization rates are typically in the 6–12 percent range. The rest is just idling. This all adds up to a major opportunity when it comes to improving efficiency at data centers.

Responsive power management allows you to "cut the fat" by dynamically adjusting the power state of servers in direct response to application demand. That results in much less energy being wasted on powering and cooling idle servers that aren't helping you meet your Service Level Agreements.

(Of course, this is over and above other hard-wired energy efficiency measures that you may already have in place at the facility level—anything from newer lighting technologies to passive cooling measures.)

When there's an emergency, this kind of leaner operation means your diesel and other secondary power can last longer with little or no impact on performance. On a normal day, it simply means much lower energy costs.

But what if things get really bad and you're suddenly in the position of having to preserve your critical applications above everything else? An application-aware power management solution with fully granular administrative control will let you allocate less power to secondary applications, protecting your most vital services or biggest revenue sources.

On a cost level, you'll also be able to limit the amount of expensive secondary power—typically two to ten times more expensive than grid power—that is used on servers that aren't generating revenue.

Of course, modern power management solutions are useful for a lot more than safeguarding your uptime during a crisis. But it's during electricity shortages, blackouts, and disasters that the connection between smart power management, energy efficiency, and uptime becomes impossible to ignore.

Aaron Rallo is the Founder and CEO of TSO Logic.
He can be reached at arallo@tsologic.com

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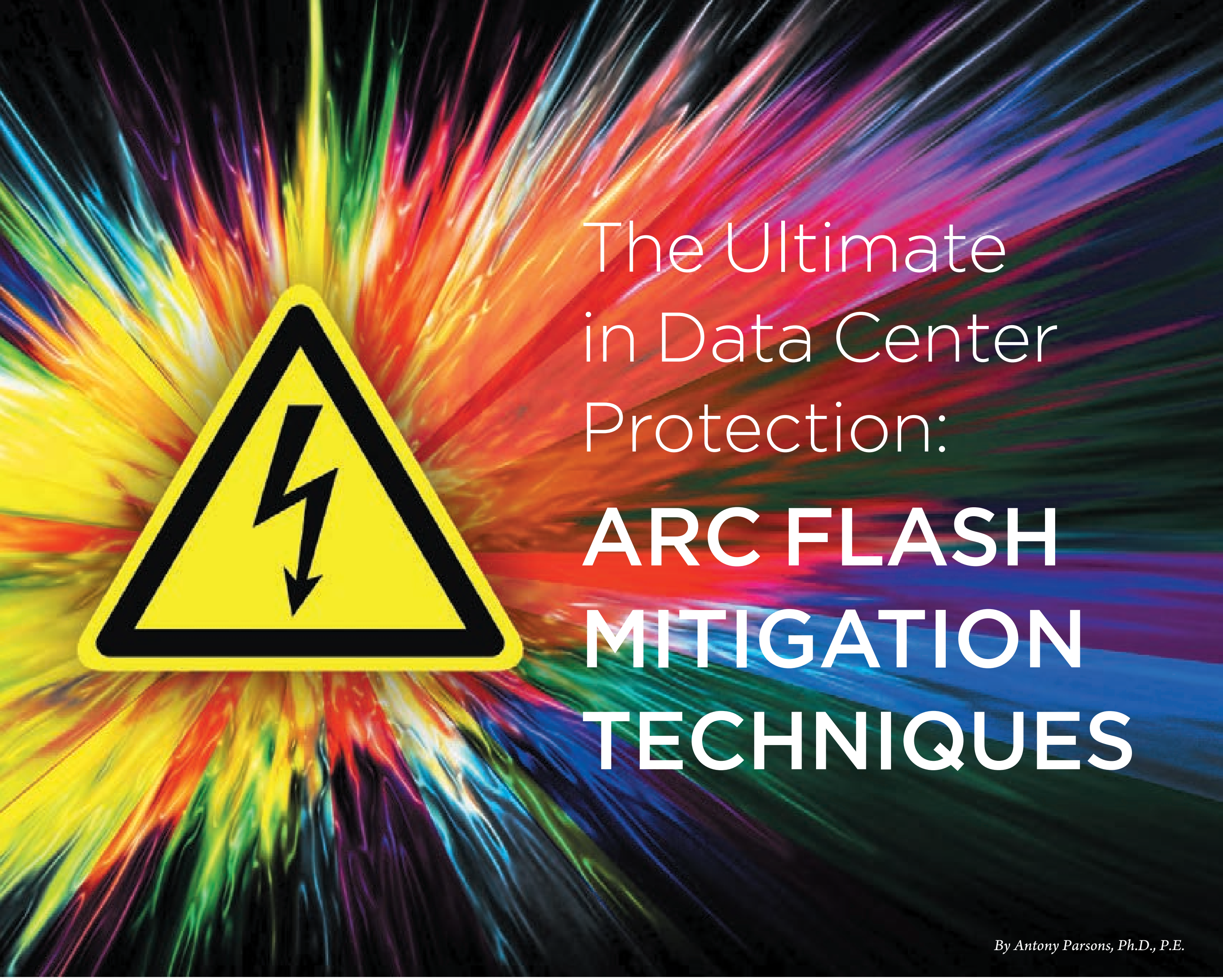

