Backup Power:

Benefits to Expect from a UPS

BY JAMES MCNAMARA

For many companies across the Northeastern United States and Canada, the summer 2003 blackout raised concern about the need for backup power in support of critical processes and systems. Elsewhere, the blackout was motivation to assess the effectiveness of the backup systems they already had, leaving those facility managers either relieved or dismayed when their systems were put to the test.

In the world of backup power, there has traditionally been only one option for safeguarding against power outages and the costly results they inflict: an uninterruptible power supply (UPS) with standby diesel generators. In recent years, however, on-site power systems configured for critical load support (CLS) have emerged as a second—and, in many ways, more beneficial—option. As more and more businesses consider CLS technologies, they should be sure to consider a number of different economic, application-specific, and site-specific factors to determine which solution is going to be most appropriate and effective.

Economics

A 2001 study by EPRI and the Electricity Innovation Institute estimated that industrial and digital economy firms lose $45.7 billion annually to utility outages. How these losses materialize is highly variable and industry dependent. Some companies experience no appreciable product or material loss from short-term outages but count losses in tens to hundreds of thousands of dollars if they have to send employees home. For digital economy (DE) and continuous process manufacturing companies (CPM), a disturbance lasting even a fraction of a second can result in the loss of valuable data or the disruption of sensitive processes creating lost product, lost productivity, damage to equipment, and expensive downtime for repairs.

The business and technology consulting firm Mirifex, the Center for Regional Economic Issues at Case Western Reserve University's Weatherhead School of Management, and CrainTech, surveyed 129 executive-level business and other organizational managers in Ohio, New York, Pennsylvania, Michigan, Wisconsin, and Southern Canada and documented the very real economic consequences from the blackout. Among the key results were the following:

• 66% of the businesses surveyed lost at least a full business day due to the blackout

• 24% of the businesses surveyed lost more than $50,000 per hour of downtime—which would result in losses of more than $400,000 for an 8-hour day. And 4% of businesses lost more than $1 million for each hour of downtime

• 46% of the businesses surveyed said lost employee productivity was the largest contributor to losses suffered due to the blackout

• production/manufacturing and customer sales/service were the areas of business hardest hit by the blackout

In a beverage manufacturing plant, this critical load support system is designed for combined heat and power (CHP), delivering approximately 70% of the plant's electricity and 30% of its hot water needs.

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Against these quantifiable and unquantifiable costs, the investment in a backup power system and the economic benefits of reliable, 24/7 power become quite a bit clearer.

UPS/Standby Diesel

As a sort of power insurance policy, a UPS provides continuous power for short time periods when utility-supplied power fails. Because they are very expensive and occupy large areas, these systems are best deployed to provide seamless support to only the most sensitive of loads for very short periods.

Though these systems are tried and proven, they are not perfect. The battery banks required to support a large load are massive and expensive, as can be the often-valuable floor space given over to them. Batteries also require constant monitoring and replacement. Failure can be precipitous, and a battery can go from fully serviceable to failed in as little as one week.

Battery banks for a UPS are typically sized to provide 15-45 minutes of continuous operation. In general, every 100 kW of UPS capacity requires about 1 ton of batteries. As 90% of utility disruptions are 15 seconds (sec) or less, UPS systems will provide reliable ride through of these short-term disturbances. If a utility disruption lasts longer than 15 sec, a signal will be sent to the standby diesels, so that it will start, synchronize, and connect to the load within 20 sec. In a properly designed system, transfer to the backup gen sets occurs seamlessly and well before the UPS batteries are fully drained.

To guard against catastrophic failure, batteries must be tested and maintained on a regular basis.

"Batteries are the bane of our existence," says Alan Katz, segment manager for MGE UPS Systems, a company with thousands of customers in the massive area affected during the 2003 blackout. Katz notes that 99% of UPS failures are due to the chemical batteries that support them, because, unfortunately, battery technology hasn't progressed much in more than 100 years. "Lack of battery maintenance was the only thing that caused our equipment to fail during the outage," says Katz. Disposing of old batteries also poses an additional cost as well as creating environmental problems.

