Critical Power Management Systems (CPMS)

Jointly published by

building operating management

ASCO®

EMERSON
Network Power
Executive Summary

Power control systems are essential to ensuring the reliability of emergency/backup power systems. Leading organizations, such as Digital Realty and Geisinger Health System, devote resources to evaluating possible power control improvements. And a recent ASCO/Building Operating Management survey of facility executives shows that there is a strong desire among facility executives for more power control information than they have now. The need for additional information is particularly strong among data center and health care facility executives. However, many facility executives are not familiar with current technology options and best practices.

Products used today for power control applications often lack best practices features in such areas as monitoring, control, reporting and power quality analysis. When power management is critical to business operations, the best practice is to use a dedicated critical power management systems (CPMS) to monitor, control and analyze their emergency power.

This white paper reports on the findings of the power control survey, highlighting key power controls capabilities and describing the benefits of those capabilities for facility executives.

Introduction

A rising number of organizations — hospitals, financial institutions, telecommunication companies, co-location data centers and many others — are making significant investments in emergency/backup power systems. But those systems themselves are vulnerable to problems that can undermine the money spent to ensure reliable power. Power controls offer facility executives a range of capabilities to ensure the performance of critical power systems when they are needed.

The marketplace is full of products that offer individual power control capabilities. However, many products used for power control applications lack best practices features in such areas as monitoring, control, reporting and power quality analysis. A survey of facility executives shows that most power control systems in use today lack important functions in those areas. What’s more, many facility executives lack awareness about those functions and their potential benefits. Wider use of power controls that offer those capabilities could provide significant benefits to facility executives seeking to maximize the reliability of their emergency/backup power systems.
Cost of Power Interruptions

There is a significant need for emergency/backup power in the United States. A study conducted by Lawrence Berkeley National Laboratory in 2005 estimated the cost of power interruptions at $57 billion annually for the 15 million U.S. commercial customers.

Even more revealing was the researchers’ finding that momentary interruptions (defined as five minutes or less) were responsible for more than two-thirds of the total cost. That discovery showed “it is the length of the ‘down-time’ resulting from a loss of power that determines the cost of interruption, not necessarily the length of the interruption itself,” said Joe Eto, who along with Kristina Hamachi-LaCommare, authored the study.

Data centers are particularly sensitive to interruptions. Data center downtime costs business more than $5,000 per minute, according to a 2011 Ponemon Institute study of U.S.-based data centers. That study found the average reported incident length was 90 minutes, resulting in an average cost per incident of more than $500,000.

For businesses that rely on IT systems to support critical applications, downtime can be even more costly. The highest cost of a single such event in the study topped $1 million, or more than $11,000 per minute.

In health care facilities, power problems can result in losses more significant than financial costs, so it’s not surprising that many health care organizations have made significant investments in emergency/backup power.

For example, Geisinger Medical Center has 14 emergency generators. The health care campus has also installed three backup generator panels to allow portable generators in the event of catastrophic failure. In many cases, the medical facility can transfer loads from one building’s generator to another generator, should the need arise, says Al Neuner, vice president of facilities operations.

What’s more, the uninterruptible power supply (UPS) is on its own dedicated utility feed, so that patient-sensitive units, such as operating rooms and intensive care units, do not experience the 7- to 10-second blackout a main line power failure might cause before emergency generators take over, says Neuner.

“We try to think of every worst-case scenario and then avoid it,” explains Richard Schetroma, electrician supervisor for Geisinger Medical Center.

An ASCO/Building Operating Management survey of facility executives suggests that further investments in emergency/backup power are likely. The survey found that a significant number of facility executives would like to have more of their load on backup/emergency power. Of respondents to the survey, 54 percent indicated that less than one quarter of the facility load is on emergency power, while only 12 percent reported that three quarters or more is on emergency power. Asked what percentage of the load they would like to have on emergency power, only 26 percent said less than one quarter, while 30 percent said three quarters or more.

(See Figures 1 and 2 above.)
Importance of power management

That recognition of the importance of emergency/backup power extends to the systems that manage the emergency power system. Asked about the importance of power management of the emergency power system, 42 percent of facility executives in the survey rated it critically important. And 52 percent said they needed the power management system to be available at all times, with another 18 percent willing to accept an hour of downtime or less each year. (See Figure 3.)

Facility executives responsible for data centers and health care facilities rated power management as even more critical than overall survey respondents.