The Ultimate in Data Center Protection: ARC FLASH MITIGATION TECHNIQUES

By Antony Parsons, Ph.D., P.E.

The data center industry is growing increasingly aware of arc flash hazards, the dangerous conditions associated with the possible release of energy caused by an electric arc. Because of the high levels of fault current and voltages typically associated with electric power distribution systems, these arcing faults carry high levels of energy, releasing a great deal of heat and pressure into the environment. Arc flash events can result from a number of causes, including inadvertent contact with energized parts, contamination, or equipment failure. The resulting heat and pressure wave can cause severe injury or even death to workers. The heat and pressure can also cause significant damage to the equipment within which arcing faults occur. Given the high levels of potential energy through dense power infrastructures, data centers present prime conditions for arc flash.

NFPA 70E, the Standard for Electrical Safety in the Workplace, is the primary industry consensus standard in the United States that addresses arc flash safety. It contains extensive information on safe work practices, analysis procedures, requirements for documentation and equipment labeling, and Personal Protective Equipment (PPE) selection principles intended to allow for workers to be appropriately protected against arc flash hazards.

Increased awareness of arc flash hazards and years of research into the phenomenon led to increasingly stringent regulations in the late 1990s and early 2000s. In the decade or so since, the understanding and awareness of arc flash and related hazards has increased greatly among electrical workers, engineers, and safety personnel. But while much attention has focused on the need for system analysis and the selection of appropriate PPE, the application of product or design solutions intended to reduce the hazard levels or mitigate the risk of

arc flash events has received relatively little attention.

The most effective arc flash safety programs are those that do not rely solely on worker training, warning signs, and PPE, but also look to incorporate "safety by design" or other engineering controls that have been successfully applied in arc flash mitigation projects.

ANALYSIS & LABELING

NFPA 70E requires that a customer perform an Electrical Hazard Analysis, including an evaluation of both shock and arc flash hazards, when workers are going to be exposed to energized equipment operating at 50V or more. The incident energy analysis calculates the severity of the arc flash hazard at various locations in the system based on the available fault current and the arcing fault clearing time. Determining these parameters requires collection of a great deal of information on the system, including cable sizes and lengths, transformer and motor nameplate data, etc.

NFPA 70E requires that equipment be labeled to advise personnel of information sufficient to select PPE appropriate for the location, including either the required PPE level or available incident energy level.

MITIGATION STRATEGIES

Arc flash mitigation involves taking steps to minimize the level of hazard and/or the risk associated with an arc flash event. The American National Standards Institute (ANSI) defines a hierarchy of mitigation controls, listed from least- to most-effective:

- Personal Protective Equipment (PPE)
- Administrative Controls (work policies & procedures)
- Warnings
- Engineering Controls
- Substitution (less hazardous materials, processes, etc.)
- Elimination

While PPE, administrative controls, and warnings are required for every facility and make up essential parts of electrical safety policies and practices, they are the least effective mitigation techniques. PPE, in particular, is often mistakenly viewed as the solution to arc flash hazards. The reality is that even when PPE is properly selected, it does not guarantee freedom from injury.