Beyond batteries, standby gen sets can also be a weak link in a typical UPS system. Though most undergo regular testing, many fail to start or to properly connect to the load when needed.

Backup Power:

Another problem, which became evident to many companies that relied on UPS systems during the blackout, is that a gen set may have limited on-site fuel storage, a limitation that can cause great competition for re-fueling services during such a widespread long-term outage.

Finally, while most of these systems do pay off when called upon, they take up space and consume maintenance dollars the rest of the time.

CLS Approach

By contrast, combined heat and power systems configured for CLS can operate in continuous parallel with the utility-delivered power to provide functionality beyond simple backup power. Equally important, CLS systems can generate savings for their owners every day.

For example, a CLS system at a manufacturing plant could be designed for combined heat and power (CHP), providing not just power to equipment, but also process steam and/or heating and cooling for the facility. The result is a multi-tasking system that can offset the cost of otherwise meeting those facility needs, thereby enhancing the payback of the project.

In addition, CLS systems that provide CHP are inherently more efficient and therefore may qualify for energy-efficiency incentives in states like California, Massachusetts, New York, Connecticut, and New Jersey; which may also significantly reduce payback periods. In areas with high spark spreads, a CLS system can often pay for itself in less than four years.

In a CLS approach, critical loads are fed from a common bus with dual power supply from the utility and the on-site generation. Should a utility outage occur during normal operation of the generator, the utility multifunction relay opens the utility tie breaker in as few as three cycles, separating the critical load bus seamlessly from the rest of the facility and failed utility. The generator continues to power critical loads after the separation. The controls will monitor for, detect, and verify stable utility voltage and automatically synchronize and re-close the utility tie breaker, returning to normal grid parallel operation once again in a seamless fashion. The CLS architecture has the following advantages:

• Increased power reliability. The generating asset in the CLS approach is already up and running and does not need to be called upon to start and connect. When running in parallel with the utility, the critical loads have the benefit of the combined reliability of both the utility and the on-site generator. It would take the coincident failure of both to lose power supply to critical loads.

• Lower life-cycle costs and smaller footprint. CLS systems have lower life-cycle costs than a large UPS system with backup gen sets and do not use large arrays of costly stationary batteries with their maintenance, limited life, and replacement costs. Designed and installed as part of an integrated controls package, the economics of installing a facility CLS system tend to be more favorable than they would be for an isolated effort.

• Continuous savings stream. Generating in parallel with the utility delivers significant cost savings through on-site production of power and heat.

• Fuel supply reliability. CHP systems typically use natural gas fired engines or turbines, which will have an uninterrupted fuel supply during a prolonged utility outage. They can also be configured for dual-fuel operation allowing them to run on stored fuel in the event of a concurrent disruption to the natural gas supplies.

The CLS system controls sense utility disturbances in a fraction of an electrical line cycle and open the utility breaker to isolate critcal loads from the failed utility. It takes 3-5 electrical line cycles (50 – 80 milliseconds) to open the utility breaker. This separation is typically not detectable to facility operations. The generator carries critical loads through the utility outage. Parallel operation with the utility resumes automatically and seamlessly after utility power is restored.

Depending on the condition causing the utility outage, the generator may momentarily "see" a utility fault and/or other utility-connected loads, and it must recover from a possible short duration overload. During this time, power quality within the Computer and Business Equipment Manufacturers Association (CBEMA) curve is not assured as the protected loads will experience a let-through transient, a voltage sag for several cycles in duration and magnitude, depending on the fault condition. If power quality within CBEMA standards must be absolutely guaranteed in all fault cases, additional power conditioning will be applied. The CBEMA curve is the Information Technology Industry Council's (fomerly the Computer and Business Equipment Manufacturers Association) definition of the voltage envelope which typically will not cause interruption of most IT equipment.