Despite the importance that facility executives attach to critical power management, only 24 percent have a single best-practices system that monitors, controls, and provides reporting and power quality analytics for the emergency/backup power system. (See Figure 4.)
There are many products that are used to manage the emergency/backup power system. At one end of the spectrum are simple systems with limited capabilities. However, when power management is critical to business operations, the best practice is to use a dedicated critical power management system (CPMS) to monitor, control and analyze their emergency power. Sophisticated CPMS are used in medical centers, high-end data centers and co-location facilities, and telecommunications sites, among other types of facilities. These systems often have some functions and alarms integrated into a building management system (BMS) or data center infrastructure management (DCIM) system. High-end CPMS feature integrated devices communicating on a dedicated network.

Power controls often need to cover emergency generation sets, circuit breakers, transfer switches, bus bar, paralleling control switchgear and other emergency power system equipment. The focus is to ensure power reliability should something happen to the main utility feeds.

Power controls can also facilitate on-site power system testing, load management and bus bar optimization. The system can also monitor normal and emergency voltages and frequency; indicate transfer switch position, source availability, normal and emergency voltage and frequency, current, power, and power factor; and display transfer switch event logs, time-delay settings, rating and identification.

High-end power controls are proprietary or semi-proprietary solutions, running on their own dedicated, independent backbone. They can provide energy monitoring, power controls, detailed reporting capabilities and high-end power quality analytics. They generally are integrated so that they may feed some data into BMS and data center information management (DCIM) systems. However, the volume and speed of the data that sophisticated power controls are processing would overwhelm most BMS or DCIM systems.

In the healthcare industry, power controls can play a vital role in complying with NFPA requirements as well as Joint Commission reporting mandates to maintain accreditation. These requirements include emergency power testing programs for generator load testing (sometimes called “30 percent” testing) and emergency power supply system (EPSS) maintenance. The programs require testing the power sources from their utility power sources to the emergency generators and then back to the utility power again. Such transfers can disrupt complex medical equipment and operations, as well as the BMS itself.

For other mission-critical facilities like data centers and telecommunications sites, dedicated and fully integrated power monitoring system complies with National Electrical Code requirements and EN50160 Power Quality Compliance.

"A newer section added to the National Electric Code provides guidance on the design of critical operations power systems (COPS), which can apply to facilities or areas within facilities where power loss and disruption to operations could affect public health, national security or the economy," explains Caroline Fenlon-Harding, vice president of WSP Flack + Kurtz. "The control and monitoring systems supporting COPS must be designed to provide a high degree of reliability and resiliency. For COPS, the design of the control and monitoring systems would need to include physical security and protection, fully selective coordination, surge protection, and other specialized requirements."
Inside the Technology

Sophisticated power controls operate at extremely high speed and have the ability to cache or share vast amounts of data from one device to the next without disrupting other building functions.

The majority of data transfer between subsystems of the power control system itself happens at speeds and bandwidths that would incapacitate most BMS or data center information management (DCIM) systems. High-end power controls are normally accomplished through either standalone proprietary networks or through individual vendor agreements to share critical information under one marketing umbrella. These standalone networks then feed essential information to the BMS or DCIM.

"When the client needs such power quality details as waveform capture or transient harmonic displays, extremely high rates of speed are required," says Morris Toporek, senior vice president for Environmental Systems Design (ESD). "At that level of technology, there are no standardized platforms or protocols like Modbus or BACnet. The facility executive is tied to vendor proprietary software to accomplish sophisticated analysis."

In some situations, such as Northwestern Memorial Hospital's Prentice Women's Hospital in Chicago, this communication is accomplished with a self-sustaining, isolated network that includes an Ethernet dual fiber optic ring that is self-healing.

Roles for other systems

Although BMS and data center information management (DCIM) systems may not be able to handle the volume or speed of information required for advanced critical power applications, they need to be sophisticated enough to import crucial operational data from power controls.

"The building automation system should allow a one-line diagram of the emergency backup power system," observes Robert McCarthy, senior associate with ESD.

In addition, some power monitoring details do not require lightning speeds and can be accomplished at the BMS level. For example, business-critical facilities and medical centers may have two or more utility mains.

With such solutions, facility executives have to watch swing loads. "You want to make sure your loads are balanced," says McCarthy. "If, for whatever reason, there is too much load on one side, problems may occur on a failure that causes a switch to the other side. Facility executives must know if their system can be supported by one side for redundancy."