Using the other techniques may be more effective. Engineering Controls are considered more effective than PPE because they seek to reduce the degree of hazard, and are considered to be more effective than administrative controls and warnings because they often do not rely solely on workers following proper procedures and safe work practices.

DEVICE SELECTION & SETTINGS

As arc flash incident energy varies linearly with time, proper selection of overcurrent protective devices is a powerful mitigation strategy. Since incident energy is proportional to arcing time, the use of faster-acting devices is key.

Circuit breakers, particularly those with adjustable trip settings that allow for shaping of the device tripping curves, may allow for better performance across a broad range of available fault current levels. To provide the maximum benefit, though, the breaker settings must be chosen with arc flash levels in mind, and instantaneous tripping must be employed. Selection of breaker settings that strikes an optimal balance between arc flash reduction and maximizing selectivity requires that arc flash be considered as part of the device coordination study.

Proper device selection is not only an issue for low-voltage fuses or breakers — it is important for protective relays as well. Older-style electromechanical overcurrent relays typically have an adjustable pickup level, an adjustable time delay based on a fixed curve shape, and may or may not have an instantaneous element. The relatively limited adjustability of the relay characteristics for these devices may make it difficult for them to provide good arc flash protection in some circumstances. Newer, digital relays typically allow for more flexibility in developing settings, making it possible to "custom-fit" a time-current curve that allows for faster clearing of an arcing fault while still maintaining selective coordination.

MAINTENANCE SWITCHES

Selection of proper device settings is not always straightforward. Settings must be chosen to properly protect equipment while still allowing for normal load currents and routine temporary overcurrents to flow without causing a trip. The need for coordination between various levels of devices typically means that overcurrent protective devices closer to the source are set with higher pickup levels and/or with longer time delays than devices farther downstream, but this can result in longer trip times and higher levels of incident energy.

One way to provide protection while minimizing the impact of miscoordination is the use of so-called "maintenance" switches. These are external switches that are wired into a circuit breaker or relay to allow an operator to select between "normal" and "maintenance" settings. In "normal" mode, the breaker or relay is typically set for normal selective coordination, which may result in a high incident energy level downstream. When work is being

performed, the switch is turned to the "maintenance" setting, which modifies the trip settings of the device in order to reduce the incident energy levels downstream.

RELAY SYSTEM DESIGN

In addition to selection of proper device types and settings, the basic design of a protective relaying scheme can help reduce arc flash levels in a system. For example, bus or transformer differential protection typically allows for faults inside the zone of protection to be cleared quickly without creating concerns over coordination issues. Since they typically operate quickly, they are also effective at reducing arc flash levels, so their use may be considered for locations where differential protection might not have been used in the past. Another mitigating relay design is using a relay installed at the low-voltage side of a transformer to trip a breaker on the high-voltage side rather than a local device. This "virtual main" system can increase the zone of protection all the way to the transformer secondary terminals, where good protection may otherwise be hard to achieve.

OPTICAL RELAYING

One relatively new way to deal with the competing needs of selective coordination and fast tripping is to use relays that detect the presence of arcing faults by looking for the flash of light associated with the arcing fault inside the equipment enclosure. When both a high current and a burst of light are present, the relay operates very quickly to clear the fault, typically through operation of an overcurrent protective device, but sometimes through activation of a shorting switch that creates a bolted fault that clears the arc even more quickly than a circuit breaker could operate.

SYSTEM GROUNDING

The method of system grounding can have an impact on arc flash hazards. High-resistance grounded (HRG) systems are not new, but recently they have been promoted as an arc flash mitigation means. The idea is that HRG systems inherently limit the energy delivered to a ground fault by limiting the available fault current to just a few amperes, providing a great deal of protection. Ground faults with such low current levels are unlikely to produce the explosion and intense heat characteristic of a typical arc flash event. However, HRG systems do not eliminate the possibility of a multi-phase arc flash occurring, nor do they reduce the energy delivered to phase-to-phase or three-phase faults.