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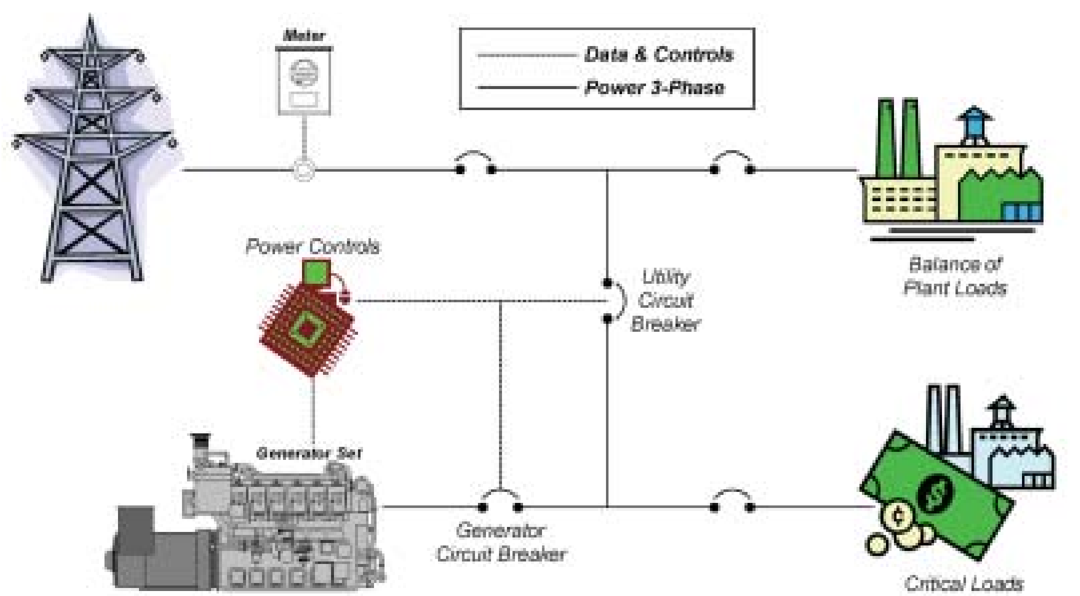

Critical load support systems augment utility-generated power to ensure a continuous power supply, delivering substantially enhanced reliability for essential business processes.

Intelligent Integration

Protective functions must be present to prevent adverse affects on the utility grid. These features must be designed to meet the specific requirements of each distribution system. The major objectives are that the distributed resource (DR) contribution to a fault on the distribution system is limited, that the generator does not adversely affect distribution system protection coordination and that the DR does not conflict with utility fault clearing schemes.

Intelligent integration of protective relays and circuit breakers with the cogen control system are the key to allowing the critical load support concept to work safely in parallel with the utility grid. Equipped with a digital utility multi-function relay, the system is capable of detecting a utility failure within several alternating current cycles and supporting a defined critical load during the outage. Most distribution systems faults are temporary and can be cleared by interrupting power and extinguishing an arcing fault.

Utilities typically employ reclosing schemes in which the power source is interrupted and restored usually from within several cycles to several seconds. When the distribution is interrupted, the DR must come offline to extinguish the fault and preclude the utility from reclosing the generator while out of synchronization, which can destroy or damage generation and/or distribution equipment. The CLS system is designed to isolate within 3-5 cycles when the distribution is interrupted and remain isolated until acceptable utility parameters are again detected, thus avoiding damage caused by asynchronous reclosure.

Conclusion

Though the flurry of activity and interest in backup power subsided in the later months following the August 2003 blackout, concerns about the reliability of grid power are as valid and as serious now as they were immediately following the event. Businesses, particularly those in the manufacturing and digital economy segments, must be proactive in reinforcing their current power sources if they want to avoid significant losses from spoiled product, damaged equipment, employee downtime, and, in some cases, lost customers.

Few power systems experts will dispute the value of using traditional UPS for protecting small and extremely sensitive loads (less than 3 cycles), or for short duration outages. But for many applications, an on-site power system configured for CLS can offer benefits far greater than simple backup power, including lower life-cycle costs, smaller environmental footprint, greater fuel flexibility and in areas with high spark spread, a continuous savings stream that can pay for the system in four years or less. ***eun***

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