While such issues need to be handled carefully and quickly, they do not generally require microsecond or millisecond reactions, as other power control functions do.

Although a BMS or data center information management (DCIM) system doesn’t have the range of capabilities of that sophisticated power controls can provide, either the BMS or DCIM can play a role in protecting the emergency power system. For example, the power controls may send automatic alerts on system operation via e-mail, pager, or selected system alarms to the BMS or DCIM.

The design eliminated nine miles of wiring that would have been needed to connect the hospital’s 2,000 kW gensets and paralleling switchgear to more than 60 power transfer switches. The gensets and switchgear had to be located in a garage across the street from the hospital.

Junnaid Malik, electrical engineer with Cosentini Associates’ mission critical group, is using a similar self-healing ring topology for a prominent bank’s emergency power management system’s communications. “Self-healing means that communication happens both ways on both rings,” Malik explains. "One ring could be physically cut and the system could still communicate."

Geisinger Health System monitors crucial power generators through both its BMS and its security system. "We are monitoring emergency power at both locations 24 hours daily," explains Neuner. “So, if one misses the alarm, the other location will catch it before we experience power problems.”

Neuner says that Geisinger is constantly evaluating and improving its emergency power monitoring and control solutions. Though Geisinger’s current power monitoring and control system is reliable and redundant, Neuner and Schetroma regularly investigate new tools to make the health facility’s backup power as fail-safe as humanly possible.

“We are concerned at every level from the primary electricity feed to the endpoint with avoiding any single points of failure,” says Neuner. “There are many emergency power system tools to assure reliability and redundancy.”
Monitoring capabilities are an opportunity for most facilities

Monitoring is a primary line of defense against problems with the emergency/backup power system. But the survey results suggest that monitoring is an untapped opportunity for most facilities.

Monitoring applications often cover “from the minute electricity enters the building from the utility main line or lines to the last switchboard,” says McCarthy. But though extensive monitoring capabilities are available from some power controls, most existing systems lack important functions.

According to facility executives who participated in the survey, the most common monitoring applications are generator and transfer-switch status monitoring. But a significant number of facilities lack even those best-practices capabilities. And about half of facilities executives who don’t have specific monitoring capabilities see a need for those functions, according to the survey. (See Figure 5.) Those facility executives may well be looking for opportunities to improve monitoring.

BTC Management Corp. currently uses an energy management system to monitor control points of key equipment in its high-rise senior apartment buildings, according to Lionel Kier, executive director. “We are looking into a monitoring system and transfer switches to tie-in our cogeneration equipment,” says Kier.

The starting point for evaluating monitoring options is for the facility executive to pinpoint information needs. “Not every node needs a meter,” observes Malik. “You want to generate the data that is useful, so that the facility executive gets what he or she needs without overpaying for the system.”

In critical applications, meters can be synchronized down to one millisecond. This allows troubleshooting when an event occurs, according to the experts.

When problems happen, “things cascade very quickly,” says Toporek. “When you are doing forensics, you need fast and accurate time marks to track down where things went wrong.”

At Hartford Hospital in Connecticut, UPS monitoring is integrated with the power controls network, to provide remote monitoring. The hospital relies on IT capabilities to maintain electronic medical records and to record patient information in real time. “All of our clinical facilities have wireless access points for mobile computing devices to record data from the time they first see a patient,” explains Dave Rosicke, who oversees the medical center’s IT and communications networks. But with the advantages of wireless also come the problems that power disturbances and outages can cause.

<table>
<thead>
<tr>
<th>Monitoring Application</th>
<th>YES</th>
<th>No, and don’t need</th>
<th>No, but would like to have</th>
<th>Not Sure</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Status</td>
<td>57%</td>
<td>16%</td>
<td>18%</td>
<td>9%</td>
<td>855</td>
</tr>
<tr>
<td>Circuit Breaker Status</td>
<td>34%</td>
<td>25%</td>
<td>23%</td>
<td>18%</td>
<td>833</td>
</tr>
<tr>
<td>Transfer Switch Status</td>
<td>48%</td>
<td>16%</td>
<td>20%</td>
<td>16%</td>
<td>847</td>
</tr>
<tr>
<td>Power/Energy trending</td>
<td>34%</td>
<td>22%</td>
<td>24%</td>
<td>20%</td>
<td>829</td>
</tr>
</tbody>
</table>
Many control functions available

A wide range of capabilities enable facility executives to use sophisticated power controls to control and interact with equipment like generators and transfer switches. But many systems do not offer all of those capabilities. According to the survey, the most common control capability in systems today is stop/start. But 40 percent of respondents indicated that their systems do not offer stop/start capability. For the next most common capabilities — transfer control and making changes to settings — 52 percent and 60 percent of systems respectively do not provide those functions.