An HRG system would make it less likely that a ground-fault in a system would escalate into a damaging three-phase arcing fault, so the risk of an arc flash event is reduced. But, the incident energy calculations and equipment labels would still show the incident energy levels calculated based on the three-phase fault, and worker PPE would not be reduced.

ARC-RESISTANT SWITCHGEAR

Worker safety can also be increased by containing and redirecting the effects of an arcing fault that occurs in a piece of electrical equipment. Arc-resistant switchgear provides protection from internal arcing faults to workers performing "normal operations" (e.g., operating a breaker) while standing in front of or around the perimeter of the equipment. Equipment qualified as "Arc-Resistant" has been lab-tested to show that an internal arcing fault will not:

- Cause doors or covers to open or blow off during the event
- Fragment and eject parts within the protected area
- Allow the arcing fault to burn through the enclosure
- Allow cotton indicators spaced about the gear to ignite
- Have any of its grounding connections become ineffective

There are several application issues that must be considered when using Arc-Resistant Switchgear, including ensuring that the available fault current and fault clearing times are within the values defined for the equipment, access is limited to above and below the gear, required room dimensions are observed, and if/how to vent gases and other byproducts of the arcing fault.

One drawback of traditional passive Arc-Resistant Switchgear is that it may not do anything to reduce the intensity or duration of the internal arcing fault itself. The equipment may be designed to contain the "blast" but the internal damage may be significant.

REMOTE OPERATIONS

Increasing the effective working distance (distance between a worker and the location of the arc) is also a very effective mitigation strategy, since energy levels drop off exponentially as the working distance is increased. Remote operation of circuit breakers or switches is an established technology that can be accomplished in a number of ways. Remote switching of devices may be done from remotely-mounted operating switches, pushbuttons, HMI screens, and even over networking through SCADA systems or network-connected relays. There are even portable devices that can be temporarily mounted to control switches or other operating mechanisms. In all cases, the ideal situation is for the remote operating point to be located outside the arc flash boundary of the equipment being controlled.

DESIGN CHOICES

There are certain fundamental design choices that can impact the ultimate levels of hazard and risk when the system is in operation. Consideration of these issues in the initial design stage can help engineers more effectively design safety into a system rather than trying to develop patchwork solutions after-the-fact.

An initial arc flash analysis can identify potential areas of concern before the design is complete, leading to better choices of network topology and equipment specifications. Waiting to perform an arc flash analysis after the design is complete and equipment is being manufactured has the potential to either handicap mitigation efforts or make them much more expensive.

Mitigation efforts in existing facilities should include careful prioritization of efforts, including identification of locations where implementing solutions may be more difficult but where high energy levels or frequent worker exposure justify the efforts.

MAINTENANCE

Properly maintained electrical equipment is less likely to fault and more likely to be able to clear faults that do occur. Proper maintenance practices are an important part of an electrical safety program and must be employed along with other mitigation techniques. For facilities with existing maintenance programs in place, installation of engineering controls such as maintenance switches or optical relaying may require that such procedures be updated to include the new equipment.

Maintenance should also be considered in the system design phase. In facilities such as data centers where uptime is critical and business conditions do not allow for extended facility shutdowns for maintenance, "run to failure" should not be the response. Instead, redundancy should be designed into the system such that individual pieces of equipment can be taken completely out of service without interrupting power to critical loads. If redundancy is designed into a system, that redundancy must be actively maintained as well.

Infrared thermography is a routine part of the electrical maintenance program in many facilities. Loose connections or other defects in electrical equipment may create "hot spots" that give early warning of impending failure and are readily visible to infrared cameras. Installation of infrared viewing windows in equipment allow for infrared scans to be performed without exposure to hazardous energy. Not only is hazard exposure reduced because equipment covers do not have to be removed, but the entire process is made faster and therefore less expensive, making it easier and more cost effective to perform periodic inspections.

