Why Precision Timing Is Critical for Hospital Emergency Power Supply Systems in Hospitals

This blog post discusses electrical power monitoring systems (EPMS) testing using sequence of events recorders (SERs) and related equipment. It details why highly accurate time logging is not only necessary but also essential to fully understanding how, when, and perhaps even why events leading to a power outage occur.

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Having a safe, reliable, and continuous source of electric power is essential in a world that continues to undergo a digital transformation. Without power, organizations find themselves unable to properly support their customers and stakeholders. But even more daunting is the increased potential for damage to property and injuries to people when electric power is interrupted.

Various industries including healthcare, air transportation, amusement parks, data centers, and universities are all at elevated risk during a power failure because they each manage large groups of people. Hospitals, though, rank among those most in need of reliable emergency power because of the high potential for loss of human life.

Hospitals at Great Risk

Power outages have dramatically affected hospitals, hospital staff and patients in recent years. For instance, when Hurricane Sandy struck in 2012, power outages caused by flooding forced the evacuation of 6,300 patients from 37 healthcare facilities, residents, hospitals, nursing homes, and assisted living facilities. [4] The outages made it impossible to sterilize instruments and led to the loss of refrigeration and cooking in their cafeterias. Hospital staff could neither read X-rays and other diagnostic imaging nor register incoming patients. Transporting patients within the hospital became impossible with elevators out of service.

During the 2020 wildfires in California, Winters Healthcare had to choose between providing emergency electricity to its electronic health records or the refrigeration system that preserves vaccines and other drugs. They chose to preserve the health records and sent their refrigerated supplies to another hospital.

As Hurricane Laura approached Louisiana and Texas in August 2020, the Medical Center of Southeast Texas (MCST) transferred two-thirds of its patients to hospitals further inland in the state. Other hospitals in both states canceled elective surgeries and outpatient procedures, and MD Anderson Cancer Center shut down entirely for three days.

Between 2009 and 2017, the number of power outages affecting health-care organizations increased 24 percent. Even today, nearly one in five facilities (18 percent) suffers an outage at least once each month. More than one-third of those (36 percent) last an hour or longer, although even outages of a few seconds can damage sensitive medical equipment. Although it's difficult to detail all the effects a power outage can afflict upon hospital staff, management, and patients, the following are common effects: [3]

- Loss of HVAC systems disables heating, cooling, and ventilation.
- Respiratory devices, sterilization devices, and other critical equipment cease working, threatening patients in cardiac, intensive care, and neonatal units.

- Without lighting, high-risk surgical procedures must be postponed until power is restored or conducted with only emergency lighting.
- Water systems can lose pressure, rendering meal preparation and food service impossible and drastically curtailing personal hygiene measures.

Monitoring Is Essential

It's no surprise that facility managers and engineers are concerned about assuring a safe and continuous supply of electrical current to the critical areas of a hospital and its campus, so health-care professionals and staff can continuously deliver services following a power outage.

As part of their required compliance testing and emergency preparedness plans, hospitals test their emergency power supply systems (EPSS) monthly in accordance with their Authority of Jurisdiction's (AHJ) requirements to verify and document the emergency power system will perform as intended during an actual outage. Even with monthly testing, continuous monitoring is needed so that issues can be identified and corrected in advance that could result in a disturbance in power to critical loads.

Electrical power monitoring in hospitals is a form of predictive maintenance revealing how and where failures may occur before they do. Equally important, monitoring and recording real-time activity for later study allow forensic root-cause analysis after a power outage so management can take remedial steps to prevent future outages.

Sequence of Events Recorders

Hospital electrical systems are unlike most other commercial systems. They typically have several electrical supply points from the utility and the backup generators that are managed and controlled to provide reliable power to essential hospital loads. Certain areas within the system are considered "critical" because the extremely high risk to human life during an outage requires extra attention for these areas' proper operation.

Sequence of events recorders (SERs) allow monitoring of the entire, complex electrical system in real-time to generate and record alerts when fault conditions are detected. SERs provide system-wide precision time synchronization to all connected intelligent devices. They capture the state change of device inputs such as circuit breakers, automatic transfer switches, protective relays, UPS switching, and other devices, and they provide a time stamp at 1 mS intervals for state changes that occur in up to 32 such devices per SER.

A short, 1 mS frame is needed because many events occur asynchronously and with durations that can be far less than the 16.7 mS (duration of one power cycle). Capturing these state changes with highly accurate timing provides the information required during post-event analysis to pinpoint the root cause of the incident. Highly accurate timing verifies the proper operation of electrical equipment and provides insight on prevention of future occurrences. Other systems that might be used in a hospital facility, such as the building management system (BMS) typically don't record power system events or those that do record at a rate much slower and determining an accurate sequence of events is not possible.

However, to achieve 1 mS resolution, each SER deployed in an electrical power monitoring system (EPMS) relies on an internal time clock accurate to 100 μS or better. In turn, the onboard clocks in each SER need a method for synchronizing with an authoritative time signal. Commonly used GPS/GNSS, NTP, and similar time signals do not provide sufficient accuracy.

For greater accuracy, the IEEE 1588 standard outlines a method for synchronizing clocks connected in an Ethernet network using precision time protocol (PTP). A typical hospital EPMS uses several SERs, one of which is designated by the best master clock (BMC) algorithm as the "grand master" to which "slave" clocks in other SERs synchronize. The BMC engages all the clocks in an ongoing interchange that maintains synchronicity. The algorithm can even designate a new grand master if the original cannot perform its role.

SERs Deliver the Results Management Seeks

Cyber Sciences' CyTime Sequence of Events Recorder uses PTP to ensure that system performance can be documented and managed month over month and year over year. SERs provide direct evidence that components of the EPMS are performing as they should—or not. With timing accurate to within 0.5 mS across the hospital's entire electrical system, management can easily verify the electrical power supply system is working as it should. Or, if it is not, the SERs can pinpoint the cause of malfunction or failure. Yet to manage a complex hospital electrical system, managers need one more key component.

Event Manager

The CyTime Event Manager gives management the ability to view and monitor I/O status from multiple SERs in one easy-to-understand web interface. It also allows users to consolidate events from all downstream SERs pertaining to a single incident, providing powerful event reconstruction analysis. This valuable resource can help identify power loss events more quickly, saving time and money for power restoration in critical power applications. With each SER capable of monitoring up to 32 inputs, the Cyber Sciences solution can handle even the most demanding and complex hospital electrical system.

The Cyber Sciences CyTime Event Manager offers a simple setup using a standard web browser and unlimited monitoring of any number of SERs from a browser. For example, every SER in the network is displayed with its name, IP address, and four clickable buttons. Those allow updating firmware on any SER in the network, configuring time synchronization settings, input/output settings, and managing passwords for all connected SER devices.

Summary

Cyber Sciences, Inc., manufactures high-quality specialty products for monitoring and control of electrical distribution systems for data centers, hospitals, microgrids, alternative energy, and other critical-power facilities. Key applications include SERs and time synchronization, helping customers ensure the reliability, safety, and efficiency of their electrical power systems. As a component supplier, Cyber Sciences enables OEMs, systems integrators, and solution providers to complete their own comprehensive solutions for their end customers.

To learn more about emergency power supply system testing and monitoring for your hospital, go to: https://www.cyber-sciences.com/healthcare/ or contact us for further information.

Sources

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