Deciding on which control strategies to implement requires understanding the business’ operational processes. “How much can be automated and how much requires manual intervention?” Fenlon-Harding asks. The decision, of course, depends on the design complexity of the mission critical facility.

Paralleling generator controls was important to CernerWorks Technology Centers. The company’s 100,000 square foot data center uses modified differential ground fault (MDGF) technology for the generator paralleling gear.

CernerWorks data centers manage patient records and other data for a number of hospitals in the United States, so “power reliability is one of our fundamental focuses,” according to Ron Mustard, senior director of CernerWorks.

MDGF offers selective coordination between the data center’s multiple generator breakers in the paralleling gear in all generator failure scenarios. For a center with three separate utility feeds that will have eight generators and top out at more than 13.5 megawatts at total build out, eliminating this single point of failure is critical. “Lives are at stake here so our systems must be available,” says Mustard.

Another controls issue to address is the compatibility of the control devices. “A particular control relay might not have the accuracy necessary to provide effective transfer functions,” explains Fenlon-Harding. “Best practices require making sure control devices can be synchronized for proper sequencing of power transfer. Even though they may be proprietary systems, it’s important that they can be integrated so that they can work with each other.”
Reporting capabilities can be crucial

When evaluating power controls options, facility executives should be aware of the range of reporting capabilities available from sophisticated power controls. For example, the reporting capabilities of power controls can help meet various regulatory requirements for mission critical facilities, such as the National Fire Protection Association’s NFPA 70, NFPA 99 and NFPA 110 requirements for hospitals, as well as Joint Commission reporting requirements to maintain accreditation.

The survey shows that the most common reporting capability is alarm reports, but even in that case, 43 percent of facility executives who responded say their system doesn’t offer that capability.

Geisinger Medical Center is phasing in reporting capabilities, says Schetroma. Currently five of the medical center’s fourteen generators are partially set up to provide reporting capabilities. “We do not have full communications yet, but we are moving that way,” Schetroma says.

For regulatory and accreditation officials, Geisinger Health System will keep both electronic reporting and paper log books for review, even after communications upgrades are fully commissioned. “Some reviewers still do not like to see computerized records for reporting and testing,” explains Neuner.

Some server farms, notably those using Sun Microsystems, have power factor requirements for their servers. IEEE standards also may come into play. “Reporting capabilities of CPMS can show building operators if power is out of those acceptable tolerances,” says Malik.

Event analysis and disturbance reporting can be used to provide data on the specific piece of equipment that failed, according to Fenlon-Harding. “That allows the facilities executive to go back to the manufacturer and point out that piece of equipment is not operating within its warranty.”

Co-location data centers can use the reporting function to report on any downtime as part of their service level agreements with tenants, observes Els. “Co-los can use those reports for marketing too.” For instance, the power controls reports may show that even when downtime occurred, tenants were back up and running within three seconds.

Using interfacing software, power controls reports also can provide information that can be used for accounting and operational expenses. “We actually are seeing some larger IT operations using the reporting function to meet accounting needs,” Els says.
Best practices: power quality analytics

Power quality applications of power controls are as unique as the businesses that are using them, say experts. For example, power quality analytics can be used to identify where a failure could have occurred and for prefunction testing to look closely at systems, their responses and to simulate transients, says Fenlon-Harding.

Post-event troubleshooting is another key function of power quality analytics. Why did the facility lose a particular breaker that tripped the PDU and caused a chain of events that caused a switchover to the UPS? “Was it an electrical spike, a floating ground or a short?” asks McCarthy. “There are so many different events that you need a recording scale that is fast enough to identify exactly what started the event within a very small time frame, often milliseconds.”

Facility executives should keep in mind that power quality analysis is very different than traditional monitoring. “For quality, you are looking at power harmonics, transients, high speed in milliseconds and accurate data,” says McCarthy.

Power quality analytics can also be used for trending and predicting growth, according to Malik. “You may want to know where you are experiencing current level voltage distortion,” he explains. “You may be a co-location facility and want to plan for growth by adding servers. Or maybe you are adding variable frequency drives to control energy costs. VFDs can cause distortion by chopping up incoming power quality. That distortion creates poor power quality for servers.”