Newer continuous monitoring technology has the potential to allow for earlier detection of potential issues as well as to allow for development of "condition-based" maintenance programs based on actual site conditions. Properly placed thermal sensors can perform essentially the same diagnostics as thermographic scanning, but on a continuous basis. Partial-discharge monitors can detect degradation of insulation systems before they actually break down and cause a fault. Advanced trip units and relays monitor or predict breaker contact wear. These and other monitoring solutions can be wired to local alarming, facility-wide SCADA systems, or set to automatically alert operators of potential issues.

CONCLUSION

Application of engineering controls to help mitigate arc flash hazards can be a very effective way to enhance safety for electrical workers. Ideally, arc flash safety is taken into consideration when a facility's electrical distribution system is designed, but many techniques are equally applicable as retrofits to existing systems. Products such as specialty relaying and remote operating mechanisms intended to specifically address arc flash are still relatively new, and future developments will add additional "tools" to the mitigation toolbox. Advances in related fields, such as those related to maintenance of electrical equipment, should not be overlooked either. Although the application of some solutions results in increased costs, the financial impact of even a single serious injury makes arc flash mitigation an ultimately wise investment.

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2013 FALL CONFERENCE HIGHLIGHTS

TURNING VISION INTO ACTION

The Fall Conference themed "**End-to-End Reliability – Turning Vision into Action**" will be held November 17-20 at the JW Marriott San Antonio Hill Country. The Conference will feature compelling keynotes, high level speakers, concurrent sessions, an end user only forum, a NEW Marquis Plus+ Partner Showcase, a spectacular sponsored event, and more.......

Carly Fiorina, Former Chairman & CEO of Hewlett Packard will kick off the conference with a session entitled "**What it Takes to Stay Competitive: Sparking Innovation for Business and Economic Growth**". Innovation is a requirement for any company that wants to stay ahead of the competition and thrive in the global economy. Innovation is not simply a breakthrough idea, a hot new product or a lucky accident. Instead, consistent and effective innovation requires the focused introduction of new ideas and new ways of doing business. Innovation must be managed, measured and inspected. As the leader of the largest technology company in the world, no one is more qualified to speak about innovation than Carly Fiorina. As an active participant in the public policy and political process, Carly also speaks knowledgeably about the role of government and the impact of regulation and taxation on innovation.

A panel of industry leaders will discuss the importance of data in achieving high reliability and reducing energy use but also compare approaches to gathering data, understanding which information is important and how to access it, as well as confirming conclusions drawn from the data at a panel discussion entitled "**The Power of Data in Data Center Operations**".

MODERATOR:

Kevin Heslin
Senior Editor
The Uptime Institute

PANELISTS:

Stephen Fairfax
President
MTechnology, Inc.

