Is your back-up power ready?

By Michael Stout

Prior to Hurricane Katrina, most hospitals and emergency medical facilities trusted their back-up generators to provide long-term power protection. But when basements flooded, New Orleans' hospitals were without power for days. Critical life-support, operating-room, laboratory, communications, and data services shut down. As a result, The Joint Commission (TJC) issued a sentinel event alert on Sept. 6, 2006, stating that electric power is a mission-critical resource. Citing the range in magnitude and impact of power failure from relatively modest curtailment to catastrophic regional blackouts attributable to a violent storm or terrorist attack, TJC further stated that meeting National Fire Protection Agency codes and standards are only a start and issued a new standard, EC.7.40, in addition to existing standards EC.7.10 and EC.7.20. Responsibility for enacting the new standards was assigned to each facility's management and engineering staff. [For details of changes and suggestions for proactively assessing a facility's vulnerabilities, go to *www.nfpa.org/index.asp?cookie%5Ftest=1*.]

During a power outage, there is a lag of several seconds while the generator(s) turns on. This is often disruptive to analyzers, gas chromatography/ and liquid-chromatography/mass spectrometry, centrifuges, computers, data-storage systems, network devices, and other microprocessor-based equipment sensitive to power pollution and blackouts, and which demand a constant flow of clean, regulated alternating current (AC) power. Incorporating on-line uninterruptible power systems (UPSes) is an essential extra layer of protection. The on-line UPS provides no-break battery back-up during generator start-up. It regenerates clean, tightly regulated power when operating from utility or generator sources, removing unwanted frequency drift, voltage transients, and harmonics. Examining different types of UPS topologies and selecting an on-line UPS can ensure reliable operation of critical lab equipment when utility- or generator-power quality is at its worst.

The Institute of Electrical & Electronic Engineers defines UPS topologies as off-line, line-interactive (hybrid), and dual-conversion online, whose differences is often not clearly understood; 90% of UPSes on the market are off-line or line-interactive, are low-cost, and address basic backup needs of home PCs and office desktops. Utility or generator power is fed directly through these until power is lost. Then the switch-over to a battery-powered inverter creates a 10- to 20-millisecond power dropout, which can be very disruptive to sensitive equipment. Moreover, the AC output created during battery operation is quasi- or modified (not true) sinewave AC power and can disrupt the operation of and even damage sensitive laboratory and hospital equipment.

The line-interactive or "smart" UPS incorporates a boost/buck transformer that senses incoming utility or generator voltage and automatically switches transformer taps, attempting to regulate the UPS' output voltage, or automatic voltage regulator (AVR) feature. The AVR provides a crude method of output voltage regulation — typically, ±8% to ±12%. Worse, the UPS has to switch to battery mode every time the AVR has to switch transformer taps, adding voltage dropouts to the mix. This "band-aid" approach often causes more problems if used with lab instruments. The AVR can also result in a greatly reduced battery life in locations with constantly changing utility voltages due to overcycling of batteries.

Again, the dual-conversion on-line UPS regenerates totally new sinewave power both in utility and battery back-up modes. It converts the incoming AC power to filtered and regulated direct current (DC), which is continuously supplied to a high-quality, pulse-width-modulated (PWM) inverter that regenerates clean, new tightly regulated AC power. This active approach assures superior ±2% output voltage regulation and provides the highest level of power conditioning demanded by sensitive lab and hospital equipment.

In contrast to off-line and line-interactive UPS designs, the on-line UPS only uses battery power when utility power is not present. Therefore, battery life is typically much longer. The on-line UPS has no disruptive switch-over drop when utility power is lost or restored. Most also provide input power factor correction that reduces harmonics that may adversely affect building wiring and other equipment operating inside a lab. Another feature available with some on-line UPSes is galvanic isolation, which eliminates neutral-to-ground and common mode noise paths as well as ground loops by electrically isolating the instrument to increase accuracy and data-communications reliability.

On-line UPSes are available in small portable form factors in sizes ranging 1kVA unit to 40kVA units that may be used to protect individual or multiple pieces of equipment distributed throughout a facility. Some are available in large permanently mounted form factors in sizes from 40kVA to several hundred kVA that are capable of powering the entire facility. Installing one large on-line UPS to protect an entire facility may still leave power-sensitive equipment unprotected from localized power-pollution problems. Other large motors, pumps, photo copiers, X-ray, magnetic resonance imaging systems, and other equipment having a high intermittent power demand located throughout a facility are often a source of localized power pollution. As the sensitive equipment is connected to the output of the large centralized UPS, the disruptive equipment can cause voltage sags and swells in addition to high-voltage transients.

Since many on-line UPS models have DC-start functions and an inverter rated for continuous or sustained duty, they may be packaged on a portable cart with large extended battery banks to provide from 20 minutes to several hours of emergency AC power for essential equipment in the event utility and generator power is not available.

Many hospital and emergency medical facilities are backing up medical and billing data in real time off-site over the Internet or over dedicated data lines. Any disaster plan must include adequate back-up time to assure the data transfer is completed successfully. Multiple on-line UPS units with enough battery back-up time to power every piece of equipment (e.g., computers, servers, networks, routers, and data-line equipment) in the system is mandatory. Back-up generators alone are not dependable for this critical function.

In every lab, accurate results are mandatory. In law enforcement forensics DNA testing, a sample may be limited to a one-time attempt at obtaining accurate results. A momentary loss of change in utility voltage may result in the "bad guy" being put back out on the streets. The integrity and security of patient records and e-mails is mandated by law and is only as secure as a facility's computers, servers, networks, and off-site back-up systems.

Meeting these mandates will not only include the assurance of multiple power sources for a facility's network but also will include an assessment of the local telephone company and ISP's ability to continue to support reliable service during disaster scenarios. As one New Orleans hospital found out, there is no substitute for a standard Plain Old Telephone Service, or POTS, line powered by the telephone company's back-up batteries. When all of its T1 and fiber lines went down, the POTS line and a laptop with an acoustic modem saved the day.

When creating and implementing any disaster plan for facility power, implement as much redundancy as possible, an assessment of which should extend outside the facility to the local power utility, telephone company, and ISP. Multiple utility and generator sources are a good first step but must be supplemented by permanent and distributed high quality. ☐

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