McCarthy notes that putting forensic capabilities everywhere is not generally practical. Instead, he stresses identifying key locations and watching those carefully.

Power quality analytics are the leading edge of power control technology. Perhaps not surprisingly, the survey indicates that power quality analytics are less widely used than other power controls capabilities. What’s more, among respondents who said their systems didn’t have power quality capabilities, a lower percentage indicated a need for those functions than is generally the case with power controls capabilities as associated with monitoring, control and reporting.

Other Functions

Power controls can provide benefits beyond supporting the reliability of the emergency/backup power system. For example, in terms of operations, maintenance is more easily scheduled by bypassing units and swinging their loads to others in the emergency power system. What’s more, reports help with budgetary planning as well as document power reliability and other business benefits for co-lo tenants, according to Malik.

Power controls include both functional testing and ongoing commissioning, even when facilities are not required to perform monthly or periodic emergency power testing. “You want to test and retest to make sure everything is operating as it was designed and constructed,” Els says. Though power reliability is their primary function, power controls also can help with energy savings. For example, Fenlon-Harding sees the knowledge gained through such systems being used to transfer loads, optimizing utility peak demand loads. She sees that additional tier to traditional power monitoring and control systems as “more and more important.”

As useful as those additional functions can be, the primary benefit of power controls is the information it provides facility executives. Power controls offer high visibility into the power movements within a facility. It’s peace of mind, says Fenlon-Harding. “If an event happens, you can track what happened and fix it.” More importantly, it can enable facility executives to prevent problems in the first place.
Digital Realty has all its bases covered when it comes to monitoring and controlling emergency power at its 116 mission critical buildings worldwide. It is now looking at modernizing the systems, so the company’s technical operations division is talking to various power controls providers to find the proper fit as it completes a detailed needs assessment.

“As a general rule, you don’t want to go too fast at this stage,” points out Gary Coley, senior real estate manager for Digital Realty in Arizona. He recommends the team doing the evaluations be as diversified as possible. “You want lots of eyes and ears, so the team’s input is not limited in the final selections.”

Another aspect to evaluate at this stage is the working relationship with vendors, because the complexity of the system and its criticality mean things will not always perform as conceived. “The company relationship is almost as important as the products themselves,” says Coley. Facility executives should probe to find out how a vendor will handle any issues that may come up.

Flexibility is another crucial issue to examine, says Coley. “You don’t want your new system to paint you into a corner, so that you cannot use what you just bought because your business model changed,” he notes.

Digital Realty hopes to finish its needs assessment by the end of the first quarter, 2013. Once the assessment is complete, solutions identified will be tried in pilot facilities to make sure they perform as anticipated.

Before implementing power controls, experts advise beginning with a detailed needs assessment. “You need to identify what this business needs from its emergency power monitoring and control solution,” observes Caroline Fenlon-Harding, vice president of WSP Flack + Kurtz. “The needs assessment helps determine the level of system required and involves also understanding who’s watching the system, what happens when an event happens and how well equipped the facility is to respond to that event.”

“A co-location facility may be concerned about kilowatts but possibly less interested in power quality or branch circuit monitoring,” says Junnaid Malik, electrical engineer with Cosentini Associates’ mission critical group. “Another client may need very clean power, so waveform analysis will be essential. Each client is different. The role of the consultant is to make sure the facilities executive is getting the information he or she needs and not overpaying for that technology with data capabilities that will not be used.”

One critical issue is tolerance for downtime, says Herbert Els, vice president of WSP Flack + Kurtz IT design group. What is considered acceptable in downtime varies widely. Five minutes may be the maximum one enterprise can tolerate. Another may find eight hours to be tolerable. “It’s important to determine and document acceptable downtime,” notes Els.

The ASCO Power Monitoring & Control Survey was sent via email to a random sample of 15,000 Building Operating Management subscribers on August 2, 2012. Reminders were sent to non-respondents on August 7, August 10, August 14, and August 19, 2012. A total of 1,049 subscribers chose to opt out of the survey or failed to respond due to an invalid email address, yielding a final sample of 13,951.

The survey was closed for responses on August 21, 2012. With 991 qualified responses returned and with a net sample of 13,951, the rate of response for the email survey was computed to be 7.1 percent. The overall estimated margin of error for this study is +/-3.09 percent at the 95 percent confidence level.