David Schirmacher
SVP of Operations
Digital Realty

John Sasser
Vice President Operations
Sabey DataCenter Properties

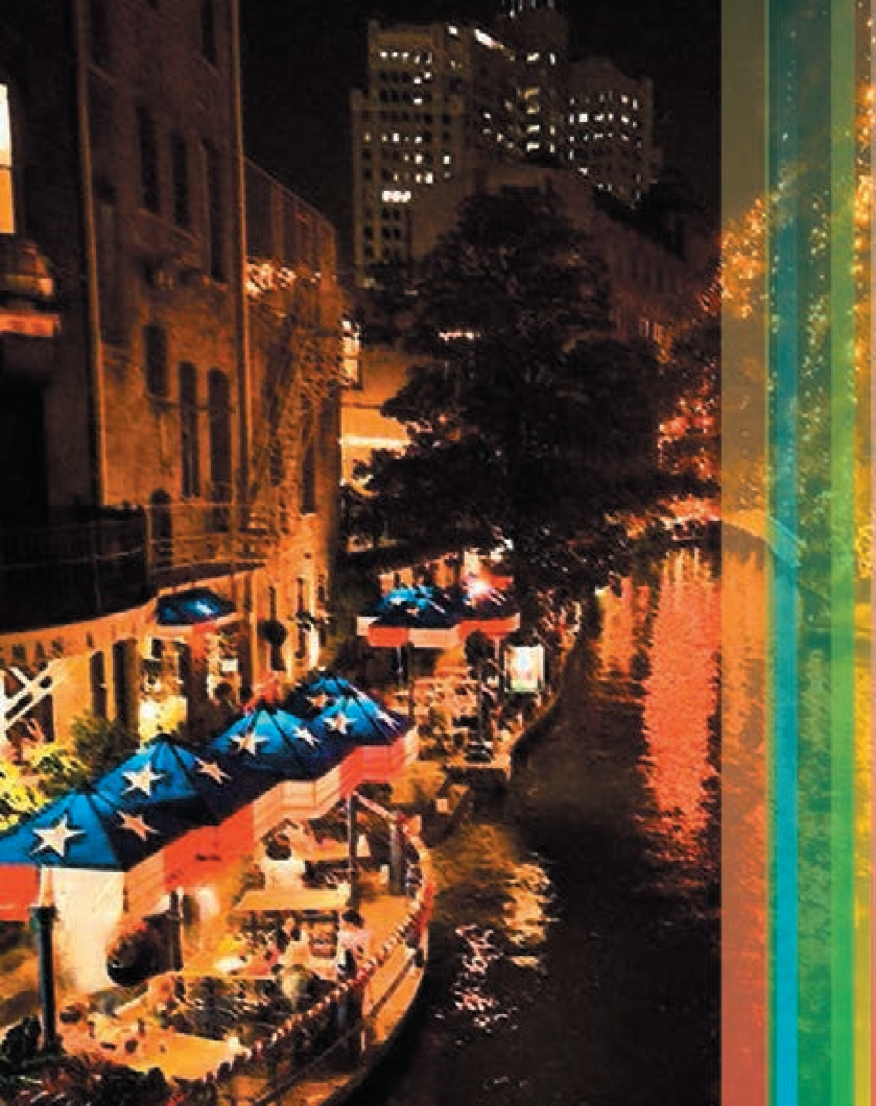
W. Pitt Turner, IV
Director Emeritus
The Uptime Institute

Director of Data Center Operations for Facebook, **Delfina Eberly**, will open the second day with a keynote presentation entitled "**Optimizing Data Center Operations**".

The closing keynote is entitled "**The Integral Role of Power and Monitoring in DCIM**" and will be delivered by **William Dougherty** of RagingWire and **Luke Dalske** of Schneider Electric.

In keeping with the theme, additional presentations will be delivered on topics such as:

- Water Cooling of IT Equipment
- Benefits of Modular Data Centers
- The Evolving State of the Data Center Industry
- Maintenance Considerations for Emergency Power Systems
- Who is Responsible for Energy Efficiency?
- Meeting Today's Data Center Security Challenges



"Six Flags Over Texas" is the slogan used to describe the six countries that have had sovereignty over some or all of the current territory of the U.S. state of Texas. This slogan has been incorporated into shopping malls, theme parks, and other enterprises and now it is the theme of the 7x24 Exchange Sponsored Event.

You are invited to join 7x24 Exchange for a journey to La Villita, the little village in downtown San Antonio on the historic "River Walk" for a celebration of the Six Flags Texas has served under. The destinations you will experience are Spain, France, Mexico, Republic of Texas, the Confederate States of America and United States of America. In addition to experiencing the culture, food and entertainment offerings from these 6 countries you will also have the opportunity to enjoy a one of a kind River Barge cruise showcasing the best of what downtown San Antonio has to offer. Feel free to stay after the event is over as 7x24 Exchange will be providing transportation back to the resort until 1:30 A.M. so you can enjoy downtown San Antonio.

Located on the south bank of the San Antonio River, La Villita was San Antonio's first neighborhood. It was originally a settlement of primitive huts for the Spanish soldiers stationed at the Mission San Antonio Valero (the Alamo). After a flood in 1819, brick, stone and adobe houses replaced the earlier structures. In 1836, La Villita was the site of General Santa Ana's cannon line in the Battle of the Alamo and a map from early that year showed the village to be of considerable size.

Late in the 19th century European immigrants from Germany and France moved into the area. These pioneers became San Antonio's business leaders, bankers, educators, and craftsmen. The cultural mix that occurred at this time is best illustrated by the variety of architectural styles reflected in La Villita's buildings. The architecture portrays the evolution of buildings from palisado to Victorian houses.

The first part of the 20th century saw La Villita decline into a slum area. In 1939, as ground broke on the San Antonio River Walk development, city fathers led by Mayor Maury Maverick acted to preserve this colorful part of San Antonio's history. Today La Villita is a thriving art community that stands as a monument to San Antonio's past.

In addition to enhanced programming
7x24 Exchange International presents

Six Flags Over Texas at the River Walk

Special thanks to the partners that made this event possible:

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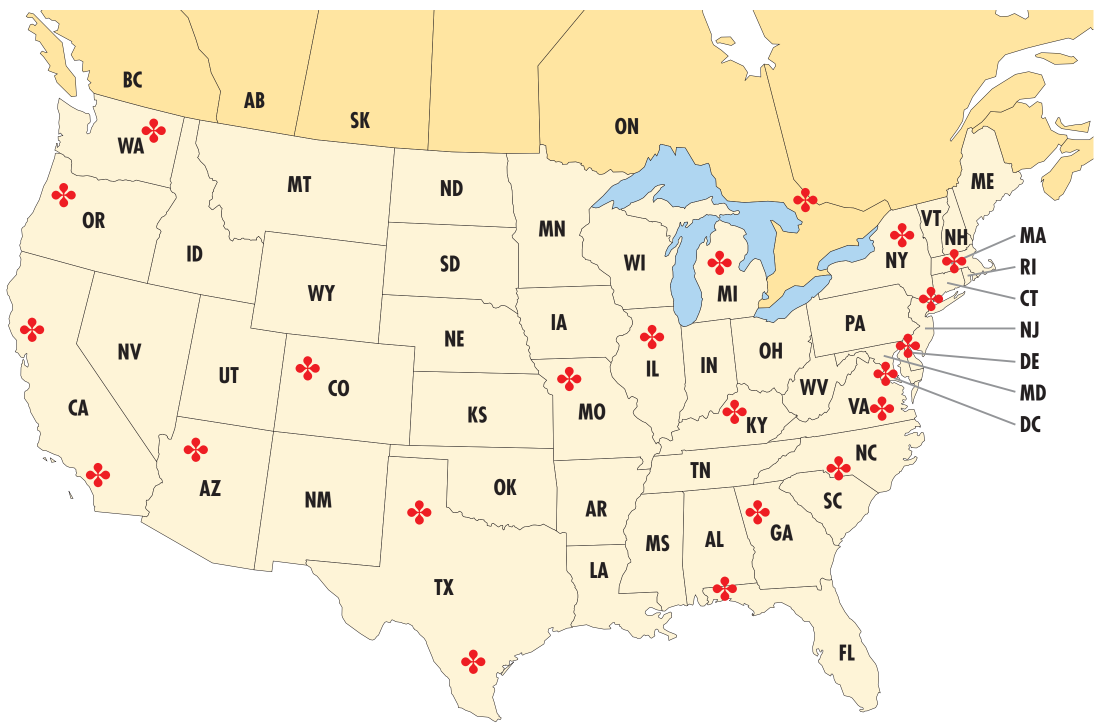

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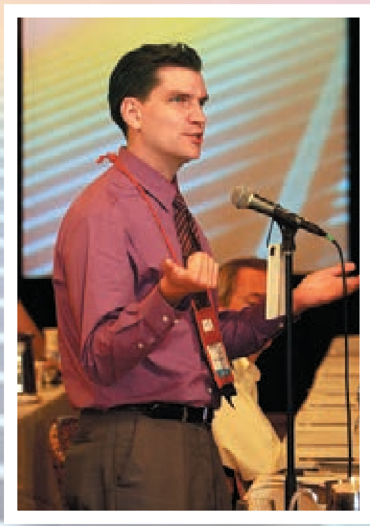


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SESSION


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7x24 MAGAZINE OPPORTUNITIES

Following are the Editorial Guidelines together with the Member Advertising Rate Card. Advertisers interested in placing an ad may fax the insertion order to 7x24 Exchange at 212.645.1147 or email to tara@7x24exchange.org. Questions? Please call Tara Oehlmann at 646.486.3818 x104.

MEMBER ADVERTISING RATE CARD

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Size	1X	2X	3X
Full Page	$1,500	$1,300	$1,100
2/3 Page	1,100	1,000	900
1/2 Page Island	900	800	700
1/2 Page	700	600	550
1/3 Page	600	550	500
1/4 Page	500	450	400

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Size	1X	2X	3X
DPS	$5,000	$4,500	$4,000
2nd / 3rd Cover	2,500	2,200	2,000
4th Cover	3,500	2,750	2,500

COLOR RATES

Process Color (4/c): $900

Revisions and Proofs: $50

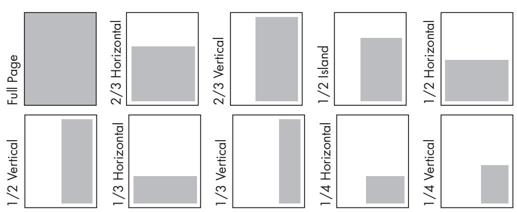
Position Guarantee: 15% premium

*Non-Members add 40% to all rates

NON-BLEED AD DIMENSIONS

Size	Width	Length
Full Page	7.5″	10″
2/3 Horizontal	7.5″	6.5″
2/3 Vertical	5″	10″
1/2 Island	4.875″	7.5″
1/2 Horizontal	7.5″	4.875″
1/2 Vertical	3.625″	10″
1/3 Horizontal	7.5″	3.25″
1/3 Vertical	2.5″	10″
1/4 Horizontal	4.5″	3.25″
1/4 Vertical	3.25″	4.5″

8 1/2″ x 11″ MECHANICAL REQUIREMENTS



Live Area: 7.5″ x 10″
Trim Size: 8.5″ x 11″
Bleed Size: 8.75″ x 11.25″
Halftone Screen: 133 lines up to 150 lines

DPS Mechanical Requirements:
Live Area: 16″ x 10″
Trim Size: 17″ x 11″
Bleed Size: 17.25″ x 11.25″
Halftone Screen: 133 lines up to 150 lines

Press optimized PDF or EPS accepted. No JPEG or TIFF accepted.

Convert all spot colors to CMYK.

Do not use 4 color black. All 4 color black will be replaced with 100% black at the advertiser's expense.

Fonts must be embedded or outlined.

Maximum ink density 280%

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Manuscript specifications: Feature articles vary in length from 500 to 2,000 words. While we accept articles in a variety of formats, it prefers to receive materials on CD. All articles must be received by the deadline to be considered for a specific issue. Material submitted after the deadline will be considered for the following issue.

Bylines: All articles should include a brief (1-2 sentence) author biographical sketch at the end of the article, that includes the author's name, title, affiliation, address, and phone number. Photos of authors are never used. We do not pay authors for contributions.

Visuals: Authors are encouraged to submit photographs and charts, graphs, or other illustration that will help readers understand the process being described, though it does not guarantee that visuals will be used with the article. Submit all charts, graphs, and other artwork separately; do not incorporate them in the body of the article. Indicate caption material separately. We reserve the right to publish submitted visuals.

Editorial procedures

All articles are reviewed for suitability. Accepted materials are then edited for grammar and to conform with our editorial style. All attempts are made to preserve the author's writing style, however, we have the right to edit for style, clarity, and to fit space allotments, and to make final selection on headlines, subheads, and graphic treatment. Manuscript submission implies author agreement with 7x24 Exchange's Editorial Policies.

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save the date

June 2014

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